UNIVERSITI PUTRA MALAYSIA

REHABILITATION OF DEGRADED PEAT SWAMP FOREST IN RAJA MUSA FOREST RESERVE, SELANGOR, MALAYSIA

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By

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THIS MSC. THESIS IS SPECIALLY DEDICATED TO

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science.

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Chairman: Prof. Dato' Nik Muhamad Ab. Majid, Ph.D

Faculty: Forestry

Data from the Third National Forest Inventory shows there are about 0.23 million ha of logged-over peat swamp forests (PSF) in Peninsular Malaysia. It is important to improve the productivity of these areas by planting commercial tree species in order to sustain its role as an important source of high quality timber species. The main objectives of this study are to determine appropriate planting technique and identify suitable timber species to rehabilitate highly degraded PSF. Field planting that represents the core of the study was conducted in Compartment 101, Raja Musa Forest Reserve, Selangor, Malaysia. The area was classified as highly degraded PSF and occupied mostly by weeds especially *Imperata cylindrica*. Four different planting techniques were tested, namely open planting, open planting with mulching, open planting with topsoil and open planting with nurse tree. Six indigenous PSF species were used, namely *Anisoptera marginata*, *Calophyllum ferrugineum*, *Durio carinatus*, *Ganua motleyana*,

Gonystylus bancanus and *Shorea platycarpa*. Light intensity and foliar analysis were also measured. Light intensity was measured in the nursery to examine the response of the same species used in the field planting to different light intensities. Meanwhile, foliar analysis was conducted to compare the nutrient status of the seedlings among the four different planting techniques.

Open planting was found to be the best technique in rehabilitating highly degraded PSF. The technique produced the highest survival rate of 83.33 percent, lowest planting cost and easiest method. Foliar analysis indicated no significant differences in macronutrient status of seedlings among the different planting techniques. This indicates that the different planting techniques did not affect nutrient uptake by the planted seedlings. Out of six species used in the study, *G. motleyana*, *S. platycarpa*, *A. marginata* and *G. bancanus* with survival rate of 92.19 percent, 79.69 percent, 79.17 percent and 73.44 percent respectively were found to be suitable for rehabilitating degraded PSF. However, based on the availability of seeds and wildings, *G. bancanus* is found to be the best species for rehabilitating the degraded PSF.

Total cost of the field planting in an area of 1.55 ha is about RM 15,929.20. The total costs incurred constitute wages for workers/labours, transportation and materials used for planting and plot maintenance with RM 6,336.00, RM 7,043.20 and RM 2,550.00 or 40 percent, 44 percent and 16

percent out of the total cost, respectively. It is recommended that the Forestry Department carry out rehabilitation program in the degraded PSF. Permanent nursery to raise planting materials of PSF species should be established to support the rehabilitation program. Forest fire can be a major threat to degraded PSF particularly in areas dominated by grass. Therefore, it is also recommended that studies to determine the best prevention and control measures of forest fire in the PSF be conducted.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi keperluan untuk ijazah Master Sains.

PEMULIHARAAN HUTAN PAYA GAMBUT TERNYAH-GRED DI HUTAN SIMPAN RAJA MUSA, SELANGOR, MALAYSIA

Oleh

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Data hasil dari Inventori Hutan Kebangsaan Ke-3 menunjukkan terdapat lebih kurang 0.23 juta ha hutan paya gambut (HPG) yang telah dibalak di Semenanjung Malaysia. Adalah amat penting untuk meningkatkan produktiviti kawasan-kawasan hutan tersebut dengan menjalankan penanaman spesis pokok komersial bagi mengekalkan peranannya sebagai sumber untuk mendapatkan kayu-kayan. Objektif utama kajian ini adalah untuk mendapatkan teknik dan mengenalpasti spesis pokok yang sesuai bagi pemuliharaan kawasan-kawasan HPG yang ternyah-gred peringkat paling serius. Tanaman di lapangan yang merupakan komponen terpenting dalam kajian ini telah dijalankan di Kompatmen 101, Hutan Simpan Raja Musa, Selangor, Malaysia. Kawasan berkenaan dikategorikan sebagai HPG ternyah-gred peringkat paling serius dan didominasi oleh rumput-rampai terutamanya *Imperata cylindrica*. Empat teknik tanaman telah diujikaji iaitu tanaman terbuka, tanaman terbuka dengan sungkupan, tanaman terbuka dengan tanah atas dan tanaman terbuka dengan pokok teduhan. Enam

spesis asal HPG telah digunakan iaitu *Anisoptera marginata*, *Calophyllum ferrugineum*, *Durio carinatus*, *Ganua motleyana*, *Gonystylus bancanus* dan *Shorea platycarpa*. Data-data berkenaan intensiti cahaya dan analisa daun juga telah turut diambil. Kajian intensiti cahaya telah dijalankan di tapak semaian bertujuan bagi mengetahui tindakbalas spesis-spesis sama jenis seperti yang digunakan pada tanaman di lapangan kepada intensiti cahaya yang berbeza. Manakala, analisa daun dijalankan bagi membandingkan status pengambilan nutrien oleh anak benih yang ditanam dengan menggunakan teknik-teknik yang berbeza.

Tanaman terbuka telah didapati sebagai teknik terbaik bagi digunakan untuk memulihara HPG ternyah-gred peringkat paling serius. Teknik tanaman terbuka tersebut memberikan keputusan kehidupan anak benih sebanyak 83.33 peratus, kos menanam paling rendah dan merupakan kaedah tanaman yang paling mudah berbanding dengan teknik-teknik yang lain. Tambahan pula, analisa daun menunjukkan tiada perbezaan ketara status pengambilan nutrien-nutrien utama oleh anak benih-anak benih yang ditanam dengan menggunakan teknik-teknik yang berbeza. Ini bermakna, teknik tanaman yang berlainan tidak mempengaruhi pengambilan nutrien oleh anak benih yang ditanam. Manakala itu, daripada enam spesis yang telah digunakan, *G. motleyana*, *S. platycarpa*, *A. marginata* dan *G. bancanus* dengan kehidupan 92.19 peratus, 79.69 peratus, 79.17 peratus dan 73.44 peratus didapati sesuai untuk digunakan bagi program pemuliharaan kawasan HPG ternyah-gred peringkat paling serius. Namun demikian

berdasarkan kepada keadaan semasa terutamanya dari segi bekalan anak benih, *G. bancanus* merupakan spesis yang paling sesuai digunakan bagi tujuan penanaman di kawasan HPG ternyah-gred.

Kos keseluruhan bagi tanaman di lapangan yang melibatkan kawasan seluas 1.55 ha adalah lebih kurang RM 15,929.20. Ia melibatkan kos upah, pengangkutan dan bahan tanaman serta penyelenggaraan plot selepas tanaman iaitu lebih kurang sebanyak RM 6,336.00, RM 7,043.20 dan RM 2,550.00 ataupun 40 peratus, 44 peratus dan 16 peratus dari kos keseluruhan tersebut. Adalah disarankan agar pihak jabatan perhutanan menjalankan program pemuliharaan di HPG yang ternyah-gred. Tapak semaian tetap bagi tujuan penyediaan anak benih tanaman spesis HPG harus diujudkan bagi menyokong usaha-usaha pemuliharaan tersebut. Kebakaran hutan boleh menjadi ancaman paling utama kepada HPG ternyah-gred terutamanya kawasan-kawasan yang didominasi oleh *I. cylindrica*. Oleh itu, adalah turut disarankan agar kajian yang mendalam dijalankan untuk mendapatkan kaedah sesuai bagi mencegah dan mengawal kebakaran di HPG.

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I certify that an Examination Committee met on 25th October 2001 to conduct the final examination of Ismail Bin Hj. Parlan on his Master Science thesis entitled "Rehabilitation of Degraded Peat Swamp Forest in Raja Musa Forest Reserve, Selangor, Malaysia" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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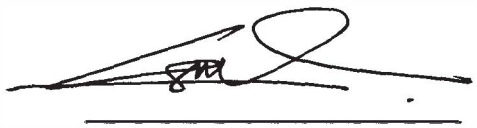
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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LIST OF ABBREVIATIONS

A. marginata	:	*Anisoptera marginata*
a.s.l.	:	Above sea level
ANOVA	:	Analysis of variance
BDI	:	Basal diameter increment
C. ferrugineum	:	*Calophyllum ferrugineum*
D. carinatus	:	*Durio carinatus*
dbh	:	Diameter at breast height
EFB	:	Empty fruit bunches
FR	:	Forest reserve
G. bancanus	:	*Gonystylus bancanus*
G. motleyana	:	*Ganua motleyana*
PSF	:	Peat swamp forests
RLI	:	Relative light intensity
S. platycarpa	:	*Shorea platycarpa*
THI	:	Total height increment

CHAPTER ONE

INTRODUCTION

1.1 Forestry in Peninsular Malaysia

1.1.1 Forest Resources

In general, forest has three main basic roles; providing social-cultural, economic and environmental services. In terms of socio-cultural services, the rural communities living in or near forest area, depend mainly on the forests for their living. The economic contribution of forests is well recognised, as it provides important raw materials to the wood-based industries. Timber products are traded not only in domestic but also in international markets that help to generate income for economic development of the country.

Environmental services of the forest are not easily translated into financial values. Although they are intangibles, the roles of the forests in watershed protection, conservation of soil and water resources, conservation of genetic resources and support for agriculture and other land use have long been recognised (Ministry of Primary Industries Malaysia, 1989).

Peninsular Malaysia is very fortunate because it is well endowed with relatively large tracts of rich and diverse tropical rain forests that have been acknowledged to be amongst the most complex terrestrial ecosystems in the world. Peninsular Malaysia also has one of the richest floras in the world, containing 1,500 genera and more than 7,900 species of flowering plants (Ministry of Primary Industries Malaysia, 1989).

From the Third National Forest Inventory, out of the total land area of about 13.16 million ha, 5.84 million ha or 44.4 percent is still under forest in Peninsular Malaysia (Chin e*t al.*, 1997). Of the 5.84 million ha, 4.73 million ha are under the Permanent Forest Estate (PFE) and the remaining is stateland forest, wildlife reserve and others (Table 1). Out of the 4.73 million ha under PFE, 2.83 million ha and 1.90 million ha are classified as production and protection forests, respectively (Chin e*t al.*, 1997).

Table 1: Forest resources of Peninsular Malaysia

Forest category	Area (Ha)
Permanent reserve forest	4,730,216
Stateland forest	478,409
Wildlife reserve	611,692
Others	18,543
Total	5,838,860

Source: Chin e*t al.* (1997)

1.1.2 Forest Types

Foxworthy (1927) as cited in Wyatt-Smith (1963), classified forest types in Peninsular Malaysia into three broad groups; littoral, lowland and mountain or hill forests where each is further subdivided into a number of sub-groups. These subgroups are as follows:

i) Littoral forests	(a) Beach forests
	(b) Mangrove swamps
ii) Lowland forests	(a) Fresh water swamp forest
	(b) Seasonal swamp forest
	(c) Secondary forest
	(d) High forest (up to 600 m above sea level (a.s.l.))
iii) Hill forests	(a) Mid mountain forests (above 600 a.s.l.)
	(b) High mountain forests
	(c) Ridge forests

A classification of forest types was further refined by Wyatt-Smith (1963) who classified forests in Peninsular Malaysia into six main groups and fifteen subgroups. Among the main groups, Lowland Evergreen Rainforest is the most extensive. According to Wan Razali (1994) as cited in Shamsudin (1997), the Upper, Hill and Lowland Dipterocarp Forests that fall under the group of Lowland Evergreen Rainforests constitute the major subgroups in Peninsular Malaysia as they cover approximately 87 percent of the total

forested areas in Peninsular Malaysia. Lowland, Hill and Upper Dipterocarp Forests cover areas with altitudinal limit of <300 m, 300 m - <700 m and ≥700 m - <1,200 m a.s.l., respectively.

Peat swamp forest (PSF), mangrove, freshwater alluvial swamp and riparian forests on the other hand are grouped under Swamp and low-lying Forests. Generally, PSF covers areas at altitudes from sea level to about 50 m a.s.l. (Faizal and Looi, 1999).

1.1.3 Forest Management and Conservation

PFEs are permanent reserves and they will, under existing legislation be managed on a sustainable basis for protection, production, amenity, research and education purposes. These uses must be managed sustainably in accordance with general principles of sustainability that are ecologically viable and commercially feasible. The management of these forests is clearly stated in the National Forestry Policy, which was formulated and approved by National Forestry Council and later endorsed by the National Land Council in 1978.

In Peninsular Malaysia, the productive inland forest under the PFE is managed under the Selective Management System (SMS). Before SMS, the Malayan Uniform System (MUS) was used since 1950's (Wan Mohd. Shukri, 1997). The MUS consists of removing the mature crop in one single felling of

all trees down to 45 cm diameter at breast height (dbh) (Wan Mohd. Shukri, 1997).

MUS has been successfully applied to the Lowland Dipterocarp Forest, but later found to be unsuitable in the Hill Dipterocarp Forest (Wyatt-Smith, 1963). Consequently, the SMS which entails the selection of optimum felling regimes based on pre-felling forest inventory data was introduced in 1978 (Wan Mohd. Shukri, 1997). In practice, under the SMS the next cut is expected in 30 years after the first logging with an expected net economic out turn of 30 – 40 m^3 ha^{-1} (Wan Mohd. Shukri, 1997). According to Cedergren and Shamsudin (1999) the SMS is also applicable in managing PSF in Peninsular Malaysia.

Meanwhile the forests which are classified as protection forest are used as water catchment, flood control and conservation purposes. Out of 1.90 million ha allocated as protection forest, approximately 0.74 million ha or 12.7 percent of the total forested land has been designated for the conservation of biological diversity such as national parks, wildlife reserves and bird sanctuaries (Ministry of Primary Industries Malaysia, 1999).

1.2 Justifications of the Study

Many researches on forest rehabilitation have been carried out throughout Peninsular Malaysia (Ang *et al.*, 1992; Abd. Rahman *et al.*, 1992; Paudyal and Nik Muhamad, 1992; Nik Muhamad *et al.,* 1994). Among the degraded areas in logged-over forests where research has been conducted are temporary decking sites, skid trails and road shoulders (Wan Razali and Ang, 1992).

Open and line planting are the most common techniques used in rehabilitating logged-over forests (Ang *et al.*, 1992; Thang and Zulkefli, 1992; Suhaili, 1996; Ismail, 1998). Rehabilitation using open planting technique is normally concentrated in open spaces such as temporary decking sites and road shoulder whereas line planting is used to stock poor secondary forests. Various studies on planting of indigenous timber species in logged-over areas using open and line planting techniques have been reported by Thang and Zulkifli (1992), Ang *et al.* (1992), Abdul Rahman *et al.* (1992) and Suhaili (1996).

Chin *et al.* (1997) estimated that in 1992 there were about 0.23 million ha of logged-over PSF in Peninsular Malaysia. There is no report about how much is considered as degraded areas. However, Woon and Mohd. Parid (1999) reported that more than 30 percent of logged-over PSF in North Selangor is classified as highly degraded areas (Table 2).

Table 2: Degradation classification of PSF in North Selangor

Class	Description	Rehabilitation measures	Ha
I	**Highly disturbed PSF**: cleared land/burnt area - trees are generally cleared and the areas are dominated by grass (especially *Imperata cylindrica* or Lalang) and recently logged-over forest with no big trees and low residual vegetation.	Replanting and enrichment planting	22,213
II	**Moderately disturbed PSF**: some pole-sized trees as well as regeneration, but with very poor distribution and thick under-growth.	Enrichment planting and liberation thinning	23,954
III	**Less disturbed PSF**: unlogged or selectively logged. Good residual stand with regeneration, but poor in commercial species.	Liberation thinning	18,823
IV	**Undisturbed/intact PSF**: unlogged areas.	Virgin forest reserve	7,826
		Total	72,816

Sources:

Shamsudin *et al.* (1997); Anon (1997a); Woon and Mohd. Parid (1999)

The highly disturbed areas are not only poor in stocking but also susceptible to forest fire. Woon and Mohd. Parid (1999) estimated the stumpage value of undisturbed and less disturbed PSF to be at RM 15,765 ha^{-1} and RM 10,510 ha^{-1}, respectively whereas the highly and moderately disturbed PSF have no stumpage value at all. It is important to improve the productivity of these areas by planting with commercial tree species, in order to sustain its role as an important source of high quality timber species as well as protecting the environment. Other wise these areas will be colonised by secondary non-commercial species especially *Macaranga spp.* and *Imperata cylindrica*.

Unfortunately, information on appropriate planting techniques, suitability of species for planting and the supply of planting materials are not available for PSF particularly in Peninsular Malaysia. It was observed that not much work has been done to rehabilitate degraded PSF and even existing reports showed that rehabilitation has never been conducted in this forest type in the past (Wan Yusoff and Abdul Rahman, 1997; Ismail, 1998).

It has never been customary in the past to carry out post-felling treatments including planting in logged-over PSF (Shamsudin and Aziah, 1992). This is mainly due to the fact that most logging activities in PSF was concentrated in areas demarcated for alienation to various agricultural projects and other land uses. After all commercial timber species have been harvested, the area will be cleared and burnt prior to cultivation of agricultural

crops such as oil palm and rubber trees. With the current development where many PSF areas under PFE have been logged and the realisation that these areas need to be rehabilitated after logging (Razani and Jalil, 1997), research to examine appropriate planting techniques using suitable commercial tree species in logged-over PSF need to be conducted.

Normal planting techniques applied in rehabilitating inland forests (lowland or hill forests) cannot be adopted directly due to vast differences in environmental conditions between inland forests and PSF. PSF is a unique environment where hydrological parameters are critical in controlling tree growth, besides soil productivity and light conditions. A major difference in planting in these two forest types is the timing of planting.

In inland forests, planting is conducted during the rainy seasons but it is not possible in PSF because generally during this time the PSF is completely flooded. Besides planting techniques, the choice of suitable species for rehabilitating degraded PSF also need to be further investigated. The ability to produce sufficient planting materials through seed and various propagation techniques, for example via stem cutting and tissue culture are regarded as important considerations in selecting suitable timber species for rehabilitating degraded PSF.

1.3 Objectives of the Study

The main objectives of this study are to:-

i) determine appropriate rehabilitation techniques, and

ii) evaluate performance of selected species for rehabilitating degraded PSF.

The main study (field planting) was conducted at Compartment 101, Raja Musa Forest Reserve (FR), Selangor between 1999 to 2000.

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