2) Pests and Diseases

Kenichi Abe
Plantation forest pests in Sabah
FRC Publication, Sabah, Malaysia, No. 8, 119 pp., 1983, English

The author is a Japan Overseas Cooperation Volunteer. This report covers 2 years and 1 month work during his duty in Sabah, Malaysia.

In Sabah, recent attention is being focused on plantation forests. The plantation forests in Sabah consist mainly of exotic fast-growing hardwood species. With the increase in plantation, insect pests on these plantation trees have come to light.

The study was conducted on the insect pests of main tree species. The results of the study are described in this paper. The study was concentrated on 12 species of pests most injurious to plantation forest in Sabah.

The study of forest pests requires a great amount of time spent on finding out such aspect as how they attack their host trees, their biology and also how they are placed in a biological control scheme. This report covers only half of the whole study course. It is hoped that the study will continue and succeed.

Key words: Insect damage, Plantation, Exotic species, Fast growing species

P.S. Thapa
Termites of Sabah (East Malaysia)
Sabah Forest Record, Sabah Forest Dept., Malaysia, No. 12,
374 pp., 1981, English

Little is known about the termites of Sabah although several termite species have been described from Sarawak, and the fauna of these areas resemble closely.

The present collection of termites from Sabah was made by the author during the period 1966-70 while he was on deputation from the Government of India to the Government of Malaysia (Sabah) under the Colombo Plan on an entomological assignment. The assigned task took him to different parts of Sabah and gave him the opportunity of collecting the termites from all the districts of Sabah, namely, Beaufort, Sandakan North, Sandakan South, Kota Kinabalu, Lahad Datu, Lamag, Kalabakan, Keningau, Kunak-Mostyn, and Tawau.

The present study includes 103 species and subspecies comprised in 33 genera and 4 families; of these 38 species and subspecies are new to science, and the major soldier of *Glyptotermes dentatus* Haviland is described for the first time. Keys to the families and genera have been given separately. Both imago and soldier castes of all the known species from Sabah are described. Where no imagoes were available, the original description verbatim (or its English translation) is reproduced to make the present study comprehensive.

Key words: Termite, Insect damage

Chey Vun Khen
Insect defoliators of forest plantation trees
FRC Publication, Sabah, Malaysia, No. 32, 79 pp., 1987, English

Defoliators can be extremely harmful to forest nursery seedlings. Extensive defoliation may lead to death of the seedlings and even if the seedlings do survive, their forms will be grossly impaired. Serious leaf damage can result in a tree losing a great deal of its chlorophyll tissues and reduces considerably its photosynthetic rate. Its normal transpiration rate can also be affected. Once these two important processes have been disturbed, the growth rate of the tree will inevitably be reduced. Perhaps of more important consequence is that this will render the tree more susceptible to borer or fungal attach.

The State of Sabah is currently undertaking rapid afforestation by planting a selected few tree species namely *Acacia mangium, Paraserianthes falcataria* and *Gmelina arborea.* Where circumstances only permit wide scale planting of a single species, the so-called monoculture system will provide food supply in abundance for some potential defoliator which may escalate above the threshold level to constitute an outbreak.

Most of the insect defoliators of main plantation trees (5 species) in Sabah are described in this report.

Key words: Plantation, Insect damage, Defoliator

R.S. Thapa
The biology and ecology of the borer *Cyriopalus wallacei* Pasc.
(Iobang pusing)
Sabah Forest Record, Sabah Forest Dept., Malaysia, No. 11,
33 pp., 1974, English

Until the present studies, very little was known on the biology and ecology of the cerambycid borer, *Cyriopalus wallacei* Psc. The studies on these aspects were undertaken during the period 1967–70 in the virgin dipterocarp forests of Sabah.

The borer attacks living trees, somewhat defective and unhealthy, of many diterocarp species. The female beetle lays forty to eighty-seven eggs on a dried-up branch stub, knot or portion of wood in the top part of the tree-trunk. The larvae which hatch out within fourteen to thirty-five days, start boring wide tunnels in a descending spiral between the sapwood and heartwood region until they reach the base of the tree trunk. In the course of larval tunnelling several ejection holes, ca. 0.5 in. diameter, are opened by the larvae to throw out dust which gets accumulated in a heap around the tree base; these holes get healed up within three to four months. The larval period lasts twenty to twenty-one months and the pupal period, over one month. Emergences of beetles occur after two to three months of cessation of larval activity form early January to early March. The life-cycle is thus completed in nearly two years. However, even though heavily tunnelled, the tree is not killed and continues to grow, as a result of which the exit holes get healed up within six to eight months leaving behind shallow, oblong scars on the bark which may even be seen for years afterwards and are the indicators of borer damage to the tree.

The borer is polyphagus. Its common hosts in Sabah are white serayas (*Parashorea tomentella* and *P. malaanonan*), majau (*Shorea leptoclados*) and yellow serayas (*Shorea* spp. -Richetia group). In Malaya, yellow meranti (yellow seraya) is its common host.

Obtaining these conditions in the virgin dipterocarp forests of Sabah which is composed of several species, it is unlikely, under the present system of forest management, that the borer populations would ever increase to epidemic level. No control measure is therefore necessitated.

Key words: Dipterocarps, Insect damage, Borer

Toyohiko Mori
Handlist of insect pests of forest plantation in Sabah
FRC Publication, Sabah, Malaysia, No. 28, 55 pp., 1986, English

The number of forest plantations is increasing every year in Sabah (e.g., Stephens, 1985; Liew, 1985). The plantations consist mainly of exotic fast-growing species such as *Acacia mangium, Eucalyptus deglupta, Gmelina arborea* and *Paraserianthes falcataria* (Liew, 1985). In present day plantations there ia a high risk of natural calamities such as insect infestations, disease and fire. As more forest plantations are created, the risk from these factors, especially harmful insects, will increase.

To date, very few studies have been conducted on pests in forest plantations of Sabah. Little is known the life cycles and ecology of most species.

The present handlist is intended to provide a brief guide to the main insect pests of exotic forest plantations in Sabah, and it deals with termites, beetles, moths, etc. damaged to main tree species. Limited information is included on the biology, host tree and distribution. The handlist provides a baseline for further studies on insect pests. It is hoped that it will be of assistance to forestry workers.

Key words: Insect damage, Plantation, Termite, Borer

Teguh Hardi TW., Sri Esti Intari & Bahagiawati AH
Life cycle and potential preying capacity of *Curinus coeruleus* of the jumping plant lice, *Heteropsylla cubana*
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 504, 51-57, 1988, Indonesian

Since the beginning of October 1986 laboratory rearing of *Curinus coeruleus,* a predator of the jumping plant lice, *Heteropsylla cubana* has been carried out for investigation of their trophic relations.

The following results of the laboratory rearing were obtained:

1. The eggs of *C. coeruleus* had a very high hatchability percentage (75.34).
2. The life cycle of the insect in Bogor was more rapid than in Hawaii.
3. The larvae and adults exhibited a differential feeding behaviour;
   - The fourth stadium larvae consumed a mean of 328 eggs of the jumping plant lice per day.
   - 90.8 percent the adult of *C. coeruleus* fed preferentially on the nymphs on an average of 106.4 per day, while the remainder fed on the imagoes.

Key words: Insect damage, Natural enemy

Chey Vun Khen
A preliminary report on insects infesting the fruits of some forest-trees
FRC Publication, Sabah, Malaysia, No. 27, 48 pp., 1986, English

A simple project on the insects infesting the fallen fruits of several natural and plantation forest-trees was conducted. The fruits investigated belonged to *Dipterocarpus grandiflorus, Shorea beccariana, Eugenia tawahense, Gmelina arborea,* and *Acacia auriculiformis.* The majority of the insects obtained from the various fruits were the beetles (Scolytidae, Curculionidae), moths (Pyralidae), and other microlepidopterans.

And also, in this paper, the various insects found infesting fruits are discussed for the said four tree species.

Key words: Insect damage, Fruits

Shinichiro Ito
A survey of heart-rot in *Acacia mangium*
SAFODA-JICA Project Report, Sabah, Malaysia, 26 pp., 1991, English

A. mangium has been remarkably free from disease problems until recently. In 1981, heart rot in *A. mangium* was reported in Sabah by Gibson (1981) from thinning of a 44 month-old seed stand where 12% of the thinning had heart rot. A similar observation was made in four-year old thinnings from Kemasul plantation in Peninsular Malaysia (Lee 1985). Lee (1988) also conducted an extensive study of heart rot in four, five and six year-old stands in same plantation. From her study, it was found that discolouration and heart rot in *A. mangium* are caused by fungal invasion of poorly healed wounds, especially those left by brunch stubs.

Heart rot has a high potential for loss to forest production in quantity in addition to reduction in quality. Gibson (1981) identified this heart rot as a major potential problem for future plantation forestry with *A. mangium* in Sabah. Furthermore, it was recommended that a survey of the problem be conducted at the earliest opportunity. However to date, no detailed research of heart rot in *A. mangium* has been conducted.

In the case of *A. mangium,* pioneer fungi will invade from dead branches of about 4-year old trees, and cause the discoloration of wood. After that, heart rot fungi invade from same dead branches and come to cause the decay of heartwwood in about 6 or 7 years old trees. In more than 8-year old trees, the decay advances more and heartwood become soft.

From this study, it is concluded that *A. mangium* trees are very susceptible to heart rot disease. So it will appear that losses in wood quantity and quality of *A. mangium* from heart rot is very high. If it is proposed to produce good quality sawlogs, it is highly desirable that artificial pruning of *A. mangium* be required.

Key words: Heart rot, Acacia, Tree disease, Fungi damage

S.S. Lee, S.Y. Teng et al.
Discolouration and heart rot of *Acacia mangium* Willd. some

preliminary results
Journal of Tropical Forest Science, FRIM, Malaysia, Vol 1 (2), 170–177, 1988, English

The association of discolouration and heart rot in stems of *Acacia mangium* Willd. trees with external cull indicators, the amount of wood affected and the associated fungi were determined in this study. It was found that cankers associated with decayed branch stubs and poorly healed basal pruning wounds were good indicators of discolouration and heart rot. The volume of discoloured wood ranged from between 18 to 48% (n=8) while the volume of heart rot ranged from between 2.7 to 17.5% (n=8). The length of the bole of the sample trees affected by heart rot ranged from between 34 to 100%. Seventeen species of fungi were isolated from the discoloured and decayed wood. Species of *Phialophora, Trichoderma, Rhinocladiella, Thelaviopsis* and *Paecilomyces* were most frequently isolated. However, no single species could be identified as the main discolouration or decay causing organism.

Key words: Heart rot, Acacia, Fungi damage

4. Forest Mensuration and Management

1) Growth, Increment of Trees and Stands

Hendi Suhaendi
A comparative study of volume and growth variations in the international provenance trials of *Gmelina arborea*
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 518, 1–11, 1989, Indonesian

Gmelina arborea is an exotic tree species in Indonesia, but has been given high priority to be selected as a preferred species for the establishment of Industrial Forest Plantations due to its suitability for furniture manufacture and as raw material in the pulp and paper industries.

Based on mensurational studies in stands up to seven years (planted in 1979), Suhaendi (1989) showed that provenance No. 4040 was promising for sites similar to Pasirhantap, while provenances No. 4045 and 4004 suited best to conditions prevalent in Haurbentes. Phenological data on flowering and fruiting of the provenances involved were collected and reported by the same author. However volume and increment data, though very important for the selection of the provenances were not available yet.

The objective of this research is to make comparisons of growth potentials of seven years old plantations of six provenances established in Pasirhantap and Haurbentes experimental gardens, West Java.

Nine trees in 150 m^2 plots were measured. In Pasirhantap, provenance No. 4040 had the greatest total production namely 212.293 m^3/ha, which is in agreement with a CAI of 34.560 m^3 and a MAI of 30.328 m^3, while in the Haurbentes trials the best growth was observed in provenance No. 4045 and 4004 namely 408.527 m^3/ha and 197.693 m^3/ha, corresponding with a CAI/MAI of 74.840 m^3/58.361 m^3 and 74.260 m^3/28.242 m^3 respectively.

Key words: Fast growing tree species, Current annual increment, Mean annual increment

Cahyono Agus D.K. & Anwar Bale
The effect of several soil properties on the difference performance of *Acacia mangium*, Willd and *Eucalyptus urophylla* stand
Faculty of Forestry, Gadjah Mada Univ., Yogyakarta, Indonesia, 21 pp., 1990, English

Traditionally, plantation forestry involved the use of slow-growing species (i.e. long rotations) and a low intensity of wood utilization (mainly use of stem wood).

Because of increasing demand for wood resources, management is now more intensive, involving the use of fast-growing species, shortened rotations and more intensive utilization (e.g. whole tree harvesting, utilization of thinnings).

Successful plants must be able to adapt to differences in the environments. Such adaptability is particularly important for tree species because they occupy different

environments during progressive stages of development and encounter a range of environmental extremes throughout their long life-cycle.

In the reforestation activity of grasslands and brush, many fast growing species, such as: *Acacia mangium, Eucalyptus mophyla, E. alba, E. deglupta, Paraserianthes falcataria,* etc. have been grown in Riam Kiwa, South Kalimantan.

Individual tree species have an affect on soil, this is achieved by their litter, their root activity and their associated micro-climate. This research should show whether individual tree and trees species have a specific influence on soil productivity.

Key words: Acacia, Eucalypt, Soil texture, Fast growing tree species

Wan Razali Mohd
Modelling the tree growth in mixed tropical forests 1. use of diameter and basal area increments
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (2), 114-121, 1988, English

Tree growth can be expressed by either diameter increment (dD) or basal area increment (dBA). Little work has been done to determine which of these two parameters is the appropriate dependent variable for use in growth models. This paper examines the growth of regenerated mixed tropical forests in Peninsular Malaysia which were measured over a period of 13-20 y. Least squares regression equations were developed to relate dD and dBA to initial tree diameter at breast height (DBHOB) in 36 permanent growth plots of 0.4 ha each. The residual plots relating dD and dBA to DBHOB show the existence of non-homogeneity of variance. The transformations of dD and dBA to remove non-homogeneity of variance were carried out and used to relate to DBHOB. Furnival Index was then constructed and adjusted to compare likelihoods of different statistical models for dependent variables that have been expressed in the same sample space. The result indicates that diameter increment is a more appropriate dependent variable to be used in growth models in mixed tropical forests.

Key words: Tree growth, Diameter increment, Tropical forest, Breast height diameter

B.B. Mohamad
The productivity and growth after logging of a typical hill dipterocarp forest in Peninsular Malaysia
FRIM Report, Malaysia, No. 48, 17 pp. 1986, English

The study consists of a number of cutting trials where logging has been carried out to various lower diameter-at-breast-height (DBH) limits. The objectives is to study and quantify the effects of different intensities of logging in a hill dipterocarp forest on the growth of succeeding stand.

The forest area under study is located within compartments 142 and 144 of Labis Forest Reserve in the State of Johor, Peninsular Malaysia. The experimental area covers 132 ha. of rich dipterocarp forest on hilly and rugged terrain with elevations ranging form about 100m to 500m a.s.l.

Some of the conclusion that can be drawn from this study are that:

a) The trees of <10.0 cm in size grow considerably slower than the trees >10.0cm DBH.
b) At higher logging intensities, the trees <10.0cm DBH grow very rapidly whereas those in the low intensity logging plots show very little growth.
c) The trees of 10.0cm DBH and larger grow extremely well during the first two years after logging but the rate falls rapidly during the subsequent years.
d) The basal area growth of the trees during the early years after logging is much too low to be of any significant value.
e) Despite all the mixed findings on the diameter and basal area growths, volume increments can be considered modest with an average range of 2–3m^3/ha/yr.
f) The growth of the dipterocarps was high but of little value due to their extremely small representation in the residual stand. In this respect the relatively high increment of the LHW nondipterocaprs seems to offer as much hope as the dipterocarps.

Key words: Dipterocarps, Natural forest, Growth, Felling

K. Sandrasegaran
A note on the growth of *Shorea guido* (blanco) BL. (menbatu)
The Malayan Forester, Malaysia, Vol. 28, No. 4, 319–345, 1965, English

This species occurs sporadically throughout the Malay Peninsula, on low-lying undulating land, and hills up to about 1,800ft. It is a medium to large, emergent–storey tree, frequently exceeding 8ft. in girth and attaining a height of 155 ft. The outer bark is characteristically dull yellow–brown in colour, rather smooth to flaky with vertical cracks. The bark is usually shed in irregular flakes. The inner bark is of a pinkish tinge and the heartwood is red. In the Malayan Grading Rules, 1960 edition, the timber of *S. guiso* is grouped under the standard name of Red Balau. This timber is used primarily for heavy constructional purposes. Commercially, a problem exists in seasoning; the timber must be dried slowly to prevent splitting and warping.

This is a species of very wide distribution which has been recorded from Cochin–china, Thailand, Malay Peninsula, Borneo and the Philippines.

A linear plot to study the growth of individual trees of *S. guiso* was established in 1939 in Compartments IV and V of the Telok Muroh Forest Reserve. This study area was designated Perak North Sample Plot No. 35. The plot is situated on the lower, landward slopes of a coastal hill. The elevational range of this plot is from 50 to 300 feet a.s.l. The soil is derived from granite. On the upper slopes the soil is an admixture of coarse sand and clay while that of the lower slopes is clay–loam. The proportion of clay increases downhill. On the upper limits of the hill are found *S. curtisii, S. lumutensis, Vatica* spp. and *Dipterocarpus* spp. *S. guiso* and *S. glauca* are located primarily on the lower slopes. The palm, *Eugeisonna triste,* is the dominant undergrowth species on the higher slopes but is found in lesser degrees on the lower.

In 1941, the average girth of all trees was 27.85 inches with P=0.05, confidence limits ±5.14 inches; and in 1957, 39.31±5.23 inches. Thus, the P.C.A.I. (Periodic Current Annual Increment) for the 16–year period is 0.72±0.08 inches.

The plot was closed in 1957 after representative height measurements had been taken.

Key words: Dipterocarps, Growth, Natural forest

T. Kawahara, Y. Kanazawa & S. Sakurai
Biomass and net production of man-made forests in the Philippines
J. Jap. For. Soc., Japan, 63 (9), 320-327, 1981, English

In four *Albizia falcata* stands, three *Gmelina arborea* stands, a *Swietenia macrophylla* stand and a natural dipterocarp stand, the above-ground biomass, net primary production, and litter fall were investigated.

These forest stands are within the concession of the Aras-asan Timber Company in Aras assan on the east side of Mindanao island in the Philippines. This area belongs to the tropical rain forest zone, which receives abundant rain fall (4,500 mm annual average).

The above-ground biomass was 102, 127, 261 and 262 ton/ha in the 9 year-old *A. falcata,* the 10 year-old *G. arborea,* the *S. macrophylla,* and the dipterocarp stands respectively. Leaf biomass in these stands was 1.6 ton/ha, 1.4 ton/ha, 9.3 ton/ha and 6.0 ton/ha, respectively. leaf litter did not vary greatly among these stands, ranging from 5.2 to 6.3 ton/ha/yr and making up 52 to 72 percent of the total litter.

The total above-ground biomass divided by the average tree height gives the apparent density of dry organic matter per unit space occupied by the forest. The dry matter density of *S. macrophylla* and the dipterocarp stands (1.3 and 1.5 kg/m^3, respectively) was about same as that of Japanese forests. However, the dry matter density of fast-growing stands was estimated as being 0.6 - 0.8 kg/m^3. Their specific gravity was so low that their dry matter density would be about half of that of Japanese forests.

The annual net primary production was 20 ton/ha, 18 ton/ha and 14 ton/ha in the *A. falcata,* the *G. arborea* and the dipterocarp stands, respectively.

Key words: Man-made forest, Growth, Biomass, Tropical forests

Y. Kanazawa, A. Sato & R.S. Orsolino
Above-ground biomass and the growth of giant ipil-ipil (*Leucaena leucocephala* (Lam.) de Wit) plantations in northern Mindanao island, Philippines
JARQ, Japan, vol. 15, No. 3, 209-217, 1982, English

In the Philippines, fast growing species are often used for reforestation after logging in some areas. However, there are only a few ecological investigation on the biomass and the productivity of these species. Such investigation are necessary not only for selecting a suitable species for a given site, but also for a better prediction of the future yield.

The field survey was carried out in the three plantations (eleven plots) of Initao, Naawan and Upper Iligan of Mabuhay Agro-Forestry Corporation.

The biomass of each part varied widely with the stand with 11-155 m^3/ha for stem volume, 6-78 ton/ha for stem dry weight, and 8-96 ton/ha for total above-ground dry weight of tree layer. The leaf amount ranged from 0.7 to 3.6 ton/ha in dry weight or from 1.26 to 6.37 ha/ha in area, but the amount of closed stands was about 2.0-3.6 ton/ha or about 3.0 ha/ha. This amount agreed well with that of deciduous broadleaved forests in Japan.

The apparent biomass density, the quotient of above-ground biomass of tree layer divided by its average height, fell within a rang between 0.46 and 0.72 kg/m^3 in closed stands. These values were approximately half as small as those of forests in japan.

Since the mean stem increment of each stand fluctuated from 10 to 50 m^3/ha/yr, the wide variations of the biomass seemed to be due to stand age as well as to site quality. An estimation of the growth process showed that on a good site the stem volume reached 200 m^3/ha 3–4 years after planting but on a poor site only 40 m^3/ha.

Key words: Fast growing tree species, Biomass, Growth

B.S. Rana, S.P. Singh & R.P. Singh
Biomass and productivity of central himalayan sal (*Shorea robusta*) forest
Tropical Ecology, India, 29 (2), 1–5, 1988, English

The sal forests remaining today represent that the last vestiges of once almost continuous stretch of forests of the submontane Indian Himalaya. This climax forest type may be replaced in future by exotic plantations. This investigation, dealing with biomass and productivity of a submontane sal forest is a part of integrated study. The major objective of the study was to compare the submontane sal forest with sal forests of other regions, and with other forests distributed in tropical world.

The sal forest lies in bhabar zone. The soil is sandy–loam with PH 6.6–6.8 and organic carbon content between 0.67–1.08%. The climate is subtropical monsoon type. Of the 2,076 mm annual rainfall, nearly more than three–fourth occurs between mid–June to mid–September. The year is divisible into three distinct seasons. (a): dry and warm summer season (Mid–march to mid–June), (b): wet and rainy season (Mid–June to mid–September) and (c): dry and cold winter season (October to February) with frequent frost.

Two forest stands near Chorgalia, viz. sal old growth stand and sal seedling coppice forest stand were selected. The former had individuals of various ages, while the latter had a prepondence of individuals in small and intermediate size classes.

Tree biomass was 455 ton/ha and 710.2 ton/ha respectively in newgrowth and oldgrowth stands. *Shorea robusta* accounted for 87% (newgrowth stand) and 94.2% (oldgrowth stand) of the total tree biomass. *M. philippensis,* the major subcanopy species showed only 1.3% and 4.0% of the total biomass. The net primary production between 18–20 *ton/ha/yr.*

Key words: Dipterocarps, Biomass, Growth

T. Suzuki & D.V. Jacalne
Above–ground biomass and the growth of bamboo stands in the Philippines
JARQ, Japan, Vol. 20, No. 1, 85–91, 1986, English

In the Philippines, 30 species of 17 erect and 13 climbing bamboos were found. They grow in marginal lands hillsides, along the banks of rivers and streams and in village homesteads. In the present study, composition, biomass and production structure of the stands of *Gigantochloa levis* and *Schizostachyum lumanpao* were investigated, and these ecological characteristics were discussed in comparing with some stands of tree species.

There were 233 clumps per ha, with the average of 39.8 culms per clump, in the *G. levis* stand, and 2,312 clumps per ha, with the average of 16.4 culms per clump, in the *S.*

lumanpao stand. The number of one-year-old culms in the total was 27.9% in the *G. levis* stand and 28.7% in the *S. lumanpao* stand. These ratios were somewhat larger than those in some stands of other tropical bamboo species. The above ground biomass of *G. levis* stand was 146.8 ton/ha and that of *S. lumanpao* was 58.2 ton/ha. The apparent dry matter density, the quotient of the above ground biomass of bamboo layer divided by its average height, was 0.88 kg/m for *G. levis* stand and 0.67 kg/m for *s. lumanpao* stand. These values were in rough agreement with those of some fast growing tree species in the Philippines. The leaf amount was, however, 8.8 ton/ha in the *G. levis* stand and 5.8 ton/ha in the *S. lumanpao* stand, which were much greater than those of fast growing tree species.

Production structure as expressed by vertical distribution of dry weight of both assimilative and non-assimilative parts was observed by using the stratified method.

The crown was formed widely and the vertex of vertical distribution of foliage was at the part ranging about two thirds of culm length or so. It seems that this type might be a kind of broadleaved tree forest.

Key words: Bamboo, Biomass, Growth

Y.P. Kao & T.T. Wang
Biomass, litterfall and net primary production of moso bamboo stands in central Taiwan
Bamboo Production and Utilization, Proceedings of the Project Group P. 5.04, Production and Utilization of Bamboo and Related Species, XVIII IUFRO World Congress, Yugoslavia, 42-48, 1986, English

Moso bamboo, *Phyllostachys pubescens* Maxel ex H. de Leh., is intensively cultivated for the production of culms and shoots in Taiwan. Most of the plantations are located in the central part of the island with approximately 4,000 ha at 1973.

This study was conducted at Chi-Tou District, Experimental Forest of the National Taiwan University which is located in the central part of Taiwan. The climate of this area is mild and relative humid. The mean temperature of January and July are 14.3° C and 23.1° C, respectively. Average annual precipitation is 2,760mm with 80% falling between May and September.

Study plots were established at two sites supporting low and high productivity Moso bamboo stands. Both sites have been established over forty years and are at the same elevation of 800m.

The biomass accumulated in the good site was 79.3 ton/ha which was 1.65x greater than that in the poor site. The difference was attributed mainly to the capacity of young bamboo production. The biomass of newly regenerated bamboo produced in the good site was 9.2 ton/ha/yr. which was 1.66x greater than that produced in the poor site.

The amount of litterfall estimated over a period of 12 months were 2.248 ton/ha/yr for the good site and 2.539 ton/ha/yr for the poor site. The amount of litterfall varied remarkably as the season changed. Greatest amount of litterfall occurred from April to July which was immediately after the bamboo shoot growth has commenced. A second peak occurred between December and next January. Net primary production (NPP) was 16.1 ton/ha in the good site and 9.5 ton/ha in the poor site.

Key words: Bamboo, Biomass, Growth

A.J. Vincent
A not on the growth of eleven individual species of the genus *Dipterocarpus* in naturally and artificially regenerated forest, Malaysia
FRIM Research Pamphlet, Malaysia, No. 38, 1–38, 1961, English

The quantitative data available on the growth of eleven *Dipterocarpus* species from the old-style subjectively sited permanent sample plots of all types have here been collected and analysed. Analysis is limited by the nature of the data; refined statistical analysis is not possible due to inadequacy of design of the plots supplying the information.

The aim of this analysis was to make interspecific comparison of growth rates, for comparable size or estimated age in natural forest and for comparable age in plantation. The former are of value in giving guidance for silvicultural preference when treating naturally regenerated crops, both within the genus and for inter-generic comparison. The latter are of value in picking out the faster growing plantation species and in planning for balanced mixtures in plantation.

Basal area per acre development for *D. baudii,* the premier plantation species, is given for one of the Instituto plots.

Key words: Growth rate, Stand age, Dipterocarps

Pahim Sulaiman
Growth of some exotic coniferous species on the upland trial plots in Sabah
Forest Research Center, Malaysia, 1–52, 1986, English

The paper described and discussed the growth of exotic coniferous species namely, *Araucaria cunminqhamii* Sweet, *Araucaria* hunsteinii K. Schumann, *Pinus caribaea* Mor., *Pinus oocarpa* Schlede, *Pinus elliottii* Engelm, *Pinus kesiya* Royale, *Pinus merkusii* De Vriese, *Pinus insularis* Endl, *Pinus occidentalis* Swatz, *Pinus massoniana* Lamb., *Pinus patula* Schl and Cham, and *Pinus radiata* P. Don, giving particular reference to their growth rates, characteristics, soil preference and their ability to produce seeds. Growth comparison with their lowland grown "counterparts" is also included.

Key words: Exotic tree species, Growth, Conifer

Soekotjo
Rate of change of diameter growth as a tool of comparing growth rate among species
Bulletin University Gadjah Mada, Indonesia, No. 18, 1–45, 1991, Indonesian

The objectives of this study were (1) to obtain information on growth rate of different species and (2) to use this information to calculate the rate of change as a tool of comparing growth rate among species.

A total of 29 one-hectare permanent growth plots were located in recently logged over

forests. Three years after establishment, diameter growth was measured.

Based on growth data, coefficient of determination, rate of change of diameter growth and inherent growth rate were calculated. It was found that rate of change of diameter growth supplies for a tool of comparing growth rate among species.

Key words: Growth rate, Diameter increment

Jun Kajigaki, Mansor Bin Alunat & Masakiyo Kawaguchi
A method of preparing photo volume table in tropical forest
Forest Research Note in Brunei Darussalam, Brunei, No. 10,
1–18, 1988, English

Purpose of this report is to show a method of preparing photo volume table in tropical forest.

Two types of photo volume table for stand volume were explained.

As an exercise for preparing photo volume table, compart 7 and 8, Andulau Forest Reserve, was investigated. And a photo volume table was prepared as a trial product according to the following volume formula.

$V = -1{,}487.18 + 402{,}756 \log (R \cdot CD^2)$

V: stand volume of bole length with bark per hectare (m^3/ha)

R: crown density (%)

CD: average crown diameter (m)

Key words: Standing tree volume table, Stand, Crown density, Stem volume

2) Harvesting

Wan Razali Wan Mohd., Khali Aziz Hamzah et al.
A volume table for planted *Acacia mangium* in Peninsular Malaysia
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 2 (2),
110–121, 1989, English

Eight unweighted (including two logarithmic transformed) and seven weighted forms of volume equations were fitted by the least squares method to volume data of a 5-y-old *Acacia mangium* plantation. Furnival's index criterion was used to select the best fit equations, for overbark and underbark volumes. The logarithmic equation, adjusted for bias, was chosen as the most appropriate model for the species. The final equations, used to construct the overbark (Vo) and underbark (Vi) volume tables are:

$Vo = 0.0003150 \times D^{1.54738} \times H^{0.80931}$, $Vi = 0.0002707 \times D^{1.51310} \times H^{0.84789}$

where Vo and Vi are merchantable tree volumes (m^3) up to 10 cm diameter overbark, D the breast height diameter (cm), and H the total log length (m). The equations were found to estimate a merchantable tree volume and hence the aggregate standing volume satisfactorily under the given study conditions. As usual, a test of applicability of these equations is needed if they are to be applied elsewhere.

Key words: Acacia, Plantation, Stem volume

Komar Soemarna & Bambang E. Siswanto
Preliminary tree volume table of *Dipterocarpus cornutus* Dyer in the
Forest District Kotabaru, South Kalimantan
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia,
No. 474, 22–52, 1986, Indonesia

The construction of volume tables for Keruing (*Dipterocarpus cornutus* Dyer) in the Forest District Kotabaru, South Kalimantan, were aimed at the improvement of the estimation of standing stock, and the improvement of the computed Annual Allowable Cut (AAC) as well.

Three regression equations were studied, i.e.

1. $V = a \cdot d^b$ or $\text{Log } V = \log a + b \log d$
2. $V = a \cdot d^b \cdot t^c$ or $\text{Log } V = \log a + b \log d + c \log t$
3. $V = \pi/4 \cdot d^2 \cdot t \cdot f$

Where d=stem diameter at breast height or 20 cm above the end of buttress, t=height of crown base, f=the average stem form factor and a, b, c are constants.

For the estimation of stem volume up to crown base the computed regression equation are $V=0.14127286\ d^{2.514157281}$ and $V=0.050334462\ d^{2.244578487} \times t^{0.650752912}$ with standard error of estimate of 15.8% and 12.0%, respectively, where as for the wood volume up to diameter limit of 10 cm the regression equation are $V=0.10622488\ d^{2.618817431}$ and $V=0.047574602\ d^{2.408990891} \times t^{0.506513256}$ with standard error of estimate of 17.35% and 15.36%. The use of height as independent variable increases the precision of the estimates of 3.8% and 1.99%.

The average stem form factor of Keruing (*D. cornutus* Dyer) is 0.56, which is

significantly different from presently assumed value of 0.70. The similar value was found from *D. cornutus* Dyer in the Forest District of Kotabaru, South Kalimantan. Therefore, the use of the presented volume tables would significantly improve the inventory result of the concerned *D. cornutus* Dyer.

Key words: Dipterocarps, Standing tree volume table, Tree height, Diameter breast height

P. Bhodthipuks
Yield of *Thyrsostachys siamensis* in Thailand
Bamboo Production and Utilization, Proceedings of the Congress
Group 5. 3A, Production and Utilization of Bamboo and
Related Species, XVII IUFRO World Congress, Japan, 169–171, 1981,
English

Thyrsostachys siamensis is one of the bamboo species commonly cut for domestic uses. They thrive almost everywhere in the central and northern parts of Thailand where the moisture content and soil quality are lower and insufficient for other large size bamboo. Nowadays, pulp and paper are in great demand so that the exploitation must be closely controlled. Consequently, the stand of the control has to rely on the yield of *Thyrsostachys siamensis*. In this paper, there are four cases in Kanchanabury and tak provinces having been studied.

As the locations of four studied cases were examined, they showed different factors concerned. The factors may include site quality, climatic condition and exploitation.

In case I, the yield of 14.22 ton/ha is the highest among four cases. This is due to good soil and prohibiting of cutting. However, the culm is small because of sharp drought period in the summer. In case II, the yield of 4.30 ton/ha is lower than in case I, but the weight of the culm is 7.08 kg/culm which is the highest. This is due to high moisture content which causes large size bamboo. Nevertheless, the number of culms is lower because the bamboo forest has been overexploited. In cases of III and IV, the yields are much lower due to being overexploited.

In order to keep the sustainable yield, exploitation should be controlled.

Key words: Bamboo, Yield volume, Growth, Minor forest products

J.K. Vanclay
Modelling selection harvesting in tropical rain forest
Journal of Tropical Forest Science (FRIM), Malaysia, Vol. 1, No. 3,
280–294, 1989, English

Long term yield estimates for natural forests require a harvesting model to enable future yields to be estimated reliably. The model should predict the felled stems, the proportion of these which are merchantable, and any damage to the residual stand. Regression analyses was used to develop a model of current logging practice in the rain forests of north Queensland. Logistic functions predict the probability of any tree being marked for logging, the probability of a felled tree being merchantable, and the probability of any tree in the residual stand being damaged by logging. Important predictor variables included tree species and size, merchantable basal area, basal area logged, logging history,

and topography. There was no evidence to suggest that soil type or site quality influenced current treemarking practice. The approach is applicable to other mixed forest types managed for selection logging.

Key words: Yield table, Selective cutting, Tropical rain forest

Djoko Wahjono & Komar Soemarna
Tree volume table and logs volume table for *Swietenia macrophylla* King, in Jember Forest District, East Java
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 493, 1–13, 1987, Indonesian

Log and stand volume table for mahogany grown in plantations in the Jember Forest District East Java Province were introduced. The construction of these table was aimed at the improvement of the log and stand volume assessment in order to avoid losses by erroneous estimation.

Tow intrinsically linear regression models have been developed namely

$I = ad^b$

and $I = ad^bt^c$

when applied to the clear bole and thick wood volume,

I : volume of the clear bole of thick wood
d : diameter at breast height
t : height of the crown base

when applied to the log volume

I = log volume
d = top diameter

The all regression equations are considered sufficient for an unbiased estimate of log and stand volume of plantation grown mahogany in the Jember Forest District, East Java.

Key words: Growing stock, Standing tree volume table, Diameter breast height

Kyoji Hashimoto & Mansor Bin Haji Ahmat
Comparison of the Malayan volume table on *Kapur* species and *Keruing* species
Forest Research Note in Brunei Darussalam, Brunei, No. 34, 1–19, 1989, English

The forest mensuration is one of the basic way in the forest inventories. However, there is no volume tables for every species existed in Brunei Darussalam.

In West Malaysia, thirteen commercial volume tables have been prepared for the indigenous trees species. This study is to test the Malayan volume on *Kapur* spp. and *Keruing* spp. in Brunei Darussalam.

Key words: Growing stock, Standing tree volume table

Mansor Bin Haji Ahmat & Kyoji Hashimoto
Comparisons of Anderson's volume equation and the Malayan volume tables on *Shorea albida*
Forest Research Note in Brunei Darussalam, Brunei, No. 41, 1–16, 1990, English

No volume equations or tables had previously been prepared for *Shorea albida* in Negara Brunei Darussalam. However, Anderson had estimated volume equations derived from Forestry and Forest Industries Development Programme (FFIDP) in Sarawak for Alan in Brunei (Anderson, 1984). While the Malayan volume tables are comprised for *Shorea* group species (A.J. Vincent and K. Sandrasegaran, 1965). There is a risk to use directly all volume equations and tables existed for other area without any test whether can be applied or not. Because they are of limited application as background and specifications for the equations are not always known. This study is to examine their applications for Alan in Brunei.

Key words: Growing stock, Standing tree volume table, Stem volume

3) Forest Management

P. Bhodthipuks
Bamboo plantation in Thailand
Bamboo production and utilization, proceedings of the congress group 5. 3A, production and utilization of Bamboo and related species, XVII IUFRO World Congress, Japan, 165-171, 1981, English

Bamboo plantation on small scale for domestic uses is commonly in practice long time ago as food, tools, handicraft and housing. Villagers have planted *Thyrsostachys siamensis, Bambusa arundinacea, B. blumeana, Dendrocalamus asper* and *D. membranaceus* along the fences and homesteads.

Commercial plantation of *Dendrocalamus asper* is only the commercial plantation in Thailand. Even though, large amount of bamboo shoots are from natural wild stands where the main source of depletion occurs. These shoots are not so good in taste as *D. asper*. That is why farmers plant only *D. asper* which is in great demand either of green or canned shoots. Actually, this species is planted everywhere in Thailand and Malaysia from the lowlands to about 1,000m in altitude. Its culms are highly priced as building materials. Low Humic Gley soils are common for plantation for they are abundant of moisture content but they require well drained soils. Alluvials are the best yet available since they are present only along rivers.

Spacing is 8/8m making at least 100 clumps per hectare. The spacing seems to be too wide but *D. apser* requires such spacing and is expected to cover the area at its mature age. After 5-7 years, they can produce 1,000 shoots annually or 1,000 dollars worth (average 1 shoot = 4kg., 1 kg=0.25 U.S. dollars). The total investment per hectare in 5 years is about 2,100 U.S. dollars including 300 dollars each year for maintenance. This means that it will take only two years to cover previous expenses and then 700 dollars a year per hectare would be net profit as sustained yield. It is good enough for Thai standard of living which is only one-tenth of the developed country's standard of living.

Key words: Bamboo, Planting, Minor forest products

H.T. Tang
Factors affecting regeneration of methods for tropical high forests in South-East Asia
The Malaysian Forester, Malaysia, Vol. 43, No. 4, 469-480, 1980, English

The tropical high forests of South-east Asia have been and are continuing to be depleted at an excessively high rate. Unless immediate and firm action is taken to reduce the rate of logging and deforestation and to dramatically increase the rate of forest development, the countries in the region may become net timber importers before the end of the present century.

The feasibility of managing tropical high forests on a sustained yield basis has become increasingly suspect in recent years. Many tropical countries have turned away from natural forests management to plantation forests management and tropical forestry itself is

increasingly becoming a matter of establishing and managing plantations in the tropics rather than of managing tropical forests as natural forests.

Any method of regeneration in tropical moist forest presents technical and operational problems related to the complexity of the ecosystems, the many species and site differences over small areas, difficulties of access and movement in the forest and the frequently large areas to treated. Where the responsibility for regeneration work falls on the concession-holder, these problems are often compounded by their general short-term outlook and primary concern for maximizing profits.

Two main strategies of forest renewal can be identified, viz, the afforestation of degraded land and the proper management of existing forests.

The selection of regeneration systems for high forests must be related to national timber production objectives which must define the quantity, quality and species composition requirements of the country. These systems can no longer be based on biological considerations alone but must also be economically justified as they will, increasingly, be subjected to cost-benefit evaluations.

In particular, the "intangible" benefits provided by natural forests must be quantified. The final test of the systems selected will be their successful implementation and this requires adequate trained, experienced and dedicated manpower.

Key words: Natural forest, Regeneration, Forest management plan, Felling

Geoffrey A. Kent
Assessment of mangrove regeneration after logging for woodchips
FRC Publication, Sabah, Malaysia, No. 29, 1-42, 1986, English

A study of the stocking, species composition and distribution pattern of mangrove regeneration in the Kuala Maruap and Kuala Segama region of Sabah was undertaken. Coupes logged in 1980, 1981, 1982 and 1983 were examined using the Linear Regeneration Sampling method. Some factors that influence regeneration were also assessed.

With the exception of the coupe logged in 1982 which had a stocking of 15,890 seedlings/ha, the regeneration was found to be extremely variable. Distribution of regeneration was a major problem. In the coupe logged in 1980, over 60% of the quadrats sampled had no seedlings. The coupes logged in 1981 and 1983 had over 40% of their sample quadrats empty. A lack of retained seed trees appeared to be the primary cause of this problem. Any future licences that are granted for large scale felling in Sabah's mangroves should include conditions aimed at ensuring adequate regeneration. Failure to do so could lead to the degradation at this valuable forest and fisheries resource.

Key words: Natural regeneration, Seed tree, Mangrove, Felling

H.C. Thang
Selective management system concept and practice
Forest Management Unit, Malaysia, 1-19, 1988, English

Peninsular Malaysia has been fortunate to be endowed with extensive areas of valuable natural tropical rainforest which are extremely complex ecosystems and are richer in tree

species than in similar areas of Africa and South America.

The forests of Peninsular Malaysia have been variously classified according to their ecological and physical conditions but for the purposes of management they can be classified broadly into the Dipterocarp, Freshwater Swamp and Mangrove forests.

Peninsular Malaysia has identified a total of 4.75 million ha of forested land as the Permanent Forest Estate to be managed under sustained yield. Approximately 2.85 million ha of the Permanent Forest Estate have been identified as production forest with the remaining 1.90 million ha as protection forest. Of the production forests, it has been estimated that 0.98 million ha are still undisturbed while 1.87 million ha have been logged-over in the past with 0.58 million ha have been logged-over forests being reloggable as they were harvested well before 1966. The long-term timber supply in Peninsular Malaysia will depend mainly on the production forests of the Permanent Forest Estate.

Key words: Productive forest, Forest management plan, Management plan

5. Forest Conservation

1) Watershed Management

Abdul Rehim Nik
Water yield changes after forest conversion to agricultural landuse in Peninsular Malaysia
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (1), 67-84, 1988, English

A paired-watershed experiment, comprising three small catchments in Sungai Tekam, Pahang, Peninsular Malaysia, was carried out from 1977 to 1986 to determine and quantify the effect on water yield of a typical forest land conversion to agricultural landuse. Two Catchments, A and B, were treated after five and three years of calibration and subsequently planted with cocoa and oil palm, respectively. Significant increases in water yield were observed in both catchments. The highest increase occurred in the second and fourth year after treatment, amounting to 706 mm (157%) and 822 mm (470%) in Catchments A and B, respectively. Different magnitudes of annual yield increment apparently reflected the various activities of land conversion including timber harvesting, under-brushing, clear felling, road construction and planting of cover crops. Management implications of these yield increases are discussed.

Key words: Rate of discharge, Logged-over area, Watershed

Baharuddin Kasran
Effect of logging on sediment yield in a hill dipterocarp forest in Peninsular Malaysia
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (1), 56-66, 1988, English

Investigations on suspended sediment yield was made from three small forested catchments before and after logging in Bukit Berembun Forest Reserve, Negeri Sembilan, Malaysia, over a period of six years from 1980. Both catchments (BC1 and BC3) were logged using normal 'san-tai-wong' method, but BC3 with close supervision and additional prescriptions, such as a proper road construction and alignment and construction of cross drains on steep logging roads. BC2 remained as control catchment. After logging, the suspended sediment yield increased by 97 and 70% from BC1 and BC3 respectively, as compared to before logging. The highest weighted suspended sediment concentration also increased from 386.0 to 844.5 mg/l from BC1 and 158.3 to 318.2 mg/l from BC3. Hence supervised logging could reduce sediment in forest waterways considerably.

Key words: Forest hydrology, Watershed, Forest land conservation

L.A. Bruijnzeel
Estimates of evaporation in plantation of *Agathis dammara* Warb. in South-Central Java, Indonesia
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (2), 145-161, 1988, English

A water balance is presented for a 19-ha catchment covered with 11- to 35-y old plantation forest of *Agathis dammara* Warb. in central Java.

During the rainy season of ratio (f) between actual evapotranspiration (ET) and Penman open water evaporation (Eo) remained close to 0.79. The study period included an exceptionally severe dry season. Due to the deep nature of the soils, moisture stress did not limit transpiration (Et) until the last month of the drought (November, f=.69). It was inferred that during years with average rainfall ET would be close to 1070 mm yr^{-1}. Measurements of throughfall of 11- and 35-y old stands of *Agathis* and in *Chromolina* thicket indicated average rainfall interception (Ei) of 23,14 and 9% of incident rainfall. Subtracting Ei from ET yielded an average rate of Et of about 400 mm yr^{-1} for the entire catchment, a rather low value.

The available information on ET and various tropical land-use types is reviewed briefly. The presently obtained throughfall figures are discussed in the light of results from over twenty throughfall studies in Southeast Asian forests. The use of a roving gauge technique is stressed if reliable estimates are to be obtained.

Key words: Forest hydrology, Water balance, Precipitation, Evapotranspiration

R. Soerjono & Irfan Budi Pramono
Water balance at Cidanau watershed, West Java
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 536, 29-34, 1990, Indonesian

This research was conducted at Cidanau watershed, West Java with the objective of estimating indirectly the water balance of Cidanau watershed based on secondary data with respect to the climate and the physical conditions of the watershed. Data on climate included rainfall and temperature. Physical conditions included several soil characteristics (field capacity, wilting point, soil texture) and land cover types.

The percentage of soil moisture available to plant growth was computed by subtracting the weight percentage of water held at wilting point from the field capacity. The quantity of water accessible for consumptive use by vegetation was estimated by multiplying this percentage with the volume of the rooting zone and peaks when the precipitation exceeds the evapotranspiration rate.

Available water of the Cidanau watershed is greatest at the time when the maximum water content is reached. Results are presented of run-off characteristics and potential evapotranspiration estimates made with the use of the formula given by Thornthwaite and Mather.

Monthly averages of surface run-off varied between 1.09 m^3 to 18.29 m^3 per second.

Key words: Water balance, Watershed, Forest hydrology

AG. Pudjiharta
The hydrological aspect of *Parkia javanica, Swietenia macrophylla* and *Pinus merkusii* in Bogor as observed with lysimeter
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesian, No. 487, 1–12, 1986, Indonesian

Research on the hydrological aspect of three selected tree species, namely *Parkia javanica, Swieteonia marcrophylla* and *Pinus merkusii* was carried out at Bogor.

Measurements of hydrological parameters were made using three concrete lysimeter, measuring 4m x 3m x 2m.

It was observed the water lost to evapotranspiration, interception and uptake amounted only up to 30.93% with *P. javanica,* while with *S. macrophylla* and *P. merkusii* were 58.34% and 64.28% of the precipitation respectively.

These figures indicate that *S. macrophylla* and *P. merkusii* transfer large amounts of water and are therefore unsuitable as a reforestation species on semiarid areas of Indonesia, where a low annual rainfall prevails.

It is expected that *P. javanica* is also not suitable to function as a soil cover, because of the sparse foliage and small crown.

Key words: Crown density, Forest hydrology, Water balance

Chairil Anwar, Karlissarini Baheramsyah & Zoefri Hamzah
Effectiveness of shrubs and agroforestry in Kadidaten Village in trimming runoff and erosion
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 511, 1–8, 1989, Indonesian

This research intends to offer information to decision makers on suitable plant cover mixtures and cropping system capable of reducing runoff and erosion on lands with slopes up to 30%.

The research is aimed at evaluation of the anti-erosion influence of agroforestry and shurbs. Calculations of runoff and soil loss were based on measurements made on 0.38 ha of land that was cropped 2 years under the agroforestry system and four plots of 4x22 meters vegetated with shrubs.

The result of the observations showed that shrubs were more effective in halting runoff and erosion than the agroforestry system. Runoff and erosion under agroforestry crops were 0.31% and 0.061 ton/ha/year, while the figures for shrubs were respectively 0.21% and 0 ton/ha/year.

Key words: Vegetation, Shrub, Erosion, Agro-forestry

Irfan Budi Pramono & Ag. Pudjiharta
Water balance on *Pinus merkusii* stand at Ciharum sub catchment, West Java
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 524, 9–15, 1990, Indonesian

The water requirement for *Pinus merkusii* is necessary to be investigated in connection with watershed managment, because this species has been considered needing much water for its growth. A research on the water balance of the sub catchment covered by *Pinus merkusii* has been conducted at the Ciharum sub catchment, Sumedang, West Java.

The aim of the research was to investigate the water balance of the *Pinus merkusii* stand so that the water requirement of *Pinus merkusii* could be derived.

The research used the sub catchment approach method. Discharge can be obtained from the monitoring of the Automatic Water Level Recorder (AWLR) which has been constructed on a V–Notch Weir. The water requirement of *Pinus merkusii* can be calculated from the annual rainfall minus the annual discharge.

The result shows that the water requirement of *Pinus merkusii* is 1262 mm per year. The ratio between maximum and minimum daily discharges is 2.2:21.7 liter/second or 1:10.

Key words: Pine, Man–made forest, Water balance, Forest hydrology

2) Soil Conservation

Ign. Purwanto & A. Ngaloken Gintings
Infiltration capacity of soils under various vegetation covers at Cijambu, Sumedang, West Java
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 518, 13–22, 1989, Indonesian

Infiltration of water into the soil is an important phenomenon which affects the hydro-orological functions of forest soils, especially in the upper parts of a watershed.

This investigation was conducted for the study of both soil hydraulic conductivity and cumulative infiltration capacity into soil under plantations of 27 years old *Pinus merkusii,* 3 1/2 years old *Eucalyptus* sp., 3 1/2 years old *Maesopsis eminii* and agricultural crops at Cijambu, Sumedang, West Java. The main soil type of the forest area is inceptisols.

The infiltration measurements were made with a ring infiltrometer. Kostikov's Equation was used for data analyses.

The results showed that the constant infiltration rates (an hour after flooding) were: 29.88 cm/hr, 26.28 cm/hr and 22.79 cm/hr for *Eucalyptus* sp., *Pinus merkusii* and *Maesopsis eminii* respectively and 8.64 cm/hr, 4.68 cm/hr for cabbage and *Eupatorium* sp. respectively.

It is concluded that plantations of *Eucalyptus* sp., *Pinus merkusii* and *Maesopsis emini* would have positive influence on physical soil characteristics especially with regard to the improvement of the soil infiltration capacity.

Key words: Infiltration capacity, Forest land conservation, Physical characteristic, Soil

Irfan Budi Pramono & Ag. Pudjiharta
Water balance on *Pinus merkusii* stand at Ciharum sub catchment, West Jave
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The result shows that the water requirement of *Pinus merkusii* is 1262 mm per year. The ratio between maximum and minimum daily discharges is 2.2:21.7 liter/second or 1:10.

Key words: Pine, Plantation, Water balance, Forest hydrology

Ag. Pudjiharta & M. Kudeng Sallata
Stemflow, throughfall and rainfall interception on *Pinus merkusii* stand in a tropical rainforest at Cikole, Lembang, North Bandung, West Java

Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 471, 49-62, 1985, Indonesian

The study which was carried out in the Cikole forest, Lembang, North Bandung Forest District was aimed at finding the rainfall interception of 10, 15 and 20 years old *Pinus merkusii* stand which grew closely together.

In this study quadratic sample plots of 10 x 10 meters were used. Each age class is represented by two replicated plots. Total rainfall (Po), throughfall (Pt) and stemflow (S) were measurd. Correlation between rainfall, stemflow and crown interception were checked by regression analysis.

The total rainfall recorded was 1794 mm. In a 10 years old *Pinus merkusii* stand the rationing of the total rainfall was as follows: crown interception 15.8%, throughfall 51.5% and stemflow 32.6%. In a 15 years old stand, these items were 22.4%, 48.7% and 28.8%, while in a 20 years old *Pinus* stand, 30.67%, 46.4% and 22.8%, respectively.

Analysis of available data showed that linear correlations hold between rainfall and stemflow, rainfall and throughfall, rainfall and crown interception.

The study indicated that the interception in *Pinus merkusii* plantation increased with the age of the stand.

Key words: Pine, Forest land conservation, Forest hydrology

W. Bingsen & Z. Xiaoke
A preliminary study on the function of water and soil conservation of a *Chimonobambusa utilis* forest
Bamboo Journal, Japan, No. 8, 68-75, 1990, English

Chimonobambusa utilis is one of the main economic bamboo species in southwestern China. This bamboo is not only used as useful boles and edible shoots, but also has functions for water and soil conservation. In order to exploit the ecological functions of this bamboo, the roles of water and soil conservation of the three forest layers, crown canopy, litter and soil layers, of a *Ch. utilis* forest were studied. Other forests were also investigated for comparison.

The study was conducted in the watershed within the Wujiang river of Guizhou province, with the elevation ranging from 1300 to 1750 m.

The mean annual temperature ranging from 9.7 to 12.4° C. Annual precipitation is about 1300 mm, and relative humidity is more than 80%.

The results are as follows:

Water-interception of the canopies: The *Fagus lucida-Chimonobambusa utilis* forest > the mixed coniferous forest > the pure *Ch. utilis* forest or the pure coniferous forest. Water holding capacities of litters: The *Fagus lucida-Ch. utilis* forest > the mixed coniferous forest > the pure coniferous forest.

Water-holding capacities of the soil layer: the *Fagus lucida-Ch. utilis* forest > the *Ch. utilis* forest > the *Pinus massoniana* forest > the *Liquidambar formosana-Quercus*

accutissima, Q. aliena forest. The results suggest that *Ch. utilis* is important for the establishment of forests. As *Ch. utilis* is a bamboo species with multifunction, the management of its forest should be decided depending on the objectives. If the object is given priority to the function on soil and water conservation, a natural bamboo forest will be remained to mix with other tree species to increase the stratification structure of the forest.

Key words: Bamboo, Mixed forest, Forest land conservation, Forest hydrolog

IGN. Purwanto & R. Soerjono
The effect of various soil conservation practice on soil erosion rates and surface run-off under teak plantation
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 520, 19-30, 1989, Indonesian

The aim of this investigation is to study the effects of various soil conservation practices in order to minimize soil erosion and surface run-off under teak planted on grumusols on slopes of 30-55% in Bojonegoro, East Java.

The results indicated that without soil conservation measures the rate of soil erosion under the teak plantation was 34,048 ton/hectare/year, while treatments using horizontal ditches, ground cover mulches and a vegetative cover reduced erosion up to 31,846, 18,816, 18,135 ton/hectare/year respectively.

Regression analyses showed close correlation between the amount of rainfall and soil erosion as well as with run-off.

Key words: Forest land conservation, Erosion, Surface runoff

Zulkiflt Yusop, Anhar Saki & Baharuddin Kasran
Postlogging effects on suspended solids and turbidity
The workshop on watershed development and management, Malaycia, 1-34, 1990, English

Five years data for postlogging period were analyzed to evaluate the impact of two selective logging methods namely, "Unsupervised" and "Supervised" on Suspended Solids and Turbidity levels. With respect to turbidity, the stream water quality of disturbed forest generally exceeded the recommended limit for portable use. Suspended solids and turbidity levels were both increased by five and nine folds, respectively during the first year after unsupervised logging. However, the increases due to supervised logging were small and revert to background level in the second year. Suspended solids transports for undisturbed state ranged from 0.08 to 0.24 mt/ha/yr. The levels were elevated following unsupervised logging, by 20 folds in the first year and remained high, between four to five folds in the subsequent years. Nevertheless, for supervised logging the suspended solids loads were only two folds as high as the control's.

Key words: Uncontrolled cutting, Run-off of soil, Turbidity, Felling

IGN. Purwanto & R. Soerjono
The impact of landuse on erosion and run-off in the Citadduy watershed
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 519, 35-54, 1989, Indonesian

In many parts of the Citanday watershed (West Java) soil erosion and run-off are rapidly depleting soil productivity, although the watershed has been managed for more than 10 years. The lands in the river basin have a rough topography with slopes ranging between 32-42%, of which only 5% were in forest lands and these conditions contribute to the erosion problems in the upland area and flood problems downstream.

Choice in management systems for erosion control in the uplands of the watershed depends on an understanding of the erodibility of the soils, erosivity of the rainfall, traditional land use, crops to be farmed and socio-economic conditions of the farming community.

Erosion and run-off measurements were made in two model farms. The findings indicated that the physical and chemical properties of soils are related with erodibility.

Key words: Water shed management, Soil texture, Erosion

Chong Sun Fatt
Sediment problems and their management in Peninsular Malaysia
Water International, printed in Netherlands, No. 10, 3-6, 1985, English

Rivers in Peninsular Malaysia under natural conditions were known to have stable regimes and carried low sediment loads. However, as a result of rapid development during the last few decades, river sediment loads have gravely increased. Consequently, problems of soil erosion and sediment discharge have emerged as matters of national concern. It has been estimated that more than 80% of the suspended sediment load is caused by human activities in the catchments. This paper discusses the natural processes and different human activities which contribute to sediment generation, the main types of sediment problem, current sediment control measures and the implementation constraints.

Key words: Forest land conservation, Run-off of soil, Erosion

Abd Razak Othman
A note on bamboo for soil stabilization and erosion control on forest roads in FRIM
Technical Information, Malaysia, Vol. 1, No. 10, 1-6, 1989, English

In FRIM, several bamboo species have been planted on several steep slopes along forest roads to protect road cutting and land slides. There are four common bamboo species planted and these can be classified in two types, large sized bamboo such as *Bambusa vulgaris, Gigantochloa levis* and *Gigantachloa scartechinii*, and small-sized bamboo such as *Schizostachyum jaculens.* Its ability to propagate, grow and establish easily is the main

reason why bamboo was planted on the slopes.

Key words: Revegetation cut slope, Bamboo, Erosion

Peh Cheng Hock
Runoff and sediment transport by overland flow under tropical rainforest condition
The Malaysian Forester, Malaysia, Vol. 43, No. 1, 56–67, 1980, English

This study represents an attempt in investigating the efficiency of overland flow as a denudational process under lowland tropical rainforest conditions, and is based on measurements of runoff and rates of sediment transport in the Pasoh Forest Reserve, Nagi Sembilan and the Bukit Lagoang Forest Reserve, Selangor. This investigation was carried out over a one-year period from January to December, 1974.

Results indicate that runoff values ranged from 1.3 litres/cm/yr to 3.1 litres/cm/yr and erosion rates varied from 0.196 $cm^3\ cm^{-1}\ yr^{-1}$ to 0.622 $cm^3\ cm^{-1}\ yr^{-1}$ at the trap sites located in the Bukit Lagoang Forest Reserve. The trap sites in the Pasoh study area recorded runoff values ranging from 0.53 litres/cm/yr to 10.6 litres/cm/yr, while erosion rates ranged from 0.248 $cm^3\ cm^{-1}\ yr^{-1}$ to 2.75 $cm^3\ cm^{-1}\ yr^{-1}$.

Key words: Run-off of soil, Erosion, Surface runoff

6. Forest Products

1) Timber

L.T. Chew, C.L. Ong & Suhaimi Muhammad
Urea-formaldehyde particleboard from Yamane (*Gmelina arborea*)
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (1),
26-34, 1988, English

Yamane, one of the species of the Compensatory Forest Plantation Programme, provides a source of suitable raw material for the manufacture of medium density urea-formaldehyde particleboards. This study indicates that yamane can be successfully blended with flakes of other species to produce urea-formaldehyde particleboards to meet the requirements of Type 1 Standard Board. The good strength properties of urea-formaldehyde particleboards comprising the flakes of yamane, batai (*Albizia falcataria*) and *Acacia mangium* indicate that these species are potential raw material for urea-formaldehyde particleboard manufacture.

Key words: Plantation, Particleboard, Fast growing tree species

Y. Tomimura
Medium density fibreboard from *Albizia falcataria*
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (1),
35-41, 1988, English

Medium density fibreboards or MDF were made from a fast growing tree, *Albizia falcataria*. Four cooking conditions, three using soaked chips and one using air-dry chips, were selected. In the manufacture of the fibreboards at three target densities, urea resin was used as an adhesive. The boards with densities of 0.4, 0.5 and 0.6 g/cc generally met the Japanese Industrial Standards JIS 5906 for 50-type, 150-type and 200-type boards respectively, based on the classification of board by bending strength. The thickness swelling of all the boards also met the specifications although no hardeners or wax were used.

Key words: Fibreboard, Fast growing tree species

W.C. Wong, K.S. Ho & C.N. Wong
Acacia mangium from Sabah for plywood and decorative panel manufacture: Initial trials
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (1),
42-50, 1988, English

Acacia mangium could be peeled and sliced easily. Decorative panel with *A. mangium* sliced veneer as face appeared to be attractive. Phenolic bonded plywood made with rotary cut. *A. mangium* veneers met the performance requirement for weather-boil-proof (WBP)

grade. However, the bond quality of *A. mangium* plywood using urea formaldehyde adhesive was found to be poor. At 15 years of age, the logs were too small to be economically peeled using existing lathes tailored for peeling big tropical hardwood logs. The small size of the logs, of which some were of poor form, resulted in low recovery rate. Trees for plywood production should be bigger and in better form.

Key words: Plywood, Acacia, Adhesion

Y. Tomiura, K.C. Khoo, C.L. Ong & T.W. Lee
Rubberwood for medium density fibreboard
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 2 (3), 175–179, 1990, English

Medium density fibreboards were made from Malaysian rubberwood. Three cooking conditions using soaked chips were selected. In the manufacture of the fibreboards at three target densities, urea resin was used as adhesive. The boards from fibres obtained at cooking pressure of 6 kg cm^{-2} did not meet the specifications for thickness swelling according to Japanese Industrial Standard JIS 5906. The boards from fibres obtained at cooking pressures of 8 and 10 kg cm^{-2} with densities of around 0.4, 0.5 and 0.7 g cm^{-3} generally met the board specifications for type JIS–50, JIS–150 and JIS–200 respectively based on the classification by bending strength. The internal bond of all boards, especially at density 0.7 g cm^{-3}, was excellent.

Key words: Fibreboard, Adhesion

Ani Sulaiman & S.C. Lim
Some timber characteristics of *Gmelina arborea* grown in a plantation in Peninsular Malaysia
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 2 (2), 135–141, 1989, English

Three trees of 33–y–old *Gmelina arborea* were examined. The timber was pale in colour with straight to slightly interlocked grain. Texture was moderately coarse. The timber was light to medium weight with basic density ranging form 345 to 620 kg m^{-3}.

The timber had indistinct growth rings, and pores with simple perforation and arranged in solitary, radial pairs and radial multiples of up to six pores. The pores were moderately small to extremely large. Parenchyma was mainly paratracheal with vasicentric and confluent type. Generally, density increased from pith to bark and from the butt end to the top of stem.

Key words: Fast growing tree species, Wood quality

N. Yamada, K.C. Khoo & Mohd Nor Yusoff
Sulphate pulping and papermaking characteristics of *Acacia* hybrid, *A. mangium* and *A. auriculiformis* from SAFODA plantation
Sabah Forestry Development Authority Report, Sabah, Malaysia, 13 pp., 1988, English

Sulphate pulps of different degrees of delignification were prepared from nine years old *Acacia* hybrid, though to be cross-breed of *A. mangium* and *A. auriculiformis* in SAFODA plantations. And results were compared with pulps from its parents. The results of pulping and papermaking of the latters were consistent with precedent investigations. The wood of *A.* hybrid gave yields in excess of 55 percent of screened pulps with very good papermaking properties. It was found superior to *A. mangium* and *A. auriculiformis.*

Key words: Pulp, Wood chemistry, Acacia

Chan Hing Hon
Construction of a solar kiln at Forest Research Center, Sabah
FRC Publication, Sabah, Malaysia, No. 6, 1–14, 1983, English

The use of solar energy for various applications has been well-developed, and a few experimental kilns have been constructed at various countries in the world.

The construction of a solar kiln of 12 m^3 capacity at the Forest Research Centre is described. Test runs indicate that the solar kiln is efficient, simple and easy to oeprate and cheap to run.

Key words: Wood drying, Moisture content

2) Non-timber

W.C. Woon, W.K. Hoi & Puad Elham
Economics of rubberwood charcoal production using the transportable metal kiln
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 1 (4), 327-335, 1989, English

The Tropical Development and Research Institute has developed a transportable metal kiln which is suitable for converting most types of wood residues to charcoal. We have successfully adapted this technology to produce rubberwood charcoal. To determine the optimum number of kilns suitable for economic charcoal production in rubber smallholdings, six operating schedules involving various number of kilns and workers were considered. The TMK was found to be technically feasible and financially viable for use in rubberwood charcoal production in the rubber smallholding during replanting. The 3 kilns/3 men kiln rental operating schedule is the most profitable schedule to adopt. The unit production cost varied from 6.7 to 10.9 cents per kg while monthly profit derived ranged from US$42.08 to US$579.05 depending on the operating schedule used. The payback period and breakeven area varied from 0.7 to 19.6 months and 0.5 to 5.1 ha respectively.

Key words: Charcoal, Wood residue

Mohd. Nor Mohd. Yusoff, L.T. Chew et al.
The adhesive properties of bark extract of *Acacia mangium*
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 2 (2), 104-109, 1989, English

Laboratory investigations on bark extract of 4-y-old *Acacia mangium* trees showed a high reactivity of the extract towards formaldehyde (Stiasny number about 100).

In this study of the adhesive properties of the bark extract of *A. mangium,* the bark extract could be used as a bonding agent to partially replace phenol for plywood manufacture. The bark extract was very reactive as indicated by its SN of above 100. The bonding properties of the plywood using bark extract as an adhesive were excellent, evidenced by the failing loads of the plywoods made, exceeding the minimum requirement for BR type of adhesive specified for the British Standards. Hence, bark extract from *A. mangium* has a great potential for adhesive production in commercial exploitation. However, further investigations are necessary to find out the properties of bark extract from trees of different age groups and to test out their applicability on a commercial scale.

Key words: Acacia, Extracts, Plywood, Adhesion, Glue

F.N. Tamolang, F.R. Lopez, J.A. Semana, R.F. Casin & Z.B. Espiloy
Properties and utilization of Philippine erect bamboos

Bamboo Research in Asia, Proceedings of a Workshop held in Singapore, Singapore, 189–200, 1980, English

Of the 48 bamboo species in the Philippines, 29 are erect and the rest are climbing; 10 of these species have been studied for he anatomic structure, pulp and paper-making characteristics, fibre morphology, chemical composition, eating qualities of their shoots, physical and mechanical properties, new industrial uses, seasoning and preservation aptitudes. The results of these studies are presented in this paper. Of special mention is the high potential of bamboos for reinforced concrete, which has been confirmed by findings in India. Bamboo reinforcement in concrete beams increased the load-carrying capacity of members considerably above that to be expected from members of the same dimensions without reinforcement;

The properties and the utilization of Philippine bamboos have been well-investigated at the Forest Products Research and Industries Development Commission (FORPRIDECOM), College, Laguna. Although the studies are not comprehensive, they indicate gaps in knowledge that have to be explored by further studies and investigations. It is on this basis that FORPRIDECOM has aligned some project proposals.

Key words: Bamboo, Minor forest products, Wood chemistry, Wood physics

H. Wang
Studies on the high yield pulping of some Taiwan bamboo species
Bamboo Production and Utilization, Proceedings of the Project Group P5. 04, Production and Utilization of Bamboo and Related Species, XVIII IUFRO World Congress, Yugoslavia, 49–55, 1986, English

Taiwan, being a subtropical island, its warm climate coupled with abundant rainfall, is an ideal place for the growth of bamboo. There are about 150,000 ha of bamboo forest in Taiwan and bamboo plays an important role in the economical life.

There are around 28 bamboo species in Taiwan, the three species used in this study are *Dendrocalamus latiflorus* (Ma bamboo), *Phyllstachys Makino* (Makino bamboo) and *Phyllstachys edulis* (Moso bamboo), which are considered as the most important bamboo species in Taiwan.

The main purposes of this study are to assess the potentiality of using bamboo species for pulping and papermaking, and the factors which influence the NS–AQ (Neutral Sulfite–Anthraquinone) pulping and the paper properties of NS–AQ pulps.

The pulp yield of NS–AQ process is 8–12% higher than that of Soda–Aq process. The NS–AQ bamboo pulps show good bonding ability. The tensile and bursting strength properties of NS–AQ pulps are superior to those of Soda–AQ pulps. The average values of fiber dimension of the three bamboo species studied are 2.05–2.71 mm in length and 16.2–21.2μ in width, while the length to width ratios are about 141–162, which are more slender than those of softwoods. Ash and extractive contents of bamboo are higher than those of woods. Lignin contents are lower than those of softwoods, but similar to those of hardwoods.

Key words: Bamboo, Pulp, Forest products industry

H. Hsiung
Research and development of production and utilization of bamboos in China
Bamboo Production and Utilization, Proceedings of the Project Group P5. 04, Production and Utilization of Bamboo and Related Species, XVIII IUFRO World Congress, Yugoslavia, 4–10, 1986, English

In China, there are more than 400 bamboo species and varieties belonging to 34 genera. The total area of bamboos except small bamboo undergrowths and alpine bamboo thickets is about 3.4 million hectares with standing stock 71.22 million tons and annual yield about 7 million tons, roughly 2 tons per hectare. The most important commercial bamboo is *Phyllostachys pubescens* which covers 2.42 million hectares with standing stock 56.55 million tons and annual production 5.0 million tons.

Since 1950, 70% of bamboo area have been increased and 10% of bamboo stands under intensive management. Bamboos are closely associated with Chinese civilization that can be traced back to 4800–5300 years ago. Traditionally bamboos have been widely used in agriculture, construction, rural industry, handcraft and daily life commodity. Tender shoots of about one hundred bamboo species are edible. Their production amounts over one million tons yearly. Many bamboos are used for Chinese gardening and soil erosion control. With the increasing demand of bamboo products and improvement of processing techniques, bamboo industry is growing up rapidly.

More than 100 factories of various sizes are engaging in production of bamboo plywood, particle boards, hardboards, laminated furniture, molded and woven bamboo products. Several modern bamboo paper mills are being constructed in appropriate bamboo regions. Accordingly, more scientists are engaging in researches on various aspects of bamboo production and utilization.

China is a country with great potentialities of bamboo resource and utilization.

Key words: Bamboo, Growing stock, Minor forest products, Wooden ware, Forest products industry

T.N. Lipangile
Development of bamboo water piping technology in Tanzania
Bamboo Production and Utilization, Proceedings of the Project Group P5. 04, Production and Utilization of Bamboo and Related Species, XVIII IUFRO World Congress, Yugoslavia, 25–30, 1986, English

Bamboo Water Supply Piping System has been well researched in Tanzania and positive results are increasingly becoming known both scientific and technological sides. The activities have been carried out for a period over a decade. Pipe lines systems of approximately 200 km have been constructed. Some schemes have given to Tanzania rural population constant and safe water supply for a period of ten years. Population of over 100,000 people is benefitted by using this technique and constructions of new schemes are being expanded in various parts of the country.

This paper explains briefly summary of the past activities carried out during the past decade, established procedure of preparing a bamboo water scheme and on going research activities to improve the general bamboo water piping technology.

Suitable Bamboo Forests available within Tanzania were identified and known to be *Arundinaria, Alpina* and *Bambusa vulgaris.* Other species of similar family could also do well. New areas for growth of new Bamboo forests plantation have also been earmarked in our future planning of development.

Standard pipe length of 4 metres uniform diameters have been prepared. The best joint for bamboo pipe has been developed which is polythelene male sockets 20 cm long. When necessary the interior and exterior of the Bamboo pipe is coated with the standard Bituminous paint approved to be in contact with drinking water. All pipes are buried in the ground.

The experience of ten years performance of some schemes shows that the adopted Bamboo piping technology is absolutely safe. No health hazards has been reported.

Key words: Bamboo, Minor forest products, Wood work, Antiseptic process

Rahin Sulaiman & Carles Philipps
Growth of three species of rattan from a trial plot in Sabah
FRC Publication, Sabah, Malaysia, No. 39, 1–36, 1987, English

Preliminary growth data from a trial plot of three species of rattans; *Calamus manan* Mig, *Calamus subinermis* H. wendl ex Beco and *Daemonoropus fissa* Blume are presented. Height growth is summarized and tentative growth functions are described. Reliability of summary growth data from the plot is examined. Precision of rattan height estimates is detailed.

Key words: Minor forest products, Rattan

John Dransfield
A manual of the rattans of the Malay Peninsula
Malayan Forest Records, FRIM, Malaysia, No. 29, 270 pp., 1979,
English

This manual of the rattans of the Malay Peninsula has been prepared in the belief that any future studies of the rattan trade will require an inventory of the rattans indigenous to Malaya and a firm taxonomy. It does not pretend to be the last word in rattan taxonomy as there are still many areas of Malaya that are little explored and several rattan species complexes have proved to be difficult to elusidate; however it is prepared as a guide for use in the field and herbarium to the Malayan rattan species.

Key words: Minor forest products, Rattan

John Dransfield
The rattans of Sabah
Sabah Forest Records, Sabah, Malaysia, No. 13, 182 pp., 1984,
English

Sabah's tropical rain forests harbour many thorny climbing palms. Known locally as "rotan", these slim supple golden yellow canes with a high strength/weight ratio enter international trade as the "rattans" of commerce.

With this book we have made a significant step towards sound management of our tremendous rattan resources.

Key words: Minor forest products, Rattan

7. Social Forestry

Darmawan Budiantho
Influence of widening spacing of teak on mean diameter of stand and food crops area in tumpangsari system
Buletin Penelitian Hutan (Forest Research Bulletin), Indonesia, No. 516, 13–26, 1989, Indonesian

Tumpangsari or taungya is a method of forest regeneration aimed at obtaining maximum utilization of interspace between tree rows for intercropping annual food crops during two consecutive years. Farmers of tumpangsari is responsible in maintaining tree plantations such as cleaning unnecessary weeds, while taking benefit from cultivating the intercrops.

Much can be done to improve life condition of tumpangsari farmers through improving cultivation of the intercrops, among others is the application of a wider initial spacing. This silvicultural manipulation may influence volume growth and stemform, hence the response is necessary to be studied in advance.

To solve the problems, a study on teak (*Tectona grandis*) spacing has been conducted in Saradan Forest District (KPH Saradan). Spacing regimes selected were 4 × 2, 5 × 2, and 6 × 2 m compared to the generally practiced spacing of 3 × 1 m. Latin square design consisting of 4 treatments was used.

The results of the study revealed that:

(1) Wider distance between plants within the same line resulted in bigger mean diameter of the stand.
(2) Wider distance between line resulted in larger intercropping area which may cause higher yield of food crops.

Key words: Agro–forestry, Spacing, Intercropping

R.S. Vinaya Rai, C. Swaminathan & C. Surendran
Studies on intercropping with coppice shoots of *Eucalyptus tereticornis* Sm.
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 3 (2), 97–100, 1990, English

Arable crops of sorghum (cv.CO.26), pearl–millet (cv.CO.6) and fodder grass (cv.BN.2) were raised in the spaces between one–year coppiced shoots of *Eucalyptus tereticornis* Sm. planted on a 2 m^2 grid. Both crop height and yield were depressed in the intercrop when compared with the monocrop but the magnitude of reduction varied with the crop. Crop height reduction was greatest in sorghum and least in fodder grass. Crop yield impairment was also largest in sorghum (35%) and least in pearl millet (17%) even though the number and size of coppiced shoots of the associated trees were largest for this treatment. The yield reduction sustained by the intercrops in the present study could be due to limitations of light, water and/or nutrients. Both sorghum and pearl millet are CO_4 plants; the lesser yield penalty associated with pearl millet may be because it is more drought tolerant

and grows better under low fertility conditions.

Key words: Eucalypt, Coppice forest, Agro-forestry

Makoto Inoue
Swidden cultivation in East Kalimantan
JICA Project Report, Indonesia, 176 pp., 1989, English

In Chapter 1, brief mention of the method of the field survey will be made. Then in Chapter 2, the Dayak Kenyah villages and other tribes' villages will be described. Especially, in Section 5, production and export of cash crops and forest minor products, which is produced or collected by the inhabitants concerned, will be investigated based on statistical data. In Chapter 3, some discussion will be made. At last I will show you some recommendations in Chapter 4 and the problems remaining in Chapter 5.

Key words: Shifting cultivation, Social and economic analysis, Social forestry

8. Others

C. Swaminathan, R.S. Vinaya Rai & K.K. Suresh
Allelopathic proclivities of *Acacia nilotica* (L.) Willd. ex Del.
Journal of Tropical Forest Science, FRIM, Malaysia, Vol. 2 (1), 56-60, 1989, English

Aqueous extracts of bark and leaf of *Acacia nilotica* (L.) Willd. ex Del. were tested for potential inhibitory effects on eight arable crops. Seed germination of the arabels was significantly inhibited by the extracts. To a greater extent, radicle and plumule growth too were affected. The inhibition by bark extract was greater than by leaf extract. It is assumed that the effective substances are phytotoxins, mostly tannin, which are present in the extract. However, the response of the crops was disparate, tomato being the most susceptible and sunflower the least. The poor growth reported in some areas, of crops irrigated from tanks, the foreshores of which have been grown to stands of *A. nilotica* may be related to tannin leached mostly from bark of the tree in rain wash.

Key words: Acacia, Extractives, Root system, Growth inhibitor

Sham Sani (editor)
Environmental conservation in Sabah
DINGS Proceedings of a Seminar, Malaysia, 191 pp., 1987, English

The environment in Sabah is being threatened increasingly by pollution arising from accelerated development in agriculture, industry and urbanisation.

There is an urgent need for collective action from the government, the private sector and the general public to pursure modes of economic development that pay specific attention to environmental preservation.

The seminar was aimed to achieve the follow objectives:

- To evaluate the current status of the environment in Sabah;
- To create awareness and commitment on conservation and improvement of the environment; and
- To discuss plans and strategies in conservation and towards the improvement of the environment.

Key words: Protection forest, Ecosystem, Land conservation

Borhan Bin Haji Mohamad & Akio Maruyama
Seminar on recent advances in forestry research and development in Brunei Darussalam
Forest Research Note in Brunei Darussalam, Brunei, 121 pp., 1990, English

This seminar was held on 5th September, 1990 in the conference room of the Brunei Forestry Centre. Seven papers were presented, their titles are as follows.

1. Summary of the Brunei Darussalm – JICA Bilateral Forestry Research Project's Achievements, 1986–1990.
2. Long-term Research Program in forestry for Brunei Darussalam.
3. Isoenzym Studies on the Genetics of *Dryobalanops* spp. and *Shorea albida.*
4. Phenological Studies on Some Tropical Rainforest Tree Species
5. Aspects of Natural Mixed Dipterocarp Forest Regeneration Appraisal
6. Commercial Volume Table for Some Major Timber Tree Species
7. Timber Utilization in Brunei Darussalam – Its Status and Future Development

Key words: Natural regeneration, Tropical rain forest, Phenology, Heredity

Tetsuo Okano
Construction of measurement system for analyzing photosynthesis and transpiration of trees
JICA Project Report, Indonesia, 15 pp., 1990, English

This measurement system is an open system using absolute measurement type infrared gas analyzer and three humidity sensors, and designed for measuring of photosynthetic and transpiration rate, stomatal conductance and intercellar CO_2 concentration of a leaf.

In East Kalimantan, by analyzing the relationships between their characteristics and environment factors, i.e. light, temperature and water, we will obtain many informations on the tropical rain forest.

Key words: Photosynthesis, Transpiration, Forest hydrology

D. Murdiyarso
A preliminary account of radiation profile in lowland tropical rain forest – East Kalimantan
Proceedings the PUREHUT SEMINAR, Indonesia, 57–211, 1989, English

Solar radiation and Photosynthetically Active Radiation (PAR) of tropical rain forest were accessed using tube solarimeters and cheap photodiodes sensors respectively. These measurements are technically possible for long term observations as to quantify the physical environment affected by the presence of canopy gaps.

Measurements within a profile indicate a drastic reduction of radiation of more than 80% after the first layer of canopy. PAR reduction did not follow the pattern of radiation interception as its spectral properties considerably different.

Key words: Photosynthesis, Tropical rain forest, Canopy

Darwis Syukur
Measurement of workmanships of some activities of the timber estate system on the P.T. Inhutani area at Sesayap
Tropical Forest Research Journal Samarinda, Indonesia,
Vol. 4 (2), 24–29, 1989, Indonesian

This research aimed as a basic for predicting cost and labour needed. This research was carried out directly to observation object either through questionnaire or data from concessions.

The result indicated that average workmanship in nursery activity was 8,398 pot/man/day with 0.576 man day and 1,429 Rp/ha as a cost. Furthermore workmanship in the activity of land clearing was 0.120/ha/man/day with 4.832 man day and cost Rp 50,000/ha.

Key words: Nursery operation, Nursery, Cost analysis

APPENDIX

LIST OF INFORMATION RESOURCES

MALAISIA

Forest Research Institute of Malaysia (FRIM)

Address: Kepong, Selangor, 52109 Kuala Lumpur, Malaysia
Tel: 6342633 Fax: 603-6367753 Telex: FRIM-MA-27007
Identification of parent organization: Ministry of Primary Industries.
Type of service: Library.
Geographic coverage of information: Malaysia, South East Asia, Worldwide.
Subject coverage: Forestry and related subjects; Forest environment, Forest conservation; Soil-science; Basic sciences; Computer science; Management; Hydrology etc.
Types of indexes privided for access to the services: Computerised indexes, Computerised catalogue and Printed indexes.
Size of present collection relevant to forestry: 120,000 volumes on forestry and related subjects. The collection comprises of books, journals, reports, standards, conference papers, gazettes etc.
Identification of target user: Researchers; Academicians; National planner (policy makers); Extension officers; entrepreneur
Date of establishment of the services: 1918
Types of services provided for users: Loan; Literature searches; Computerised services; Telex services; Document photocopying; Referral services etc.
Charge of services: Charges for photocopies
Procedure required for applying services: Book loan by application form and Inter-library loan through telex, fax. and E-mail.
Types of periodical publication available to users: Journal of Tropical Science; Reserch Pamphlets; FRIM Annual Report etc.
Procedure required for applying the publication and their charges: Through letters or application forms. Most of publication are charged for.

Forest Research Center

Address: P.O. Box 1407, 90008 Sandakan, Sabah, Malaysia
Tel: 089 531522 Fax: 089 531068 Telex: MA83016
Identification of parent organization: Forestry Department, Sabah.
Type of service: Library.
Geographic coverage of information: Mostly tropical regions.
Subject coverage: Forest and Forestry; Silviculture; Ecology; Entomology; Wildlife; Forest products and utilization; Minor forest produces; Soil and soil science; Computer science; Agriculture and its related fields etc.
Types of indexes privided for access to the services: Subject indexes and personal author indexes.
Size of present collection relevant to forestry: More than 10,000 volumes, 68 Journal titles and 15,000 items in forms of pamphlets, papers, reports.
Identification of target user: Staff of the Forest Dept. and researchers upon request.
Date of establishment of the services: 1974
Types of services provided for users: Loan of materials; Document photocopies; Sale

of publications
Charge of services: Charges for photocopies
Procedure required for applying services: Application form for approval of the Director of the Dept.
Types of periodical publication available to users: Sabah Forest Records; FRC Publication; Research Papers and Annual Reports.
Procedure required for applying the publication and their charges: Most of the Department publications are for sale, except the biennial reports which can be obtained freely. Prepayment for all publications are required. Enquiries, please write to a librarian.

BRUNEI DARUSSALAM

Brunei Forestry Center

Address: Sungai Liang, Kuala Belait, Negara Brunei Darussalam
Tel: 03-230383
Identification of parent organization: Forestry Department of Brunei
Type of service: Library.
Geographic coverage of information: Brunei, South East Asia
Subject coverage: Forest; Forestry and related subjects.
Types of indexes privided for access to the services: Subject indexes and personal author indexes.
Size of present collection relevant to forestry: More than 2,700 volumes on forestry and related subjects, and 123 journal titles.
Identification of target user: Forestry researchers; Managers and Students
Date of establishment of the services: 1986
Types of services provided for users: Book loan; Photocopying
Charge of services: Charges for photocopies
Procedure required for applying services: Application to the Director of the Forest Dept.
Types of periodical publication available to users: Nil

INDONESIA

Center for Scientific Documentation and Information

Address: Jl. Jend. Gatot Subroto 10, Jakarta 12190, Indonesia
Tel: (021) 583465, 510791, 511063 Fax: (021) 583967
Telex: (021) 62875 IA
Identification of parent organization: Indonesian Institute of Sciences (LIPI).
Type of service: Scientific and technical information center.
Geographic coverage of information: National documentation and Foreign publications

on Indonesia.
Subject coverage: Scientific and technical subjects.
Types of indexes privided for access to the services: Author indexes and subject indexes.
Size of present collection relevant to forestry: More than 160,000 titles on scientific and technical subjects.
Identification of target user: Scientific community.
Date of establishment of the services: 1967.
Types of services provided for users: Library service; Literature searches; Printing service.
Charge of services: Charge for photocopies and publications
Procedure required for applying services: Application form for book loan
Types of periodical publication available to users: Index of the Indonesian learned periodicals; Directory of Special Libraries and Information Sources in Indonesia; Index of Research Report and Surveys; Index of Conference Proceedings, Workshops, Seminars.
Procedure required for applying the publication and their charges: Application forms. Most of publications are charged for.

Library of the Forest Research and Development Center

Address: Jl. Gunung Batu 5, P.O. Box 66, Bogor 16610, Indonesia
Tel: (0251) 325111
Identification of parent organization: Agency for Forest Research and Development, Ministry of Forestry.
Type of service: Library.
Geographic coverage of information: National, international.
Subject coverage: Silviculture; Mensuration and management; Forest environment; Forest fire; Forest plant biology; Genetics and breeding; Mycology and pathology; Forest damage and protection; Agro-forestry etc.
Types of indexes privided for access to the services: List of publication and catalog card.
Size of present collection relevant to forestry: Approximately, 33,000 titles.
Identification of target user: Researchers; Students.
Date of establishment of the services: 1913
Types of services provided for users: Lending (for staff only); Literature searches; Photocopying.
Charge of services: Free except photocopies
Procedure required for applying services: Application form, indirect service by letter.
Types of periodical publication available to users: Buletin Penelitian Hutan (Forest Research Bulletin)
Procedure required for applying the publication and their charges: Direct request, indirect request by letter to the Director of FRDC, free charge as long as the stock available.

Faculty of Forestry, Gadjah Mada University

Address: Bulaksumur, Yogyakarta 55212, Indonesia
Tel: 0274-88688
Identification of parent organization: Gadjah Mada University, Yogyakarta.
Type of service: Library.
Geographic coverage of information: National, Indonesia.
Subject coverage: Forestry and related subjects; Environment; Silviculture; Forest fire, Mycology and pathology; Wildlife and national park; Forest protection and soil conservation; Timber damage and timber protection; Wood utilization; Pulp industries and chemical utilization; Marketing and trading.
Types of indexes privided for access to the services: Subject indexes; Author indexes; Periodical cumulative index.
Size of present collection relevant to forestry: Documents, serials and monographs.
Identification of target user: Research institutions; Educational institutions; Individual researchers and students.
Date of establishment of the services: 1963.
Types of services provided for users: Loan; Literature searches; Document photocopying.
Charge of services: Charge for photocopies.
Procedure required for applying services: Application form for inter-library loan.
Types of periodical publication available to users: Bulletins.
Procedure required for applying the publication and their charges: Through letter or application forms. Free charge.

Faculty of Forestry, Mulawarman University

Address: Gunung Kelua Campus, P.O. Box 13, Samarinda, East Kalimantan, Indonesia
Tel: (0541) 21118 ext. 300
Identification of parent organization: Mulawarman University, Samarind, Indonesia
Type of service: Library.
Geographic coverage of information: Regional.
Subject coverage: Silviculture; Mensulation and management; Environment; Forest protection and soil conservation; Forest fire; Ecology, Forest insects and other invertebrates; Forest products and industry; Wood ulitization; Marketing and trade etc.
Types of indexes privided for access to the services: Author indexes; Subject indexes.
Size of present collection relevant to forestry: 12,000 volumes on forestry and related subjects.
Identification of target user: Researchers; Students.
Date of establishment of the services: 1962
Types of services provided for users: Book loan; Literature searches; Photocopying.
Charge of services: Free charge except photocopies.
Procedure required for applying services: Application form.
Types of periodical publication available to users: Forest Research Record.
Procedure required for applying the publication and their charges: Application form,

free charge.

P.T. Jaakko Pöyry

Address: Jl. M.H. Thamrin 12, Gedung Jaya lt 6, Jakarta 10340, Indonesia
Tel: (021) 320759 Fax: (021) 325094 Telex: 62144 pt. jaya jkt
Identification of parent organization: Jaakko Pöyry Group.
Type of service: Consultancy for forestry and wood based industries.
Geographic coverage of information: Worldwide.
Subject coverage: Forestry and wood industry; Training; Marketing; Management.
Types of indexes privided for access to the services: Multi-client reports; Multi-client reviews.
Identification of target user: Multiclient.
Date of establishment of the services: 1982
Types of services provided for users: Consultancy including information service.
Charge of services: Negotiation
Types of periodical publication available to users: JP today, Know-how wire (magazine), Reference lists, Market reviews
Procedure required for applying the publication and their charges: Order with charge.