

添付 18: マングローブ・アクション・ リサーチ技術ガイドライン



**The Integrated Mangrove Rehabilitation and Management Project
through Community Participation in the Ayeyawady Delta**



Technical Guideline for Action Research of Mangroves in the Ayeyawady Delta



March 2013
Forest Department (FD)
JICA Expert Team (JET: Nippon Koei)

Introduction

- JICA provided technical assistance “The Integrated Mangrove Rehabilitation and Management Project through Community Participation in the Ayeyawady Delta” from 2007-2013 and implemented by FD.
- The results and technical findings are summarized in “Technical Report for Action Research of Mangroves in the Ayeyawady Delta”.
- Based on the report, possible technical essentials of mangrove forestry are compiled in this guideline.



Mangrove Forest in Kadonkani
Reserved Forest

- **However, since only results of initial few years of action research were reflected and utilized, the information provided in this guideline is intermediate results and not final conclusions nor recommendations yet.**
- Forest Department (FD) has a responsibility for management and rehabilitation of reserved forests in the delta. Therefore FD is expected to further verify and apply the techniques into FD plantations and Community Forestry (CF) activities using this guideline.

Objective

- This guideline mainly targets FD frontline staff and provides some of the probably applicable techniques and information for sustainable mangrove rehabilitation and management in the delta.



Mangrove Plantation in
Kyakankwinpauk Reserved Forest



Nypa Forest, Pyinalan Reserved Forest,
Laputta Township

Usage

- This guideline consists of three technical areas as shown in the table of contents. You can refer to whichever area you need and apply the techniques as indicated.
- You can easily find important points and remarks of the contents with their marks as shown below. Please pay attention to these marks and its explanations because they indicate key information in applying the techniques in the field.

Legend



This mark describes findings and issues through the project experience as reference.



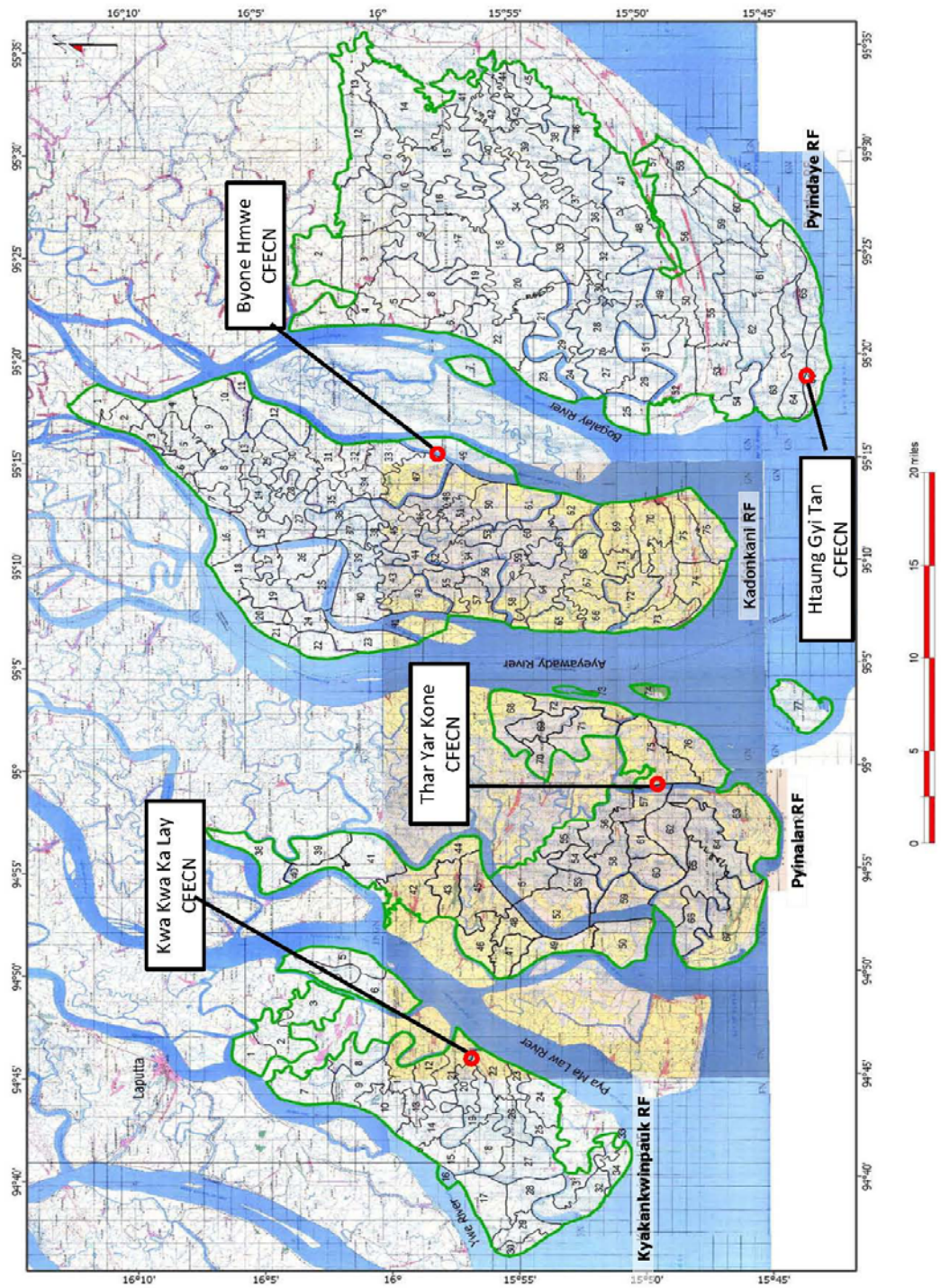
Please see the **Technical Report** to get more detail information

***Let's Utilize this Guideline for
Sustainable Mangrove Rehabilitation and Management
in the Ayeyawady Delta !!!***

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Location Map (Target Reserved Forests)



Abbreviations

Abb.	Contents
ARP	Action Research Plantation
CF	Community Forestry
C FECN	Community Forestry Extension Center and Nursery
FC	Forest Compartment
GIS	Geographic Information System
GPS	Global Positioning System
IMMP	Integrated Mangrove Management Plan
JICA	Japan International Cooperation Agency
KADK	Kadonkani RF
KKKP	Kyakankwinpauk RF
PNDY	Pyindaye RF
PNLN	Pyinalan RF
RF	Reserved Forest

Unit Conversion Table

Item	Unit in Myanmar	Metric Units
Length	1 inch	2.54 cm
	1 foot	0.305 m
	1 mile	1.609 km
	1chain =66 feet	20.13 m
	1 furlong =10chains	201.3 m
Area	1 acre	0.405 ha
	1 square mile =640 acres	2.59 km ²
	1 square feet	0.11 m ²

1. Silvicultural Techniques(1/8)

1.1 Introduction

In this guideline, **Silvicultural Techniques** means “adaptable/applicable species for mangrove forestry” and “applicable plantation techniques, particularly, proper spacing and land treatment by species” to be introduced in the delta. However, since only results of initial few years of action research were reflected and utilized, the information provided in this section is intermediate results and not final conclusions nor recommendations yet.

Report
Vol.1

Please see Technical Report for the details. You can find results of twelve Action Research Plantations (ARPs) . It summarizes tree growth (tree height) and survival rate by specie, spacing, treatment and location.



Mangrove Seedlings at Thar Yar Kone CFEEN, Pyinalan RF, Laputta Township



Established Mangrove Plantation, Kadonkani RF, Bogalay Township



Plantation with Mound Treatment, Kadonkani RF, Bogalay Township



Mangrove Plantation in Pyindaye Reserved Forest, Pyar Pon Township

1. Silvicultural Techniques(2/8)

1.2 Usage of Mangrove and Non-Mangrove Species in Delta

The following table summarizes major usages of Mangrove/Non-mangrove Species in the delta. It helps you to select species for objective-wise plantation establishment.

No.	Scientific Name	Major Usage of Tree in the Delta					
		Medicine	Food	Firewood	Charcoal	Pole	Others
1	<i>Aegiceras corniculatum</i>			+	+		
2	<i>Amoora cucullata</i>			+	+		
3	<i>Avicennia alba</i>	Leaf	Fruit	+	+	+	
4	<i>Avicennia marina</i>	Leaf	Fruit	+	+	+	
5	<i>Avicennia officinalis</i>	Leaf	Fruit	+	+	+	
6	<i>Bruguiera gymnorhiza</i>			+	+	+	
7	<i>Bruguiera sexangula</i>			+	+	+	
8	<i>Ceriops decandra</i>	Bark		+	+	+	
9	<i>Excoecaria agallocha</i>	Hard wood		+		+	
10	<i>Heritiera fomes</i>			+	+	+	
11	<i>Lumnitzera racemosa</i>			+	+	+	
12	<i>Kandelia candel</i>			+	+	+	
13	<i>Nypa fruticans</i>	Resin	Fruit				Thatch
14	<i>Rhizophora apiculata</i>			+	+	+	
15	<i>Rhizophora mucronata</i>			+	+	+	
16	<i>Sonneratia apetala</i>		Fruit	+	+	+	
17	<i>Sonneratia caseolaris</i>			+		+	
18	<i>Sonneratia griffithii</i>			+		+	
19	<i>Xylocarpus moluccensis</i>	Fruit		+	+	+	
20	<i>Heritiera littoralis</i>			+	+	+	
21	<i>Phoenix paludosa</i>		Shoot	+		+	
22	<i>Acacia mangium</i>			+		+	
23	<i>Melaleuca leucadendra</i>					+	

Note: + is Stem/branch



Information in this page is collected mainly in the interview of villagers in Pyindaye Reserved Forest(RF). The major usage and needs might be slightly different in other villages/RFs. If you promote CF activities, you are requested to confirm suitable species which match objectives and usages by the villagers in the target area.

1. Silvicultural Techniques(3/8)

1.3 Indicative Adaptable Species for Mangrove Forestry in Delta

Though it was not fully possible to identify relationship between absolute ground level and mangrove habitats during the project, following table more or less indicates general tendency of species – site matching in the delta . This table is inferred from results of Action Research Plantation(ARP) in the project, result of Integrated Mangrove Management Plan (IMMP) study, and empirical experience of FD personnel. **The table may serve you as indicative reference for species selection in consideration of tidal inundation (ground level).**

No. of days of tidal inundation per month during dry season	Indicative Adaptable Mangrove Species	
all high tides (at least 20days /month)	<u>High saline water</u> <i>Kandelia candle</i> , <i>Avicennia alba</i> , <i>Avicennia marina</i> , <i>Sonneratia apetala</i> , <i>Aegiceras corniculatum</i>	<u>Low saline water</u> <i>Kandelia candle</i> , <i>Nypa fruticans</i> , <i>Rhizophora apiculata</i> , <i>Sonneratia apetala</i> , <i>Sonneratia caseolaris</i> , <i>Avicennia officinalis</i>
medium high tides/every start of spring tides (10-19 days/month)	<i>Nypa fruticans</i> , <i>Rhizophora apiculata</i> , <i>Sonneratia griffithii</i> , <i>Sonneratia alba</i> , <i>Ceriops decandra</i> , <i>Bruguiera gymnorhizza</i> , <i>Bruguiera sexangula</i> , <i>Avicennia officinalis</i> , <i>Aegiceras corniculatum</i>	<i>Brownlowia tersa</i> , <i>Ceriops decandra</i> , <i>Bruguiera gymnorhizza</i> , <i>Aegiceras corniculatum</i> , <i>Avicennia officinalis</i> , <i>Heritiera fomes</i> , <i>Rhizophora apiculata</i>
every normal high tides/mid spring tides (3-9 days/month)	<i>Ceriops decandra</i> , <i>Bruguiera spp.</i> , <i>Heritiera fomes</i> , <i>Amoora cucullata</i> , <i>Xylocarpus granatum</i> , <i>Xylocarpus mollucensis</i> , <i>Aegilites rotundifolia</i> , <i>Avicennia officinalis</i>	
every spring high tides (at least 2days/month)	<i>Heritiera fomes</i> , <i>Xylocarpus mollucensis</i> , <i>Xylocarpus granatum</i> , <i>Excoecaria agallocha</i> , <i>Amoora cucullata</i> , <i>Phoenix paludosa</i>	
4 times in dry season by equinoctial abnormal high tides	<i>Phoenix paludosa</i> , <i>Cynometra ramiflora</i> , <i>Hibiscus tiliaceus</i> , <i>Clerodendrum inerme</i> , <i>Lumnitzera racemosa</i> , <i>Myet-kha grass</i> (<i>Heritiera fomes</i> , <i>Excoecaria agallocha</i>)	
only flooded by rain water during rainy season	<i>Phoenix paludosa</i> , <i>Hibiscus tiliaceus</i> and non-mangrove species (<i>Melaleuca leucadendron</i> , <i>Casuarina equisetifolia</i>)	

Note: Modified based on the results of IMMP study (JICA, 2002-2005)

1. Silvicultural Techniques(4/8)

1.4 Objective-wise Probably Applicable Forestry Operations in Delta

Based on results/ findings from the project, IMMP study and FD's past experience, though indicative, following objective-wise silvicultural operation can be considered in delta. **Since, only results of initial few years of plantation growth were reflected, tables below were not finalized and appropriate to use only for reference purposes as of March 2013.**

a. Protection Forest

Objective	Goal	Ground level	Probably Applicable Species	Possible Spacing	Expected Height (ft)	Expected Years to attain height (year)
1: Protection Forest	River bank erosion prevention	Low	<i>Rhizophora apiculata</i> , <i>Avicennia officinalis</i>	3'x3', 6'x6'	10-20	3-5
		Middle	<i>Bruguiera gymnorhiza</i> , <i>Bruguiera sexangula</i> , <i>Avicennia officinalis</i>	Ditto	10-20	5-8
		High	<i>Heritiera fomes</i>	Ditto	10	8
		High	<i>Clerodendrum inerme</i> , <i>Melaleuca leucadendron</i> , <i>Casuarina equisetifolia</i>	Ditto	10-20	5
	Costal erosion prevention	Low	<i>Avicennia marina</i> , <i>Rhizophora apiculata</i> , <i>Avicennia officinalis</i>	3'x3', 6'x6'	10-20	5
		Middle	<i>Bruguiera gymnorhiza</i> , <i>Bruguiera sexangula</i> , <i>Avicennia officinalis</i>	Ditto	10-20	5-8
		High	<i>Avicennia alba</i> , <i>Clerodendrum inerme</i> , <i>Melaleuca leucadendron</i> , <i>Casuarina equisetifolia</i> ,	Ditto	10-20	5
	Windbreak	Low	<i>Avicennia marina</i> , <i>Rhizophora apiculata</i> , <i>Avicennia officinalis</i>	6'x6'	10-20	5
		Middle	<i>Bruguiera gymnorhiza</i> , <i>Bruguiera sexangula</i> , <i>Avicennia officinalis</i>	6'x6'	10-20	5-8
		High	<i>Melaleuca leucadendron</i> , <i>Casuarina equisetifolia</i> , <i>Acacia spp.</i>	6'x6'	20	5



Mangrove Tree (*Heritiera fomes*)



Mangrove tree (*Avicennia officinalis*)

1. Silvicultural Techniques(5/8)

1.4 Objective-wise Probably Applicable Forestry Operations in Delta

b. Production Forest

Objective	Species Category	Ground level	Probably Applicable Species	Possible Spacing	Expected Height (ft)	Expected Years to attain height (year)
1: Firewood , pole and post Production by Plantation	Mangrove species	Low	<i>Sonneratia apetala</i> , <i>Avicennia officinalis</i> , <i>Rhizophora apiculata</i>	3'x3' 6'x6'	12ft	5
		Middle	<i>Bruguiera sexangula</i> , <i>Bruguiera gymnorhizza</i> , <i>Xylocarpus mollucensis</i>	6'x6'	10ft	5
		High	<i>Excoecaria agallocha</i> , <i>Lumnitzera racemosa</i>	6'x6'	10ft	5
	Non-mangrove species	High	<i>Avicennia alba</i> , <i>Melaleuca leucadendron</i> , <i>Casuarina equisetifolia</i>	3'x3' 6'x6'	20ft	5
2: Log/Timber Production by Plantation	Mangrove species (medium growing)	Low	<i>Avicennia officinalis</i> , <i>Sonneratia alba</i>	6'x6'	50-60ft	20
		Middle	<i>Bruguiera sexangula</i>	6'x6'	40ft	30
		High	<i>Intsia bijuga</i>	6'x6'	45ft	30
	Mangrove species (slow growing)	Low	<i>Rhizophora apiculata</i>	6'x6'	45ft	35
		Middle	<i>Heritiera fomes</i>	6'x6'	40ft	40
		High	<i>Heritiera fomes</i>	6'x6'	40ft	40
3: Log/Timber Production by Natural Regeneration	Mangrove species	Low	<i>Ceriops decandra</i>	-	25ft	35
		Middle	<i>Bruguiera sexangula</i>	-	45ft	35
		High	<i>Xylocarpus granatum</i>	-	45ft	40
4: Charcoal Production by plantation	Mangrove species	Low	<i>Rhizophora apiculata</i>	3'x3' 6'x6'	30ft	10
		Middle	<i>Ceriops decandra</i> , <i>Bruguiera sexangula</i> , <i>Bruguiera gymnorhizza</i>	3'x3' 6'x6'	10ft	15
		High	<i>Cynometra ramiflora</i>	3'x3' 6'x6'	10ft	15
5: Nypa Production by plantation	Nypa	Low	<i>Nypa fruticans</i>	6'x6'	7ft	3

1. Silvicultural Techniques(6/8)

1.5 Key Probably Applicable Techniques

1.5.1 Probably Applicable Species for Plantation

a. Mangrove Species

From only few years of action research trial, it is still too early to make conclusion for applicable species. However, following tree species have been tentatively identified as probably applicable species according to the purposes of plantation.

Main Purposes of plantation	Species (Category)
Firewood , Charcoal, poles, post	<i>Sonneratia apetala</i> , <i>Avicennia officinalis</i> , <i>Rhizophora apiculata</i> , <i>Bruguiera sexangula</i> , <i>Bruguiera gymnorhiza</i> , <i>Xylocarpus mollucensis</i> , <i>Heritiera fomes</i> , <i>Excoecaria agallocha</i> , <i>Lumnitzera racemosa</i> , <i>Rhizophora apiculata</i> , <i>Ceriops decandra</i> , <i>Cynometra ramiflora</i>
Nypa thatch/juice	<i>Nypa fruticans</i>
Log/Timber	<i>Avicennia officinalis</i> , <i>Sonneratia apetala</i> , <i>Intsia bijuga</i> , <i>Ceriops decandra</i> , <i>Bruguiera sexangula</i> , <i>Xylocarpus granatum</i> , <i>Rhizophora apiculata</i> and <i>Heritiera fomes</i>



Nypa Thatch Production in Gaw Du village, Pyar Pon Township

b. Non-Mangrove Species (Fast Growing Species)

The purpose of introducing non-mangrove species into the delta is i) to utilize fast growing species to accommodate villagers' needs toward forest products (poles, post, fire wood, and etc.), and ii) to utilize for tree cover establishment and rehabilitation where existing mangrove species are difficult for growth and survival.

Species	Suitable treatment
<i>Casuarina equisetifolia</i>	Mound treatment is preferred for Ce plantation in the delta. However, the effect of mound treatment is limited in low ground sites where tidal level exceeds the mound level.
<i>Melaleuca leucadendron</i>	Mound treatment is preferred for MI plantation. Line mound is more effective than spot mound for tree growth and its survival. However, the effect of mound treatment is limited in low ground sites where tidal level exceeds the mound level.



It is necessary to produce the seedlings of non-mangrove species in the nursery located in high ground areas without tidal inundation and locations where freshwater is available. They will be transported at the time of planting.

1. Silvicultural Techniques(7/8)

1.5.2 Possible Spacing for Plantation

From only few years of action research trial, it is still too early to make conclusion for applicable spacing. However, based on seedling growth up to 3 – 4 years from plantation establishment, followings information were identified and can be used as one of reference for selection of spacing :

Spacing	Probably Suitable Species	Remarks
1'x1'	<i>Avicennia officinalis</i> can grow in 1'x1' but the survival rate is low.	In some locations/ species, may be possible for firewood (biomass) production but yet to be confirmed.
3'x3'	<i>Avicennia marina</i> and <i>Bruguiera gymnorhiza</i> can grow well.	Species other than <i>Avicennia marina</i> and <i>Bruguiera gymnorhiza</i> are not clarified the effect of 3'x3' spacing, need to be confirmed more.
6'x6'	<i>Avicennia officinalis</i> , <i>Excoecaria agallocha</i> , <i>Ceriops decandra</i> , <i>Heritiera fomes</i> , <i>Sonneratia caseolaris</i> , <i>Aegiceras corniculatum</i> , <i>Bruguiera sexangula</i> , <i>Avicennia marina</i>	This is standard tree spacing in the delta. Most of tree species show certain growth in this spacing. This spacing widely used from empirical experience.
9'x9'	<i>Avicennia officinalis</i> , <i>Sonneratia caseolaris</i> , <i>Avicennia marina</i> , <i>Ceriops decandra</i>	Depends on objectives but it is recommendable especially for achieving higher survival rate and growth of planted trees than 6' x 6'.
12'x12'	<i>Avicennia officinalis</i> , <i>Avicennia marina</i> and <i>Ceriops decandra</i> have positive effects of 12'x12' interval.	In this spacing, it seems to be that seedlings are more prone to damages from tidal waves and strong winds. Therefore, application of this spacing shall be limited to locations with less prone to waves/winds, suitable species. Depends on objectives, it is advisable that denser stands can be thinned to this spacing after the first initial years of plantation establishment.



Mangrove Plantation
In Pyinalan Reserved Forest

1. Silvicultural Techniques(8/8)

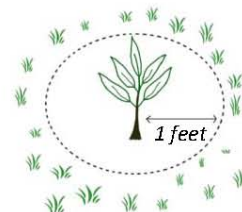
1.5.3 Probably Applicable Land Treatment for Plantation

Though only intermediate results are available as of March 2013, in order to increase survival and growth of seedlings, following land treatments with matching species seem to have certain potentials for some plantation activities.

Weeding (spot)

Recommendable Species:
Excoecaria agallocha, Ceriops decandra

Weeds around seedlings are to be removed by hand scythes, harrows or spades before planting.



Because weeding makes the ground open, it may cause more damages to seedlings by crabs.

Ploughing

Recommendable Species:
Bruguiera sexangula, Excoecaria agallocha, Avicennia marina

Surface soils are to be turned by hand ploughs before planting seedlings. By ploughing around the pits, soil conditions such as hardness are expected to be improved to develop the root system after the planting.

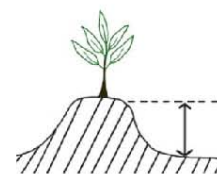


Reasons are yet to be confirmed but it has somewhat negative effects to Avicennia officinalis. No significant positive effects to Aegiceras corniculatum and Ceriops decandra.

Mound

Recommendable Species: Melaleuca leucadendron, Casuarina equisetifolia (Non-mangrove species)

In order to reduce salinity in the soils and tidal inundation for non-mangrove species, the mound shall be introduced before planting. Spot-type or line-type mounds by hand are applied using river sand. To select high ground level is also the key to the success of planting non-mangrove species.



More than 1.5 feet from the highest water level



Not necessary to introduce mound treatment for mangrove species. Even mounds are established, growth/survival of seedlings may be inhibited if planted in lower grounds which receive tidal inundation.

2. Seedling Production Techniques (1/6)

2.1 Introduction

FD is responsible to produce seedlings at their CFECNs and temporary nurseries. Seedlings are to be distributed to CFUGs and also utilized for FD plantations every year. Stable seedling production is very important activity to achieve qualitative and quantitative plantation establishment in the delta.



Thar Yar Kone CFECN,
Pyinalan Reserved Forest, Laputta Township



Htaung Gyi Tan CFECN, Pyindaye RF,
Pyar Pon Township



Byone Hmwe CFECN,
Pyinalan RF, Bogalay Township



Kwa Kwa Ka Lay CFECN,
Kyakankwinpauk RF, Laputta Township

2. Seedling Production Techniques (2/6)

2.2 Nursing Information and Probably Applicable Seedling Standards

Based on findings from the project area, following table is summary of nursing information of major species and their probably applicable standards of potted seedlings.

a. Mangrove Species

No	Scientific Name	Local Name	Seed collection time	Nursing Period	Planting Time	Average Diameter	Average Height
			month	Months	month	inch	ft
1	<i>Aegialitis rotundifolia</i>	Sar Thar	June-July	13	June-July	0.1-0.2	1-1.5
2	<i>Aegiceras corniculatum</i>	Ye Kaya	June-July	13	June-July	0.1-0.2	1
3	<i>Avicennia alba</i>	Thame Kyet Tet	Sep	10-11	June-July	0.2-0.3	1-1.5
4	<i>Avicennia marina</i>	Thame Phyu	Sep	10-11	June-July	0.2-0.3	1-1.5
5	<i>Avicennia officinalis</i>	Thame Gyi	Sep	10-11	June-July	0.2-0.3	1-1.5
6	<i>Bruguiera cylindrical</i>	Hnan Byu	Jan-Feb	5	June-July	0.1-0.2	1
7	<i>Bruguiera gymnorhiza</i>	Byu u talone	June-Dec	8-13	June-July	0.2-0.3	1-1.5
8	<i>Bruguiera parviflora</i>	Byu War Kyaing Laing	June	12-13	June-July	0.1-0.2	1
9	<i>Bruguiera sexangula</i>	Byu shwewah	June	12-13	June-July	0.2	1-1.5
10	<i>Ceriops decandra</i>	Madama	Mar.-April	15	June-July	0.1-0.2	1
11	<i>Cynometra ramiflora</i>	Myin Ka	Jan-Feb	5	June-July	0.1-0.2	1
12	<i>Excoecaria agallocha</i>	Thayaw	July-Aug	12	June-July	0.1-0.2	1
13	<i>Heritiera fomes</i>	Kanazo (kone)	July	12	June-July	0.2-0.3	1-1.5
14	<i>Heritiera littoralis</i>	Kanazo (gyi)	Sep-Oct	9	June-July	0.2-0.3	1-1.5
15	<i>Hibiscus tiliaceus</i>	Tha Man Shaw	July	12-13	June-July	0.1-0.2	1
16	<i>Kandelia candel</i>	Byu Baingdaung-she	Aug-Sep	10	June-July	0.2-0.3	1.5-2
17	<i>Lumnitzera racemosa</i>	Pyan Shar, Aikemathwe	Sep	10-11	June-July	0.1-0.2	1
18	<i>Nypa fruticans</i>	Dani	June			-	1-1.5
19	<i>Phoenix paludosa</i>	Thin Paung	June	13-14	June-July	-	1
20	<i>Rhizophora apiculata</i>	Byuchidauk (apo)	May	12	June-July	0.2-0.3	1.5-2
21	<i>Rhizophora mucronata</i>	Byuchidauk (ama)	May	12	June-July	0.2-0.3	1.5-2
22	<i>Sonneratia Alba</i>	LaMe	Aug-Sep	10	June-July	0.1-0.2	1-1.5
23	<i>Sonneratia apetala</i>	Kanbala	July-Aug	12	June-July	0.1-0.2	1-1.5
24	<i>Sonneratia caseolaris</i>	Lamu	July-Aug	12	June-July	0.1-0.2	1-1.5
25	<i>Sonneratia griffithii</i>	Laba	Mar.-April	15	June-July	0.1-0.2	1-1.5
26	<i>Xylocarpus granatum</i>	Pin Lei Ohn	May	12	June-July	0.2-0.3	1.5-2.5
27	<i>Xylocarpus moluccensis</i>	Kya Na	July-Aug	11	June-July	0.2-0.3	1.5-2.5

Nursing period is calculated based on seed collection time and the next planting season.

Some species may require short nursing period based on the requirement of planting.

Note: Modified based on the results of IMMP study (JICA, 2002-2005)

2. Seedling Production Techniques (3/6)



The information indicated in the previous table are mainly collected at Tar Yar Kone CFECN in Pyinalan Reserved Forest, Laputta. According to the locality, there might be slightly difference for seed collection time and other nursing information at other locations in delta. Also seedling standards can be adjusted based on seedling requirements/ objectives. It is advisable for you to confirm the specifications of the seedlings in your areas when you start to produce the seedlings at the nursery.

b. Non-Mangrove Species

No	Scientific Name	Local Name	Seed collection time	Nursing Period	Planting Time	Average Diameter	Average Height
			month	Months	month	inch	ft
1	<i>Acacia spp.</i>	Shar	Apr-May	12-13	June-July	0.2-0.3	1-1.5
2	<i>Albizia procera</i>	Sit	Mar-Apr	13-14	June-July	0.2-0.3	1-1.5
3	<i>Casuarina equisetifolia</i>	Pinlaikavie	May	12	June-July	0.1-0.2	1-1.5
4	<i>Eucalyptus spp.</i>	Yu Kalys	July-Aug	11	June-July	0.2-0.3	1-1.5
5	<i>Melaleuca leucadendron</i>	Malaluca	Sep-Oct	10	June-July	0.2-0.3	1-1.5
6	<i>Samanea Saman</i>	Kokko(Thin Baw)	Apr-May	12-13	June-July	0.2-0.3	1-1.5
7	<i>Terminalia beleria</i>	Thit Seit	June-July	13	June-July	0.2-0.3	1-1.5

Note: Modified based on the results of IMMP study (JICA, 2002-2005)



Mangrove Flower
(*Bruguiera gymnorhiza*)



Mangrove Seeds
(*Excoecaria agallocha*)

2. Seedling Production Techniques (4/6)

2.3 Seedling Production Techniques

Report
Vol. 3

Please refer “Seedling Production Handbook” as an attachment of the Report. Format used in the Handbook is shown below. You can find information of major species from the book for seedling production in the future.

Code: XXX	Scientific name :
Common name :	Local name :
Appropriate Size of Planting : Diameter [cm] Stem Length: [cm]	
Usage: Pole,	

Photo			
[Tree images]	[Seeds/Fruits]	[Leaves]	[Flowers]

Seed Preparation	
a. Method of seed storage	
b. Seed viability period after	
c. Pretreatment method	

Treatment	Sowing Method	Seedling Raising Method
a. Shading		
b. Watering		
c. Weeding		
d. Spraying		
e. Fertilization		
f. Precautions		

Species name	Calendar	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
	Flowering												
	Fruiting												
	Seed Collecting Time												
	Sowing Time												
	Planting												

3. Seedling Production Techniques (5/6)

2.4 Planning and Recording of Seedling Production in the CFECN

Recordings of seedling production was rather weak in the existing practices. Therefore, following simple but concise record forms are suggested.

a) Seedling Production Plan/Monitoring Record

Total number of seedlings to be produced by nurseries shall be defined based on the Seedling Production Plan of respective FD Township. Following format shall be utilized at the planning stage as well as monitoring.

Species Name	Plan		Monitoring (1) (Date:)			Monitoring (2) (Date:)		Final Count	
	No. of Seedling	Type of Seedling	Nursery Pond/Bed	No. of Seedling	Type of Seedling	No. of Seedling	Type of Seedling	No. of Seedling	Type of Seedling
Total									



Need to consider type of seedling (potted, Bare root, direct sowing) by each species. The work volume and schedule of seedling projection will be estimated based on the plan.



Sowing of Mangrove Seeds
at CFECN, Pyinalan RF



Seed collection by
Villagers at Pyindaye RF

3. Seedling Production Techniques (6/6)

b) Seedling Distribution Plan

To summarize demands of seedlings in on-going activities such as CF and FD plantations, it is suggested that seedling distribution plan be prepared using following format.

No.	Place to be distributed	Objective	Species Name	Type of Seedlings	Number of Seedlings	
					Distribution	Planting
	Total					

c) Seedling Distribution Record

It needs to record actual number of distributed seedlings using this format. Based on differences of number of seedlings between the plan and actual record, FD staff can prepare practical seedling production plan in next year .

No	Target Village	Target Area	Distributed Date	Species A			Total
				Number	Type of seedling	Size(height/diameter)	
Total							

No	Target Village	Target Area	Distributed Date	Species B			Total
				Number	Type of seedling	Size(height/diameter)	
Total							



Shall record type of seedling (potted, Bare root, direct sowing) and size of mean height and mean diameter by each species.

3. Monitoring Techniques (1/4)

3.1 Introduction

Monitoring is one of the most important activities for mangrove management in the delta. However, its method and techniques have not been always standardized, which makes mangrove management difficult. This guideline introduces practical methodology for monitoring which can be applied to FD/CF plantations in the delta.

3.2 Monitoring for FD plantation

a) Survey equipments and materials

- Potable GPS (to record location of monitoring plot)
- Measurement Rope (to set monitoring plot)
- Measurement Tape (to measure tree height & girth)
- Laminator (to prepare tree label)
- Stapler or Staple Gun (for labeling tree)

b) Measurement items

- Tree height (feet), tree girth at breast height (inches)

c) Procedure of monitoring

- Set square type monitoring plots in each plantation.
- 30'x30' is reasonable plot size for all size of plantation.
- As per existing practice in FD, sampling intensity shall be 2.5%~ of treatment area.
- GPS data should be recorded at all plot corners.
- At least three plots are necessarily to set up for each treatment (by species, spacing).
- Staple tree label and measure all tree height and girth within the monitoring plot.
- Record remarkable tree condition, if necessary.



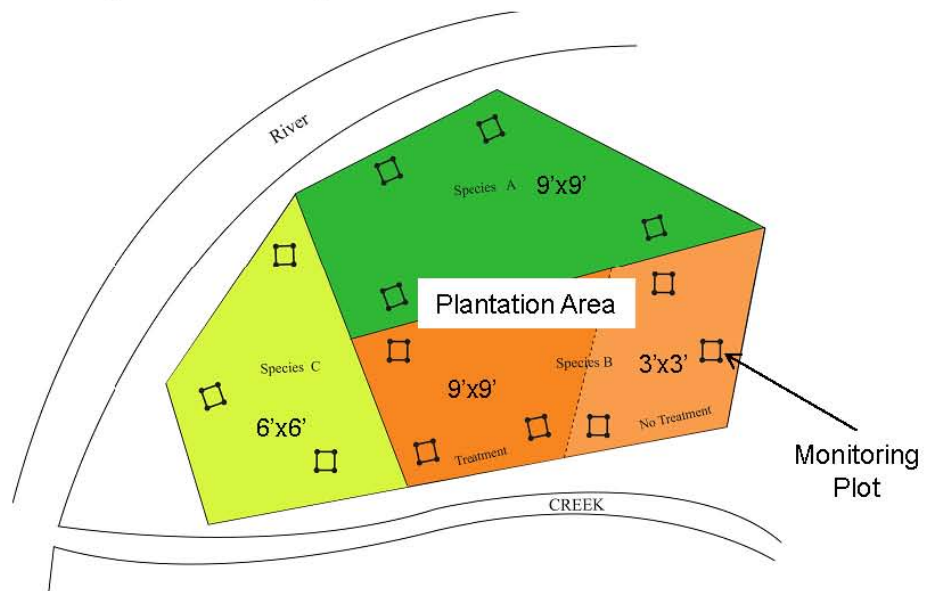
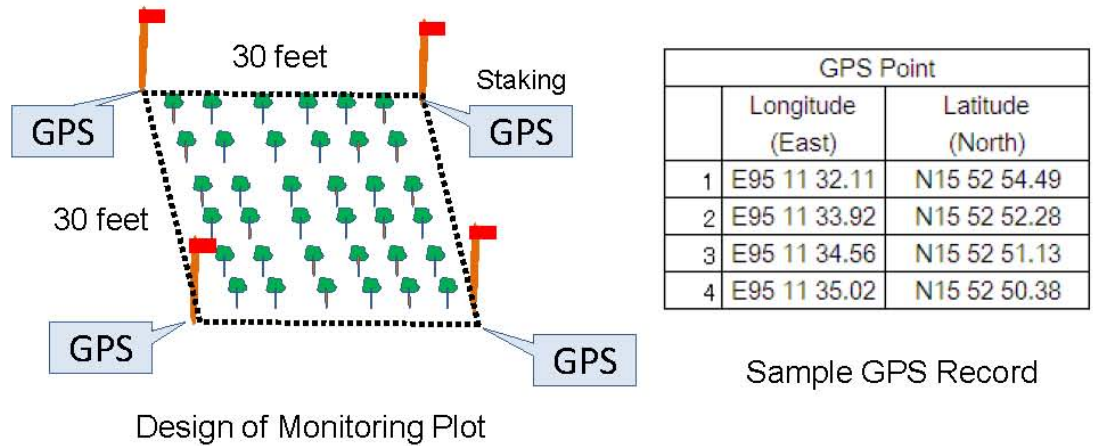
Laminated Tree Label



Staking at Plot Corner

3. Monitoring Techniques (2/4)

3.3 Design of Monitoring plot for FD Plantation



Monitoring at Low Ground



Monitoring at High Ground

3. Monitoring Techniques (3/4)

3.4 Monitoring for Community Forestry (CF)

a) Necessary equipments

- Measurement rope (to set circle plot)
- Measurement tape (to measure tree height and girth)

b) Measurement items

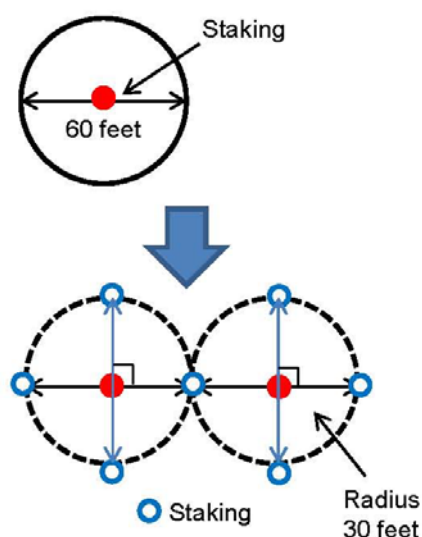
- Tree height and tree girth

c) Installation of Circle Type Plot

- One standard plot consist of two circles as illustrated.
- To decide center of the first circle using the stake with red paint on its top. To hang the plastic plate on the stick to show the number of the circle.
- To measure 30 feet as radius in four directions from the center of the circle as illustrated.
- To fix the stake with two lines at the four locations of the boundary.
- To set up second circle in the same way.



Plot setting by CFUG members,
Pyinalan RF



Design of Monitoring plot

3. Monitoring Techniques (4/4)

3.5 Monitoring Record Format

- It is recommended to use following record format, plot sketch and summary sheet for monitoring FD plantation in the delta.
- For CFUGs, format translated in Myanmar shall be used for easier understanding and recording by CFUG members.

Monitoring Record for CF Plantation

Township	_____	Date:	_____
Reserved Forest	_____	Number of Tree	_____
FC No.	_____	Radius of Plot	_____ feet
Plantation Year	_____	Area of Plot	_____ (acre)
Treatment type	_____		

Tree Number	Species Name	Height (ft)	Girth (inch)	Survival (Yes/No)	Remarks

Note: In case the height of trees is less than 4' 6", the girth shall not be measured. Even though the height of tree is more 4' 6"

Plot Sketch

Need to write down outer boundary of plot and position of each trees with number.

Need to write down starting and ending corners of monitoring.

O mark means a survived tree, and X mark which means a dead tree in the sketch.

Plot Summary

Treatment Type:	
Monitoring Plot Size:	
Monitoring Date:	
Number of Planted Tree	
Number of Live Tree	
Number of Dead Tree	
Survival Rate	
Mean Height (inch)	
Mean Girth (inch)	



All actual monitoring records and summary record in twelve ARP Plantations in the delta are attached to Technical Report.



March 2013

Forest Department (FD)

JICA Expert Team (JET: Nippon Koei)