UNIVERSITI PUTRA MALAYSIA

DEVELOPING THINNING AND PRUNING GUIDELINES FOR ACACIA MANGIUM PLANTATIONS IN PENINSULAR MALAYSIA USING TREE GROWTH CHARACTERISTICS

BIMAL KESHARI PAUDYAL

DEVELOPING THINNING AND PRUNING GUIDELINES FOR *ACACIA MANGIUM* PLANTATIONS IN PENINSULAR MALAYSIA USING TREE GROWTH CHARACTERISTICS

By

BIMAL KESHARI PAUDYAL

Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Forestry Universiti Pertanian Malaysia

July 1990

ACKNOWLEDGEMENTS

I am highly indebted to my major supervisor Dr. Nik Muhamad Majid for his encouragement and guidance throughout the study period and in conducting this research. I am grateful to my co-supervisor, Mr. Rusli Mohd. for his advice and comments. My appreciation goes to Dr. Kamis Awang for his suggestions and to Dr. Sheikh Ali Abod for his valuable advice in analysis of the results. I thank Mr. Awang Noor Abdul Ghani for his help in statistical analysis.

I wish to acknowledge the help given by Muzammal Johan, Salim Ahmad, Ibrahim Edham, and Zulkifly Md. Zin during my field work. Thanks are due to the Forestry Department, Peninsular Malaysia and also to the Forestry Departments of Selangor, Pahang and Negeri Sembilan for permission to conduct the study in their respective forest plantations. I take this opportunity to extend my sincere appreciation to Mr. Suhaimi Yussof, the Forest Officer in Kemasul Forest Reserve for his help. I extend my thanks to Mr. Saad Nyan, Miss Marhayati Mahat and Mrs. Noor Azizawati Musa for helping me in computer work. I wish to thank all those whose names could not be listed here but who have helped me in one way or another.

I would like to express my sincere gratitude to The Tribhuvan University and Institute of Forestry, Nepal for granting my study leave. I highly appreciate The Malaysian Government for providing me scholarship and Universiti Pertanian Malaysia for financial assistance to conduct the experiment.

I would also like to express my love and thanks to my wife and three children who have given me the encouragement and strength during the course of my study in Malaysia. Finally, I dedicate this thesis to my late parents.

TABLE OF CONTENTS

List of Tables

List of Figures

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in partial fulfilment of the requirements for the degree of Master of Science.

DEVELOPING THINNING AND PRUNING GUIDELINES FOR *ACACIA MANGIUM* PLANTATIONS IN PENINSULAR MALAYSIA USING TREE GROWTH CHARACTERISTICS

By

BIMAL KESHARI PAUDYAL
July 1990

Supervisor : Associate Prof. Dr. Nik Muhamad Majid.

Faculty : Forestry

Peninsular Malaysia is expected to face a timber deficit before the end of the century. The Compensatory Forest Plantation Project now undertaken as a remedial measure for this impending crisis needs research in plantation management particularly on silvicultural practices such as thinning and pruning. Thinning needs primary attention in plantation forestry if the management objective is sawlog production. The present study focusses mainly on the determination of reasonable age for first thinning in *Acacia mangium* plantation in Peninsular Malaysia. In addition to the preliminary thinning study, pruning trials and evaluation of growth pattern of *Acacia mangium* in different aged stands and on different sites were also conducted. Three sites, that is, Kemasul in

Pahang, Setul in Negeri Sembilan and Rantau Panjang in Selangor were chosen for the study. The reasonable age for first thinning was determined on the basis of basal area growth. Preliminary thinning guideline was prepared based on crown diameter and diameter at breast height relationship. A randomised complete block design was used to ascertain pruning treatment effects on diameter growth and also on tapering of stem. Tapering of stem was determined by taking diameter measurements at different heights along the stem.

The results indicated that first thinning is to be carried out at about 5 years of age. Growth parameters study showed similar growth pattern on all three sites with higher growth in Setul than the other two sites. The pruning study showed significant diameter loss by above 40 percent crown removal. A reduction of 1 cm DBH in every 1 m in height was found for taper study with all pruning treatments. The study has significant implications pertaining to the diameter size and knot-free quality timber. However, as the experiment lasted for only one year, further growth information over a longer period needs to be recorded for more concrete results.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian daripada syarat-syarat untuk Ijazah Master Sains.

PEMBENTUKAN GARISPANDUAN PERJARANGAN DAN PEMANGKASAN LADANG *ACACIA MANGIUM* DI SEMENANJUNG MALAYSIA MENGGUNAKAN CIRI TUMBESARAN POKOK

Oleh

BIMAL KESHARI PAUDYAL
Julai 1990

Penyelia : Prof. Madya Dr. Nik Muhamad Majid

Fakulti : Perhutanan

Semenanjung Malaysia dijangka mengalami kekurangan balak sebelum akhir abad ini. Projek ladang hutan dijalankan sebagai tindakan yang berkesan untuk mengatasi krisis tersebut. Walau bagaimanapun kajian dalam pengurusan ladang hutan terutama dalam aspek silvikultur seperti penjarangan dan pemangkasan perlu dijalankan. Penjarangan memerlukan penekanan di dalam perladangan hutan jika objektif pengurusan adalah untuk pengeluaran papan gergaji. Kajian yang telah dijalankan kebanyakannya tertumpu dalam penentuan umur yang yang dijangka sesuai bagi melakukan penjarangan yang pertama untuk ladang *Acacia mangium* pada kawasan ladang yang berbeza umur dan berbeza kawasan juga telah dijalankan. Tiga kawasan

yang telah dipilih untuk kajian ini ialah di Kemasul, Pahang; Setul, Negeri Sembilan; dan Rantau Panjang, Selangor. Umur yang sesuai untuk penjarangan pertama telah didapati berasaskan kepada tumbesaran ladang tersebut. Garispanduan penjarangan telah dibuat berdasarkan kepada perkaitan di antara diameter perepang dan diameter pokok pada paras dada. Kaedah rekabentuk blok rawak penuh telah diguna di dalam kajian kesan rawatan pemangkasan terhadap tumbesaran diameter dan juga pengukuran terhadap bentuk batang. Bentuk batang ditentukan dengan mengambil ukuran diameter pada ketinggian yang berbeza di sepanjang batang pokok.

Keputusan kajian mendapati penjarangan pertama hendaklah dibuat apabila pokok berumur 5 tahun. Kajian parameter tumbesaran menunjukkan bentuk tumbesaran yang sama pada ketiga kawasan kajian dengan kawasan Setul menunjukkan kadar tumbesaran yang tertinggi. Kajian pemangkasan memberi kesan yang signifikan terhadap pengurangan diameter batang setelah lebih daripada 40 peratus pemangkasan silara dijalankan. Pengurangan 1 cm diameter pada paras dada pada setiap 1 meter ketinggian telah didapati dalam kajian bentuk batang dengan rawatan pemangkasan yang sama. Kajian menunjukkan kesan yang signifikan terhadap perkaitan antara saiz diameter dan kualiti batang daripada kesan pemangkasan. Walau bagaimanapun kajian yang hanya setahun tidak mencukupi dan maklumat

tumbesaran pada jangkamasa yang lebih panjang diperlukan untuk memberikan keputusan yang lebih tepat.

CHAPTER I

INTRODUCTION

Plantation forestry in the tropics evolved as a result of deforestation. The rate of tropical deforestation has been estimated at 6.2 to 25 million hectares annually (Sedjo and Clawson, 1983; Nambiar, 1984; Wong, 1984). Evans (1986) gave an estimate of 11.3 million hectares/year, representing about one percent of the total area of the tropical forests. According to Spears (1979), the remaining tropical forest will disappear in 60 to 80 years. Pandey (1983) estimated that during the five year period (1976-80), plantations were established in the tropics at rate of 0.9 million hectares/year, nearly 13 times less than the rate of deforestation.

Malaysia is a tropical country and is a federation of 13 states located at the heart of southeastern end of Continental Asia. It comprises Peninsular Malaysia, Sabah and Sarawak. Peninsular Malaysia has an area of 13.2 million hectares, Sabah 7.6 million hectares, and Sarawak 12.4 million hectares (Salleh, 1983). Forest covers an area of about 6.1 million hectares in Peninsular Malaysia, 4.66 million hectares in Sabah, and 9.42 million hectares in Sarawak, giving a total of 20.18 million hectares for the entire country (Leng, 1987).

Malaysia is by far the major supplier of tropical logs to Japan, South Korea and Taiwan. For tropical sawn timber, Malaysia remains the leading supplier to most of the European Economic Community (EEC) countries and Australia (Baharuddin, 1986). The export of sawlogs and total timber products during the period of January-April, 1988 amounted to 5,966,864 and 7,658,914 cubic metres, respectively. The value for total timber product export was MR$2,066,660,350 thus contributing a considerable revenue to the national economy (Malaysian Timber Industry Board, 1988).

The scenario is probably going to change. Peninsular Malaysia is expected to experience a shortage in timber supply to meet domestic consumption by mid 1990's. Freezaillah (1982) indicated that with the current trend of forest exploitation and the rising demand of forest products, Peninsular Malaysia is going to face timber deficit well before the turn of the century. With increasing population and standard of living, the gap between demand and production of timber is expected to widen to about 2.55 million cubic metres (in round log eqivalent) by the year 2001 (Yong, 1984). A similar situation applies to Sabah. According to Yusuf (1985) annual production is expected to decline between 3.6 and 4.6 million cubic metres by 1990, from 11.9 million cubic metres during the 1975-1980 period. As of 1987, timber production in Malaysia was 29.5 cubic-metres: 12.2 cubic metres in Sarawak, 9.4 cubic metres

in Sabah and, 7.9 cubic metres in Peninsular Malaysia (Leng, 1987). This could be increased to 73.3 cubic metres if all productive indigenous forests were converted to plantations of fast-growing species (Yusuf, 1982). However, this is an estimate and it does not imply that all indigenous forests should be converted to plantations as the indigenous forests are capable of producing higher quality timber which is generally not the case with the fast-growing plantations.

It is apparent that the rising demand and declining production pattern of timber, even for domestic consumption purposes, has thrown Malaysia into a paradoxial situation of becoming an importer from a position of leading producer of tropical hardwoods. One of the solutions seems to be the establishment of fast-growing forest plantations. The increase in demand for forest products, low productivity and poor regeneration of natural forests are some of the reasons for large-scale forest plantation establishment in Malaysia (Sheikh, 1982). Large-scale plantation forestry started in 1974 after investigations by the Forestry Department and UNDP/FAO on the feasibility of establishing long-fibred coniferous plantation species for domestic pulp and paper supply (Nik and Kamaruzaman, 1986). Instead of pulp and paper mill establishment, a new policy was adopted to incorporate a project to compensate the shortfall between projected supply and demand of wood for domestic consumption purposes. Thus, the

Compensatory Forest Plantation Project (CFPP) is the recently undertaken project with the objective to produce multi-purpose logs for sawn timber, veneer and plywood in addition to pulpwood.

This project involves the establishment of about 188,200 hectares of fast-growing hardwood plantation species within 15 years in Peninsular Malaysia and is expected to incur a development cost of MR$406.52 million (Yong, 1984). The rationale behind this project is to grow timber species on short rotation of about 15 years to yield general utility timber with growth rate of about 17.6 cubic metres per hectare per year. Such plantations are expected to produce a net yield of 14.1 cubic metres per hectare per year or 211.7 cubic metres on a rotation of 15 years. This project was officially launched at the end of 1982.

For Peninsular Malaysia these plantations have been established at Setul in Negeri Sembilan, Ulu Sedili in Johore, Kemasul in Pahang and Rantau Panjang Forest Reserve in Selangor. The plantation targets for the Fourth (1981-85), Fifth (1986-90) and Sixth (1991-95) Malaysian Plans are 8,000,74,000 and 106,200 hectares, respectively. By mid-1989, about 40,000 ha have been established. The three major fast-growing species planted are Gmelina arborea Rox. (Yemane), Acacia mangium Willd. and Paraserianthes falcataria (Batai). These three species are especially chosen because of their

faster growth rate and adaptability to poor soil conditions and adverse sites. Acacia mangium seems to be the most promising among these three species.

If the plantation project is for obtaining multi-purpose logs for sawn timber, veneer, plywood and pulpwood, thinning and pruning seem to be an essential part of forest management. Thus, management strategy has to be directed towards proper and timely silvicultural treatments. In this context, thinning and pruning play very important roles in management decision. However, field guidelines for thinning in Acacia mangium plantation in Malaysia are not available (National Research Council, 1983; Johari and Yuan, 1986). The compensatory Forest Plantation Project dictates that thinning is to be carried out at year 8. This is just an interim guideline which is not based on any research findings. Similar case applies to pruning.

With this background and lack of sound scientific information on silvicultural operations of these plantations, measurements of parameters for developing thinning guidelines and pruning trials were conducted in three states, that is, Pahang, Selangor and Negeri Sembilan in Peninsular Malaysia.

The main objective of this study is to determine the reasonable age for first thinning in Acacia mangium plantation.

The specific objectives of the study are:

i. To prepare a preliminary thinning guideline for *Acacia mangium* plantation in Peninsular Malaysia based on the growth characteristics of the stands.

ii. To determine growth performance of *Acacia mangium* under different pruning treatments.

Growth measurements for developing thinning guideline and pruning experiment started in April and July, 1987, respectively. The field investigation lasted for one year.

CHAPTER 2

LITERATURE REVIEW

In plantation forestry of the tropics, relatively little is known about thinning practice and regimes. This is mainly because of rapid expansion of plantation programmes in this region and insufficient time to gain adequate experience. The information available is scanty for many of the species now widely planted in this region, especially in the lowland tropics. For tropical pines, substantial information is available but not so for the hardwoods. Thus, a major portion of this literature review focuses on thinning relating to temperate conifers. However, every effort has been made to incorporate thinning works on tropical plantations, especially the fast-growing hardwoods that are relevant to the present study. Yet, because of the few work done and even less reported, and the unavailability of the reported ones, information about thinning in tropical hardwood plantations is virtually non-existent in Malaysia.

Thinning: Definition and Objective

Thinning is a process which artificially reduces the number of trees growing in a stand. It can be defined as

a felling operation made in a stand at any time between establishment and the initiation of a regeneration cutting or clearfelling in which the trees removed are the same species as the trees favoured (Winters, 1977). Several reasons are to be accounted for carrying out thinning as a tending operation. Silviculturally, the primary objective of thinning is to reduce the number of trees growing on a site so that those remaining have more growing space for crown development with less root competition thus creating a favourable environment for stem diameter increment (Baker, 1934; Matthews, 1963; Day, 1966; James, 1979 and Evans, 1982).

In specifying management objectives, generally two different approaches are considered: either to maximize total volume production in a stand or to maximize growth of individual trees, for example, for sawn timber (Smith, 1962; Evans, 1982). As forest crops are thinned both to produce an intermediate financial yield and to stimulate growth of remaining trees (Matthews, 1963; Ford, 1984) a compromise has to be made and a stand is thinned without causing significant loss in total yield. Such a thinning, as applied in Queensland, Australia is termed as marginal intensity thinning based on the concept of limiting basal area. Limiting basal area (30 sq. m./ha for Pinus caribaea) is the minimum stand basal area that will still yield maximum basal area increment with no loss in total yield. Thinning at marginal intensity aims to maintain

this minimum stand basal area (Bradley, 1963; Evans, 1982). However, the minimum stand basal area required to be left after thinning depends on site conditions and growth of the species. Particularly for the production of sawlogs with certain diameter size objectives, the concept of maximum volume production has to be discarded in favour of individual tree growth. To achieve maximum growth of individual trees, basal area should be kept below the residual area required by marginal intensity thinning.

Thinning in Forest Management

Forest management has incorporated thinning for a long time and thinning decision is based on management objectives. Thinning policy, however, has always been guided by silviculture and economics although the basis of thinning to change physiological phenomena such as providing better environment for root and crown development has the major role to play. Economics plays a vital role especially in commercial thinnings. In many cases, stands are not thinned or thinning is delayed due to economic reasons although silviculturally stands should have been thinned. Evans (1982) stated that the increasing cost of thinning has prompted many forest managers not to do any thinning. However, if the primary objective is to produce sawlogs, that is, where size of the stem determines the value thinning is then economically justified.