SABAH FORESTRY DEPARTMENT

DERAMAKOT FORESTRY DISTRICT
(DERAMAKOT FR-FMU 19A & TANGKULAP/SG. PINANGAH FR-FMU 17A)

Standard Operating Procedures

Timber Stand Improvement

Document No.: SFD/DFR/SOP - 006

Approved by:

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Director Of Forestry (25. 2. 2010)

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TABLE OF CONTENTS

1.0 BACKGROUND & PURPOSE

Sabah Forestry Department (SFD) has initiated a policy to pursue certification by meeting the requirements of FSC as well as national standards in its management systems for Sabah. To ensure that its operations are in line with FSC requirements the SFD has developed a series of Guidelines for forest management in 2008 that has been adopted into procedures for use in FMU 19A and FMU 17.

The purpose of this procedure is to define the process for rehabilitation & timber stand improvement that meet the requirements of the FSC Forest Management Standard for FMU 19A & FMU 17A.

2.0 SCOPE

The scope of this procedure is limited to **rehabilitation & timber stand improvement** within FMU 19A & 17A managed by SFD. The procedure is to ensure that work may be completed in a controlled, consistent and effective manner.

3.0 RESPONSIBILITIES

The Head of Rehabilitation & Silvicultural is responsible for:

- Rehabilitation and silvicultural plannning
- Monitoring the silviculture & enrichment planting activities
- Training of forest officers
- Ensuring the implementation of this procedure

The Forest Officer (Rehabilitation & Silvicultural) is responsible for:

- Preparation of silviculture & enrichment planting treatment
- Implementation of silviculture & enrichment planting treatment
- Training of supervisors and rangers
- Reporting on treatment & planting implementation

4.0 DEFINITIONS

This procedure contains definitions of common terms used by FSC & SFD in the procedures for forest management.

Compartment: Area of forest delineated as a sub management unit within the FMU.

FSC: Forest Stewardship Council, an international non-government organization who governance the Forest Management and Chain of Custody standard

FMU: A clear defined forest area with mapped boundaries, managed by a single managerial body to a set of explicit objectives which are expressed in a self –contained multi-year management plan

NTFP: Non timber forest products – all forest products except timber, including other materials obtained from trees such as resins and leaves, as well as any other plan and animal products

PCT: Potential Crop Trees, trees below the prescribed harvesting diameter that are identified as a potential tree or future harvesting

Silvicultural treatments: Usually limited to cutting of wood climbing vines or bamboo that enter the canopy and compete with tree foliage for light. Treatment can include liberation thinning where by non-commercial trees that shade potential crop trees are girdled to kill the tree that release the PCT from competition

5.0 INTRODUCTION

Virtually all the dipterocarp forests in Sabah have been logged, by different methods and with varying degrees of intensity, resulting today in very heterogeneous residual forests different in structure and composition from the original forest. The successful regeneration of these forests is imperative to their sustainable management, thus underscoring the role of silviculture in the recovery process. Conventional logging practices and repeated logging have degraded the remaining forest resources in Sabah. Poor logging practices have opened up the forest significantly. The increase in light on the forest floor has proliferated the growth of pioneer species, bamboos and climbing vines. Therefore silvicultural treatments are needed in order to regenerate the forest stands following the logging operations.

A silvicultural system is defined by Troup (1928) as “the process by which the crops constituting a forest are tended, removed and replaced by new crops, resulting in the production of forests of a distinctive form”. Forest regeneration is the act of renewing tree cover by establishing young trees through either natural or artificial means, preferably at a suitable time after the timber harvesting event. Forest regeneration includes practices such as changes in tree plant density through human-assisted natural regeneration, enrichment planting, and changes in tree species composition, provenances and genetics. The aim of post-harvesting silviculture is to enhance the survival, growth and quality of potential crop trees for the next timber harvesting event. The systematic application of an appropriate silvicultural system is a basic requirement in SFM.

Reduced Impact Logging (RIL) has a thinning effect whereby the pole-sized trees, saplings and seedling are provided with “growing-space” whilst minimal soil disturbance creates conditions which enable seedling establishment. If conducted in accordance with the established guidelines, the RIL operation itself is a major element of a silvicultural management system.

The silvicultural treatment practiced in Sabah consists of a selective liberation of potential crop trees (PCT), avoiding a blanket elimination of secondary species and non-commercial trees. Treatments involve the selective liberation of selected PCTs mainly by the removal of overhead shade, and the cutting of impeding vegetation, such as vines and climbing bamboos. In cases of heavy disturbance of the forest structure enrichment planting may be required to supplement natural regeneration of forests. Areas identified as severely degraded without forest structure and inadequate stocking of potential crop trees may be restored under a mosaic design where small areas can be cleared and planted to form a patch work of planted and natural forested areas within the compartment.

5.1 Evaluation of the Need for Silvicultural Treatment

The objectives of silviculture are:

i. Increase of growth rates of commercial species (timber and non timber)
ii. Increase of commercial stand value
iii. Enhancement of biodiversity and wildlife
iv. Higher seed production of commercial trees
v. Enhancement of ecological sustainability
vi. Improved regeneration stocking

The main question is does a specific forest stand need treatment and what type of treatment is required to meet the objectives listed above.

Sampling of Potential Crop Trees (PCT):

An inventory of the compartment would need to be conducted to evaluate the stocking of potential crop trees that will become the future harvest trees within an estimated harvest cycle. Sampling can be conducted through a linear system whereby centerlines of 100- 500m lengths are chosen within the compartment. Typically all trees over 40 cm dbh are measured within 10 m of the line and trees 5-20 cm are measured within 5 m of the centerline. Number of climbing bamboo and woody vines should also be recorded along the 5m strip. The strip line is divided into sections of 20m lengths that form a series of plots along the center line that can be used to evaluate stand quality and climber density along different sections of the center line. Detailed methods on inventory is described in Procedure 14 Inventory Guidelines.

Inventory data needs to be analyzed to evaluate density of PCTs in the various size classes to determine adequacy of regeneration. If regeneration is inadequate then planting may be necessary. Also infestation of climbing bamboo and woody vines that average in excess of 6 clumps or vines in 10x20m sample plots (density of 300 clumps or vines/ha) should undergo climber cutting treatments.

The objective when selecting compartment suitable for harvesting is to ensure the stand density contains at least an average of 15 good quality commercial trees > 60 cm diameter per hectare. Target harvest density is about 8-9 trees/ha 60-120 cm dbh with an average volume of 5-6 m3/tree. The stand should be able to reach the target stand density within rotation cycle of 30 to 40 years. If the stand **cannot** reach the target density of 15 trees/ha > 60 cm dbh then some form of treatment is required.

Table 5.1. Guidelines on selecting treatment:

Table 5.1a. Adequate stocking of good quality commercial species

Tree Size	Density	Proposed treatment
40-60 cm	20+ trees/ha	vine cutting (if density >300/ha)
20-40 cm	<30 trees/ha	
5-20 cm	< 60 trees/ha	

Table 5.1b. Inadequate stocking of larger diameter class adequate stocking of 20-40 cm trees

Tree Size	Density	Proposed treatment
40-60 cm	<20 trees/ha	Climber cutting & liberation thinning
20-40 cm	30+ trees/ha	
5-20 cm	< 60 trees/ha	

Table 5.1c. Inadequate stocking of larger diameter class & stocking of 20-40 cm trees

Tree Size	Density	Proposed treatment
40-60 cm	<20 trees/ha	Climber cutting & liberation thinning
20-40 cm	<30 trees/ha	
5-20 cm	60 + trees/ha	

Table 5.1d. Inadequate stocking of all PCTs (**highly degraded**)

Tree Size	Density	Proposed treatment
40-60 cm	<15 trees/ha	Enrichment Planting & climber cutting
20-40 cm	<30 trees/ha	
5-20 cm	<40 trees/ha	

Table 5.1e. Very poor stocking of all PCTs (**severely degraded**)

Tree Size	Density	Proposed treatment
40-60 cm	<5 trees/ha	Intensive Planting / Mosaic System
20-40 cm	<15 trees/ha	
5-20 cm	<30 trees/ha	

5.2 Types of Treatments for Stand Improvement

The Hill Dipterocarp Forests in Sabah can be managed through a cutting cycle of about 20-25 years under a strictly controlled RIL system of selective felling, where density of potential crop trees (PCT) of commercial species are present before a timber harvesting event. Silvicultural treatment should preferably be carried out after the next seed fall, and be directed to assist the regeneration composed of advanced seedlings, poles and smaller sized trees. This operation can be combined with a liberation treatment of trees in higher diameter classes that will form part of the next cut. These treatments may include girdling of unwanted competing trees, the cutting of climbers and bamboo, as well as the cutting of saplings and other woody competing growth of undesirable species.

Silvicultural operations are difficult to prescribe without adequate data, but it is recommended for the present, both climber cutting and the liberation thinning should be carried out at approximately 10-year intervals, to assist the growth performance of the future commercial crop.

5.3 Stand Tending

SFD uses silvicultural tending (the combination of climber cutting and liberation thinning) as its major silviculture practices. These activities are essential to decrease overall competition of potential commercial tree species. The main objective of silvicultural tending is to enhance the growth and quality development of regeneration of the higher-value Dipterocarp species.

There are many types of climbers ranging from slender herbaceous to large arm-thick woody lianas. The infestation of climbing bamboo (*Dinochloa* spp.) and other vines are often severe in logged over forest. This creates a major problem for tree regeneration, because climbing plants compete with tree seedlings for light and nutrients. Increased intensity of light following forest disturbance over larger gap areas (> 2000 m^2) typically promotes the proliferation of pioneer species, climbing bamboo and vines. Several criteria should be considered when applying climber treatment such as type of climbers, age, the general forest condition, the density of climber occurrence, and the potential economic benefits resulting from their removal.

Liberation thinning is a treatment that releases commercial crop trees by removing older unwanted overtopping trees. Thinning in forestry is the selective removal of trees, primarily undertaken to improve the growth rate or health of the remaining trees. This operation contributes to increase the commercial stand value of the next cut. The objective of thinning is to control the amount and distribution of available growing space in favour of the desirable timber crop. It also provides an opportunity to reduce mortality of commercial species and remove the non-commercial or commercially less desirable, and malformed trees.

5.4 Enrichment Planting

Dipterocarp forests are capable of self-regeneration provided logging is light and closely controlled to ensure minimal damage to young regeneration. However, where this natural ability has been impaired by poor logging practices of the past, it may not be possible to depend on natural regeneration to ensure an adequate stocking of commercial trees for a future harvest. Consequently, artificial regeneration or more commonly referred to in the tropics as 'enrichment planting,' may have to be resorted to as an option for timber stand improvement. The basic idea is to restore the self-regenerating ability of poorly stocked and degraded areas to ensure optimal timber productivity from natural forests.

Enrichment planting as a silvicultural practice refers to the planting of commercially desirable species in forest areas where their natural regeneration has been determined to be poor. It is essentially the process of supplementing natural regeneration in an existing forest, and therefore does not involve the clear-felling of trees as one would expect in the establishment of a typical mono-species forest plantation.

When is Enrichment Planting Necessary?

Before a decision is made on whether enrichment planting is in fact necessary, a regeneration survey by linear sampling must be carried out. It is suggested that if more than 40 % of a given area is found to be inadequately stocked (Table 5.1d), then planting should be considered.

Methods:

Guidelines for enrichment planting are widely available in the literature of tropical silviculture (Appanah & Weinland, 1993; Krishnapillay 2002; Wyatt-Smith 1963; Lamprecht, 1989). Planting is normally carried out either in straight lines or gaps. These methods are briefly described below.

Line planting: is the most commonly applied enrichment method. Seedlings are planted in a straight line as single trees or in clusters of 3 to 5 seedlings along 'corridors' cut through the forest (Figure 7.1 and 7.2). These planting corridors run parallel to one another and measure 2–2.5 *m* in width. The distance between planting lines may vary from 10 to 20 *m*, while seedlings are usually planted at 3–4 *m* intervals along the line. Generally, planting density ranges between 250 to 350 seedlings per hectare. Seedlings planted in clusters are treated as a single unit and clusters are therefore spaced out further apart, i.e. at more or less the desired final spacing. The idea of cluster planting is to retain the most dominant tree in the cluster and thinning out the rest at a later stage. It also allows for mortality with less likelihood of affecting the planned final spacing of planted crop trees.

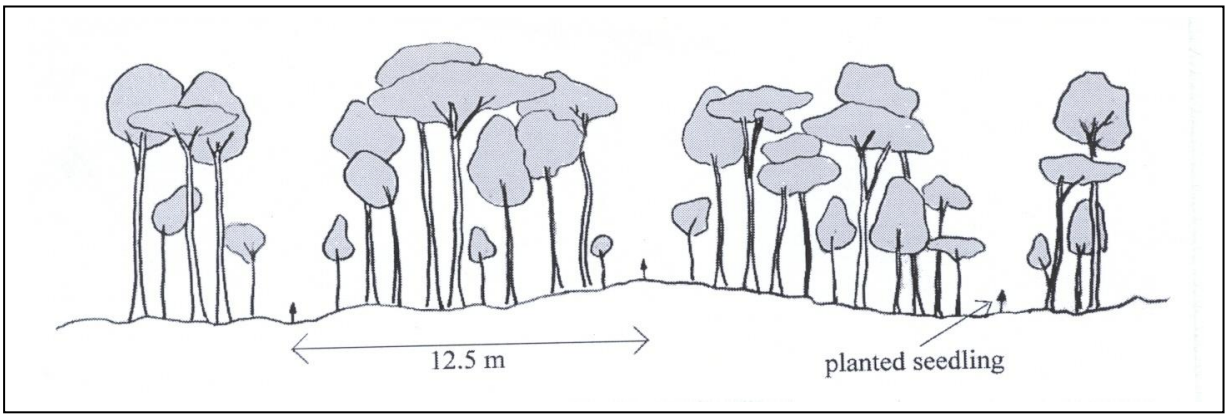
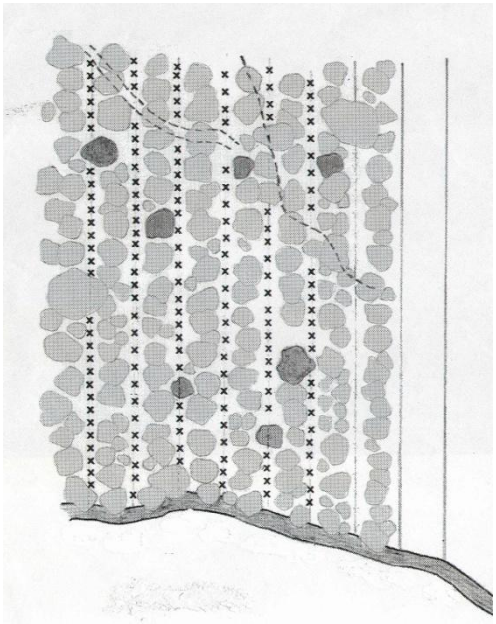


Figure 5.1: A forest profile showing how planting lines are opened up in enrichment planting to ensure that planted seedlings receive adequate overhead light. It is important to ensure that overhead light is created before planting commences. This may require the removal of 'weedy' tree species using a small chainsaw.

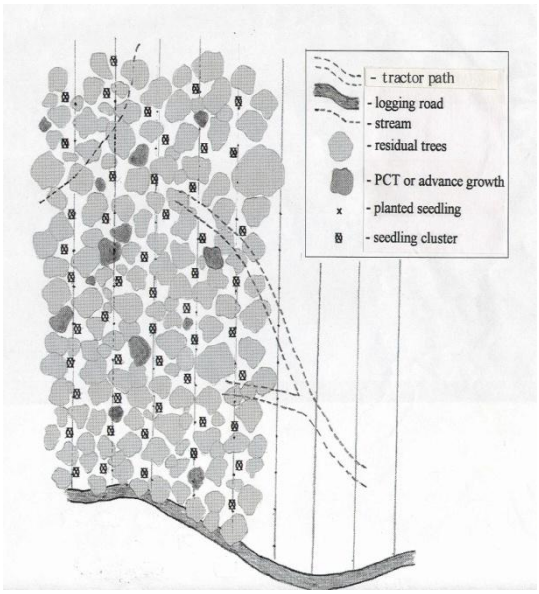
Gap planting: One alternative to planting along corridors is to plant in gaps, with 3–5 seedlings in a gap. Gap planting is especially suitable where the canopy height is high (> 10 *m*), for example, in logged forests or tall secondary forests. In this kind of forest, planting lines would be difficult to open and maintain without causing much damage to surrounding trees. In gap planting, seedling clusters are planted in gaps along a straight line. The gap center may be placed anywhere within a 4 *m* radius of a fixed regularly spaced planting spot (Figure 7.2). Therefore, a gap need not be directly placed on the established straight line. This arrangement allows flexibility in the placement of seedlings so that plants are placed in the most convenient and suitable spot. As far as possible, natural gaps are used. Otherwise, gaps may be created by felling trees such that the planted seedlings receive full overhead light. Artificially created gaps measure 20–25 m^2. This usually provides seedlings with sufficient overhead light to promote height growth without creating conditions that are too open. Planting spots space out at 12.5 x 12.5 *m* translates to a maximum of 64 seedling clusters or gaps per hectare. Such a distance between gaps is considered far enough to avoid creating large contiguous openings in the canopy in the process of creating planting gaps.

Figure 5.2 Schematic illustrations of two enrichment planting designs

a) Line planting



b) Gap planting



5.5 Mosaic Design

The concept for forest restoration under a patchwork or mosaic system whereby small areas (less than 30 ha) of heavily degraded forest areas are cleared and planted to enable more economical system that yields more control to the forest manager. The cleared areas are to be surrounded by natural forest areas that can provide habitat and protection against erosion and siltation of riparian areas. Areas to be retained would include riparian and stream side buffer zones, steep slopes and areas that contain adequate stocking of good quality potential crop trees (PCTs). Buffer zones of streams and riparian areas would need to be large enough (ie. minumum 50 m on each side of stream) to provide habitat for wildlife and service as biodiversity. Objectives of Sustainable Natural Forest Management should target to obtain a minimum of 70% of the concession area under high quality natural forests.

Adequate Stocking of evenly distributed good quality dipterocarp PCTs based on size classes:

Tree size	Density/ha
40-60 cm	20 trees/ha
20-40 cm	40 trees/ha
5-20 cm	60 trees/ha

This is a new method being tested in FMU 17A where areas of up to 30 ha that do not contain adequate stocking of PCTs are cleared and the site is prepared for planting by mulching down the

removed vegetation. Riparian buffer zones of 50 m, steep slopes (>25 degrees) and areas that contain sufficient number of good quality PCTs are being retained.

Evaluation of Areas for Clear Felling:

Before a decision is made on whether a specific area can be cleared, a regeneration survey by linear sampling must be carried out. It is suggested that if more than 70 % of a given area (less than 30 ha) is found to be severely degraded as defined in table 5.1e, the area can be cleared.

Line planting of native fast growing seedlings that are tolerant of direct sunlight is conducted in the cleared areas. Adequately stocked forest areas that are retained should be treated for climber cutting and possible liberation thinning as needed to release the existing PCTs.

5.6 Species Selection

Enrichment Planting:

Being the principal source of commercial timbers as well as the most dominant component of the mixed dipterocarp forest, the dipterocarps have always been the natural species choice for enrichment plantings in Sabah. Furthermore, dipterocarps generally achieve optimal growth in full overhead light while maintaining lateral shade, a condition that is compatible with enrichment planting techniques. Dipterocarps belonging to the red seraya group (Section Rubroshorea of the genus *Shorea*) such as *Shorea leprosula, S. johorensis*, and *S. parvifolia* are often favoured due to their relatively fast growth. Other commonly planted species in Sabah are *Parashorea* spp. and *Dryobalanops lanceolata;* this species choice is perhaps due to the natural abundance and relatively regular fruiting of these species. In recent years, there has been increasing interest in studying the suitability of planting selected non-dipterocarps in enrichment plantings, such as *Durio* spp. and *Dyera costulata*.

The following are the preferable silvicultural characteristics of ideal species for enrichment planting:

i. Species has a high (at least above average) commercial value
ii. Frequent flowering and fruiting intervals
iii. Easy seed collection
iv. Good germination rate and handling in the nursery
v. High percentage of survival after planting
vi. Fast height growth in the early stage
vii. Tolerant of reasonable amount of shade and side competition
viii. Rapid diameter growth

In areas where enrichment planting is necessary, or in blank areas of up to 1 ha requiring complete reforestation it is recommended to make use of native species. A mixture of different species is

preferable. Any existing natural potential crop trees (PCT) along planting lines or in gaps should be retained as far as possible.

Mosaic Planting:

As restoration of forests under mosaic system involves planting in cleared areas thus species should be selected that grow well under direct sunlight. Forest managers should always show preference to using native species over exotics. Any exotic species chosen for planting must not be invasive so that it could compete with the native species in the natural forest stands.

Planting within the mosaic system can serve multiple objectives within the management planning system that will influence species selection. The long-term objective for management of tropical forest is to maintain sustainable resource base of native commercial species while maintaining habitat to support viable wildlife populations and adequate biodiversity within the ecosystem.

The management of a FMU could also contain shorter-term objectives that include production of fast growing species that can be harvested within 15 years for utility timber or plywood in the cleared patches. Species such as binuang, larang, magas & batai that grow very rapidly under direct sunlight can yield a quick return while waiting for the other areas with adequate stocking of native PCTs to mature into harvestable timber. Harvesting of the planted patches could eventually be replaced with higher value and more diverse species that include commercial and habitat species.

5.7 Production of Planting Material

The nursery should use containerized seedlings produced from seeds or wildings uprooted from the forest floor and then raised in the nursery before being planted out. Satisfactory survival rates of wildings can be achieved with the use of simple high-humidity plastic enclosures. Although dipterocarps have been successfully propagated from stem cuttings, this technique for planting stock production is costly and has not been applied widely. Monitoring of growth of seedings in the nursery is critical to determine its viability for out-planting. Only seedlings that demonstrate vigorous growth should be out-planted. Seedlings that show growth slower than average should be culled from the nursery.

5.8 Monitoring & Maintenance

Monitoring for silvicultural treatments is critical for SFD to ensure the effectiveness and success of silvicultural tending and enrichment planting after timber harvesting operations. Due to the importance of ensuring success of the silvicultural investment SFD should verify that only qualified contractors are engaged in carrying out silvicultural treatments, such as climbers cutting, liberation thinning or enrichment planting. Close performance monitoring is required to ensure that treatments are carried out in full accordance with the developed silvicultural standards and prescriptions.

SFD and contractors should monitor the survival and growth performance of planted species. The necessity for re-planting will be based upon a maximum permitted percentage of mortality, as defined by SFD.

Tending and maintenance - Post planting maintenance is crucial to the successful establishment of planted seedlings. Plantings normally require periodic maintenance for about 4 to 5 years after initial establishment. The frequency of tending requirements may be determined by periodic field inspections, but generally, plantings require 3 rounds of tending per year for the first two years. Thereafter, 2 tendings per year is usually sufficient. Tending involves keeping the planted seedlings free of vines and maintaining overhead light for optimal growth. If mortality is high, the replacement of dead seedlings may be considered. This is usually done during the first year. As a rule of thumb, a survival rate of 100 seedlings ha^{-1} is set as the minimum target at the end of the tending period.