Proceedings of the Regional Workshop on the Sharing of Findings from the Activities Implemented in Indonesia and Malaysia under the ITTO-CITES Project on Ensuring International Trade in CITES-listed Timber Species is Consistent with their Sustainable Management and Conservation

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Ministry of Natural Resources and Environment, Malaysia (NRE)

Proceedings of the regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber

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Regional Workshop on the Sharing of Findings from the Activities Implemented in Indonesia and Malaysia under the ITTO-CITES Project on Ensuring International Trade in CITES-Listed Timber Species is Consistent with their Sustainable Management and Conservation

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ITTO-CITES
Regional Workshop 2010

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BACKGROUND

1– 4 December 2010

The aim of the ITTO-CITES "Project on Ensuring International Trade in CITES-listed Timber Species is Consistent with their Sustainable Management and Conservation" is to further enhanced the conservation and sustainable management of *Gonystylus* spp. There are ten main Activities under the project related to various aspects of research on *Gonystylus* spp. undertook by Malaysia and Indonesia. All the Activities were completed by December 2010. In Indonesia, the Activities were conducted by a number of agencies under the supervision of the Forestry Research and Development Agency (FORDA), Indonesia, Directorate General Forest Protection and Nature Conservation, Indonesia. The Activities in Malaysia were coordinated by the Ministry of Natural Resources and Environment (NRE).

The implementing agencies in Malaysia were Forestry Department Peninsular Malaysia (FDPM), Sarawak Forest Department (SFD), Sarawak Forestry Corporation and Forest Research Institute Malaysia (FRIM). The Activities in Indonesia were implemented by the Centre for Forest and Nature Conservation Research and Development (CFNCRD), Remote Sensing & Geomatics Laboratory of the Faculty of Forestry, Bogor Agricultural University, Research Centre for Biology of the Indonesian Institute of Sciences, and the Directorate of Biodiversity Conservation. As part of the project requirement, a four-day Regional Workshop aims to disseminate the outcomes and findings from the activities was organised (Annex A). The Regional Workshop was held on 1-4 December 2010 in Kuantan Pahang, Malaysia and participated by 61 technical experts and representatives from governmental, non-governmental, universities, research and international agencies in Malaysia and Indonesia.

The Regional Workshop aims to disseminate the outcomes, findings, and best practices to all relevant stakeholders with regards to the sustainable management and conservation of *Gonystylus* spp. in Indonesia and Malaysia. The Regional Workshop is expected to provide a platform for the executing agencies in Indonesia and Malaysia to collect information and coordinate the preparation of a final report of all Activities implemented in Indonesia and Malaysia to ITTO. It is anticipated that the Workshop will also act as a forum for participants to discuss and deliberate on further projects and activities that could assist Indonesia and Malaysia in enhancing the sustainable management and conservation of *Gonystylus* spp. Hence, the specific objectives of the Regional Workshop are as follows:

(i) To share, learn and discuss the findings of each Activity implemented in Indonesia and Malaysia under the ITTO-CITES Project.

(ii) To identify and adapt relevant findings from the Indonesian Activities by Malaysia, *vice versa*, and,

(iii) To identify potential projects and activities to further ensure that the international trade of *Gonystylus* spp. is consistent with their sustainable management and conservation practices.

The Workshop was held at Hyatt Regency Hotel, Kuantan, Pahang, about 300 km from Kuala Lumpur. Kuantan was chosen as the Workshop venue as it is only 30 km from Pekan Forest Reserve (FR) where some of the field activities under the ITTO-CITES Project were conducted.

LIST OF PAPERS	**ITTO-CITES REGIONAL WORKSHOP 2010**

1– 4 December 2010

MESSAGE FROM THE DIRECTOR-GENERAL FOREST RESEARCH INSTITUTE MALAYSIA (FRIM)

Regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Dato' Dr Abd. Latif Mohmod

Assalammualaikum and a very good morning.
First of all, may I take this opportunity to welcome all of you foreign and local participants to this regional workshop. On behalf of the workshop organisers, let me take a bit of your time to say few words as welcome remarks at this auspicious occasion.

FRIM is very honoured to organise this workshop together with the Ministry of Natural Resources and Environment Malaysia (NRE), with collaboration from other departments such as the Forestry Department Peninsular Malaysia, Forestry Department of Pahang and Sarawak Forest Department.

We sincerely thanks YBhg Dato' Zoal Azha Bin Yusof, Secretary-General, Ministry of Natural Resources and Environment Malaysia (NRE) for accepting NRE to co-organise this workshop with us. The active participation of the ministry in organising this workshop is very much appreciated by the technical departments. As all you are aware of, this regional workshop is funded by the ITTO-CITES with some allocation from the Government of Malaysia (GOM). This workshop will act as a platform to discuss and disseminate findings of all the Activities implemented in Indonesia and Malaysia under the ITTO-CITES project.

The aim of ITTO-CITES Project on Ensuring International Trade in CITES-listed Timber Species is Consistent with their Sustainable Management and Conservation is to further enhanced the conservation and sustainable management of *Gonystylus* spp. Under the project, there are ten main Activities related to various aspect of *Gonystylus* spp. being undertaken by Malaysia and Indonesia. All the Activities are expected to be completed in 2010. The Activities are being conducted by a number of agencies in Indonesia and Malaysia under the supervision of the Forestry Research and Development Agency (FORDA), Indonesia, Directorate General Forest Protection and Nature Conservation, Indonesia and the Ministry of Natural Resources and Environment, Malaysia (NRE).

There will be fourteen technical papers as part of outputs of the Activities to be presented by representatives of Indonesia and Malaysia in this workshop. This four-day workshop will also include a day visit to one of the project sites at Pekan Forest Reserve. This site is the main project site for ITTO-CITES Activities in Peninsular Malaysia. Participants will be able to see how the peat swamp forest and *Gonystylus* spp. being managed in this country.

For your information, the implementing agencies in Malaysia are the Forestry Department Peninsular Malaysia (FDPM), Sarawak Forest Department (SFD), Sarawak Forestry Corporation and Forest Research Institute Malaysia (FRIM). In Indonesia, the implementing agencies are the Centre for Forest and Nature Conservation Research and Development (CFNCRD), Remote Sensing & Geomatics

Laboratory of the Faculty of Forestry, Bogor Agricultural University, Research Center for Biology of the Indonesian Institute of Sciences, and the Directorate of Biodiversity Conservation.

As part of the project requirement, this four-day workshop aims to disseminate the outcomes and findings from the Activities organised. Therefore, this workshop has some pertinent objectives to fulfil as follows; (i) To share, learn and discuss the findings of each Activity implemented in Indonesia and Malaysia under the ITTO-CITES Project ; (ii) To identify and adapt relevant findings from the Indonesian Activities by Malaysia, *vice versa*; and iii) To identify potential projects and activities to further ensure that the international trade of *Gonystylus* spp. is consistent with their sustainable management and conservation practices. We expect this workshop will produce a comprehensive report consisting findings of all the Activities implemented in Indonesia and Malaysia under the ITTO-CITES Project. And also a list of identified potential new Activities to further enhanced the sustainable management and conservation of *Gonystylus* spp., which is the main timber species in peat swamp forest and among the main timber species of this region.

We have here today more than 60 participants mainly from Indonesia and Malaysia, and a few others from countries that have interests on these issues. We have relevant stakeholders involved with the management, conservation and trade in *Gonystylus* spp. as participants of this workshop. Indonesia sends a delegate with more than ten participants as they also conduct a number of Activities under the ITTO-CITES project. I would like to extent my personal thanks to all who participate in this workshop and their sharing of findings with us. I believe the Indonesian contributions will be tremendously significant for the betterment of management and conservation of this timber species not only in Indonesia but also Malaysia. I was informed that Indonesia and Malaysia are the only countries that produce *Gonystylus* spp. timbers.

We hope that there will be positive news and indication from our international funding agencies. We do hope additional funding will be made available not only for *Gonystylus* species but also for other species. We know that tropical forests play important roles on the stability of the environment that benefits everybody in this world. Therefore, further relevant studies and Activities by the ITTO-CITES in this type of forest are crucial and justified. As Director-General of FRIM, I encourage the involvement of international agencies in conducting and producing relevant findings, information and materials towards enhancement and improvement in the management and conservation of forests in this country.

Before I conclude my speech, once again I would like to express my sincere thanks and gratitude to YBhg Dato' Zoal Azha Bin Yusof, Secretary General, Ministry of Natural Resources and Environment Malaysia (NRE) for officiating the opening of the regional workshop later this morning. And thank you to all participants for being here and I expect your active involvement in this workshop.

With those remarks, I end my speech. Thank you for your kind attention and have a productive workshop. Thank you & Assalamualaikum.

DATO' DR ABD. LATIF MOHMOD
Director-General,
Forest Research Institute of Malaysia (FRIM)

MESSAGE FROM CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES)

Regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Milena Sosa Schmidt

These words are given on behalf of the ITTO-CITES Secretariat,

It took me three whole days to arrive to Kuantan. I am so glad to be here with you on this regional ITTO-CITES.

Four years ago when this joint programme started, there were many gaps on the information about the biology, ecology and tracking-systems for *Gonystylus* spp. You have been sharing with colleagues from Indonesia and Malaysia, many outputs that have resulted from your work under the ITTO-CITES programme since 2006. You have discussed methodologies to make NDFs, to undertake inventories, GIS & genetic studies, you have shared your experiences on assessing silviculture systems for ramin and on the development of radio frequency identification.

On the first day, there were presentations on exploratory assessment on the population distribution and potential uses of non-*Gonystylus bancanus* spp. in Indonesia and the DNA database for the same species in Sarawak. We are very proud of all the work that you have been doing. I hope that now you do have a lot of the information that was missing back in 2006.

Most important, we hope that you have established good relationships and channels of communication with your colleagues in the region. How to make use of these outputs is a key issue that was raised today. We need to make an impact assessment before we move forward. Outputs need further research before they can be implemented. A good progress has been achieved on the management, conservation and control of trade in ramin, we still have a lot of progress to achieve though. A lot of interest has been shown now from the donour countries and this interest is increasing. We think that now, thanks to the commitment of great technical colleagues like you, we will be able to demonstrate to the international CITES & ITTO communities, that it is worth continuing the financial and technical support to our joint work.

I would like to conclude by thanking the Europe Commission (EC) for providing most of the funding for this meeting. Thank you for making the implementation of ten activities possible. Thanks to Steve Johnson and Pei Sin for their hard work from the ITTO Secretariat side. Thanks to Mr. Thang, who has made a great job in this region and has achieved good communication between the teams in the two countries. Thank you to the team of FRIM who, as usual, have made a great job organising this workshop. I do not want to call this ' closing workshop' because I want to think that we will continue working together and that we just gave 'a first step' towards a full implementation of CITES for *Gonystylus* spp.
See you then the next time and have good today. Thank you.

Milena Sosa Schmidt

MILENA SOSA SCHMIDT, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

MESSAGE FROM THE INTERNATIONAL TROPICAL TIMBER ORGANIZATION (ITTO)

Regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Tong Pei Sin

It is great pleasure for me to deliver this joint welcoming speech for both the ITTO and the CITES Secretariat. It is a pleasure because this workshop building up major outputs for *Gonystylus* spp. in Indonesia and Malaysia. We had the Africa regional workshop last September and the Latin America regional workshop is scheduled in February 2011. We are delighted to have you here to participate and share your experience in the regional workshop on the Sharing of Findings from the Activities Implemented in Malaysia and Indonesia under the ITTO-CITES Programme.

We would like to extend our gratitude to colleagues from Indonesia and Malaysia who continuously committed to implement activities in producing quality outputs. Thank you for coming. That many of you travel to Kuantan serves to remind us all just how important our work is. ITTO is committed to actively raising the quality of tropical forest management for every member country. The purpose of CITES is to ensure that no species of wild fauna or flora becomes or remains subject to unsustainable exploitation because of international trade. Both want all forestry related matters to achieve their full potential. Our task is to make it possible. Our mission is to provide practical, step by step assistance. Although ITTO and CITES have been in contact for many years, the first official collaboration between the two organisations started in 2005 with the planning and preparation of the proposal for the now existing ITTO-CITES programme.

Until today we have produced quarterly newsletters, posters, brochures, and funded international and regional workshops. More than 30 activities have been funded in Africa, Asia and Latin America under the ITTO-CITES programme. Asia has had the highest number of activities under this programme and, this shows that we continue having confidence in this region that has placed itself as a role model for the ITTO-CITES initiative. Issues that we face in implementing CITES are not going to disappear over night, but we are at a turning point towards better CITES implementation. This regional workshop will be a great opportunity for Indonesia and Malaysia to share with each other their approaches and knowledge already gained in each country in managing ramin sustainably.

Also, let me take the opportunity to answer a question that you might have on the programme continuity. ITTO and CITES have started working on a follow-up proposal to seek funding availability and hopefully we will be able to share good news soon. Both Milena and I would like to thank you to the organising committee led by Dr. Khali Aziz and we would like to welcome all of you. Too much work without relaxation may not bring the best results thank you to the organising committee who gives us some time off to enjoy the atmosphere and culture of Kuantan. With that, prepare yourself to be challenged, excited and inspired. Let's continue to work together to the shared goal of strengthening CITES implementation in these important range States. Thank you all and, both Milena and myself would like to wish you a sincere desire that your involvement in this meeting will be a profitable one.

TONG PEI SIN, International Tropical Timber Organization (ITTO)

MESSAGE FROM THE SECRETARY-GENERAL OF THE MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT (NRE)

Regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Dato' Zoal Azha Bin Yusof

Salam Sejahtera and Selamat Datang or Welcome to Malaysia for the foreign delegates, guests and participants.

I am very pleased with the efforts towards improvement of management and conservation of important timber species in this region. I am very delighted that this Workshop is jointly organised by my ministry, Ministry of Natural Resources and Environment Malaysia (NRE) and FRIM, with collaborations from the departments under the NRE. As my ministry is the focal point for the CITES for Malaysia, we are very keen to involve actively to ensure that CITES related matters are being managed with care and all developments are properly kept in track. Therefore, I am really glad to be involved by giving an opening address for this auspicious occasion.

Malaysia is very glad to host this very important regional workshop on CITES-listed timber species of *Gonystylus* spp. or locally known as ramin. ITTO-CITES had contributed more than USD47,000.00 while Government of Malaysia (GOM) contributed about USD19,000.00 in-kind to organise this regional workshop. All together about USD66,000.00 or close to RM200,000.00 are being spent to organise this workshop. It shows that organising a regional workshop requires a big amount of money. Although we managed to get funding mainly from foreign countries, we ensure the money is wisely spent as stipulated in agreement with the funding agencies. Nonetheless, I think it is worth to spend this amount of money as outputs of this regional workshop are crucial and will be beneficial to improve the management and conservation of this species in this region; both Indonesia and Malaysia by being the only countries where *Gonystylus* spp. grow.

I have been informed that the first related workshop was held in Bogor, Indonesia last year. The workshop in Bogor was on introduction and monitoring of Activities being conducted in Indonesia and Malaysia. Meanwhile, this Workshop in Malaysia is meant to disseminate the findings of all those Activities as stated in the objectives of this Workshop. Therefore, this workshop is significantly important as all findings and outputs will be presented and discussed thoroughly for benefit of all stakeholders from Indonesia and Malaysia. As listed in the Programme Book, fourteen technical papers will be presented from ten project Activities in Indonesia and Malaysia.

I sincerely thanks all speakers and participants from Indonesia and Malaysia for sharing the findings of your Activities. I notice that all the technical papers are very much related to each other as the papers mainly focused on *Gonystylus* spp. We hope that all the outputs can be implemented in both countries in spirit of ASEAN and neighbouring countries in a win-win situation. Hopefully, with all sort of new information and findings, we are able to manage our natural resources more efficiently and cost-effectively.

As for local delegates, I really hope that you will take this opportunity to learn how to manage and utilise this species in a sustainable basis. Even though we have been practicing sustainable forest management (SFM) in our forest, certain aspects such as resource inventory and utilisation might be further improved. I was informed that the peat swamp forest which is the main habitat of one main *Gonystylus* spp., i.e., *Gonystylus bancanus* or locally known as ramin melawis is different from dry inland forest and requires further studies.

I encourage your active participation in this workshop and apply the findings that you find useful and practical to be implemented in your respective departments. Please use this platform to interact and discuss relevant matters with all speakers so that you have better understanding of these species. The Ministry always encourages the use of scientific findings in improving the current systems practised in our relevant departments.

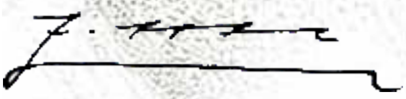
Kuantan is purposely chose as the venue as Pahang has the largest area of peat swamp forests in Peninsular Malaysia. Therefore, this state is the main producer of *Gonystylus* spp. timbers mainly ramin melawis. The workshop organisers have arranged a special field trip to the famous Pekan Forest Reserve in South East Pahang Peat Swamp Forest. These areas are being managed sustainably and only reduced impact logging (RIL) method of harvesting is allowed. I hope this ITTO-CITES Project could further improve the management and conservation of Pekan Forest Reserve. As a note to all of you, besides Pahang, Sarawak has in fact the largest areas of peat swamp forests in Malaysia. Sarawak is also the main producer of *Gonystylus* spp. timbers. In this ITTO-CITES Project, Pahang and Sarawak are the main study sites for Malaysia.

To the funding agencies, I would like to take this opportunity on behalf on the Malaysian Government to say thanks and record our appreciation for giving funding to Malaysia to conduct Activities under the ITTO-CITES Project. We hope that you are satisfied with performance of the Activities conducted in this country. I apologise for any shortcoming and will ensure all corrective measures are implemented, if any. We expect this mutual project will be continued in the future not only on this particular species, but also on other important timber species, in particular species that are listed in Appendices of CITES. We do encourage for further research and development of these species to obtain sufficient information for better management and conservation.

Please bear in mind that Malaysia is a developing country and we still rely on our natural resources including the timbers from the forests for development. Therefore, timber utilisation will continue however, in a sustainable basis. We do care for our environment, as we are the one who will suffer first from floods, drought, forest fires, etc. if the forest areas are not managed properly. That is the reason why we encourage this kind of project to be conducted for better understanding of our natural resources through improved management and conservation.

Before I end my speech, once again I would like to express my sincere appreciation to the organisers of this important regional workshop and for inviting me to deliver this opening address. And thanks to you all the participants for being here and I expect your active involvement in the workshop.

Thank you for your kind attention and have a good day and a fruitful workshop. I officially declare the Regional Workshop of ITTO-CITES Project open. Thank you.



DATO' ZOAL AZHA BIN YUSOF
Secretary-General,
Ministry of Natural Resources and Environment Malaysia (NRE)

SESSION 1 | TECHNICAL PAPERS 1-5

Proceedings of the regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Chairman: Prof. Dr. Aminuddin Muhamad
University Malaysia Sabah (UMS)

TECHNICAL PAPER 1 NON-DETRIMENTAL FINDINGS REPORT ON *GONYSTYLUS BANCANUS* : A QUALITATIVE ASSESSMENT OF *G. BANCANUS* IN TWO SELECTED PERMANENT FORESTS OF SARAWAK

Malcom Demies[1], Mohd. Shahbudin Sabki[2], Lucy Chong[1] & Ernest Chai[3]
[1]Sarawak Forestry Corporation
[2]Forest Department Sarawak
[3]Tropical Evergreen Enterprise

Abstract *Gonystylus bancanus* or locally known in Sarawak as ramin telur or ramin was assessed in two areas of peat swamp forests in the Permanent Forest Estate of Sarawak namely, Kayangeran Forest Reserve (FR) and Saribas Lupar Protected Forest (PF). Thirty eight (38) and nine (9) transects were established in Kayangeran FR and Saribas Lupar PF, respectively. A total of 1,154 ramin stems were recorded in transects covering an area of 22.05 ha in Kayangeran FR and Saribas Lupar PF. Four ramin trees with stem diameter at breast height (dbh) ≥ 10 cm were recorded. The seedlings and saplings density in Saribas Lupar PF was 144.26 and 165.25 ha^{-1} respectively while the density of ramin seedlings and saplings in Kayangeran FR was 3.4 and 7.2 ha^{-1} respectively. About 54% of the seedlings were less than 1.3 m in height while 46% of seedlings were taller than 1.3 m but less than 1.0 cm in dbh. 97% of the saplings were from the diameter group of 1.0 to 5.0 cm and another 3% were from the diameter class of 5.1 to 9.9 cm. The stocking of ramin trees in the studied areas was 0.15 and 0.33 trees ha^{-1} in Kayangeran FR and Saribas Lupar PF, respectively. The mean ramin volume is estimated at 0.33 m^3 ha^{-1} for the two sites. With such a low volume, harvesting of ramin in Kayangeran FR and Saribas Lupar PF is not recommended.

Introduction

Peat swamp forest (PSF) is one of the most important vegetation types in Sarawak. It is distributed along the coast on low-lying areas next to the mangrove forest (Figure 1). The forest is characterised by being water-logged with black or tea-colour and is always acidic (Wyatt-Smith & Panton, 1995). Anderson 1961, classified the PSF in Sarawak into six distinct communities of vegetation types or "Phasic Communities" (PC) which are differentiated based on the species composition and structure of the vegetation (Table 1).

Table 1 Phasic Communities found in PSF of Sarawak.

PC	Dominant species
1. Mixed swamp forest	*Gonystylus bancanus, Dactylocladus stenostachys*, *Copaifera palustris,* and 4 other species of *Shorea* besides *Shorea albida*
2. Alan forest	*Shorea albida, Gonystylus bancanus* and *Stemonurus umbellatus*
3. Alan bunga forest	*Shorea albida*
4. Padang alan forest	*Shorea albida, Litsea palustris, Parastemon spicatum, Combretocarpus* and *Calophyllum obliquinervium*
5. Padang paya	*Tristaniopsis, Parastemon, Palaquim* association
6. Padang keruntum	*Combretocarpus rotundatus* and *Dactylocladus stenostachys*

PC 1, 2 and 3 are composed of tall and large trees with height ranging from 30-50 m. These are the most productive PSF where the State derives its timber and forest products since 1940s. PC 5 is a dense, pole-like forest with low-canopy and PC 6 is an open savannah woodland. Logging in the PSF started in 1940s primarily for ramin. The logging activities played a major role in developing many of the towns in the State particularly those in the coastal region. According to the Sarawak Annual Report (Anon. 1952; FAO 1974) Britain, Europe and Japan were the main importing countries. Although the logging activity in PSF has now been superseded by logging in the hill dipterocarp forests, it still contributes to the timber royalties for the State. In recent years, large tracts of PSF have been developed for agricultural purposes with the establishment of *Metroxylon sagu* (sago), *Hevea brasiliensis* (rubber), *Ananas comosus* (pineapple), *Cocos nucifera* (coconut), *Elaieas guineesis* (oil palm), *Coffea* spp. (coffee) plantations, vegetable plots and other cash crops. The conversion of large areas of peat swamp areas in Sarawak into oil palm and other land use is on the rise.

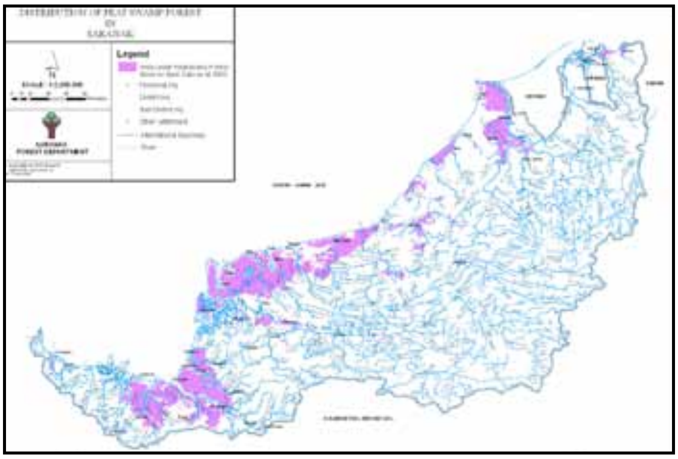


Figure 1 Distribution of peat swamp forests in Sarawak.

The acreage of PSF in Sarawak within the Permanent Forest Estate (PFE) has dwindled from 1.455 million ha in the seventies to 320,161 ha in 2004 (Lee 2005). It is thus necessary to manage the remaining PSF in a sustainable manner and the annual harvest volume of ramin be obtained from accurate scientific data through inventories of the production forests. This information together with the information on biological characteristics, ecology, regeneration, trade and management is necessary for the Non-Detrimental Findings (NDF) report. *Gonystylus bancanus* (Miq.) Kurz. or locally known as ramin telur or ramin is an endemic species in the PSF in Southeast Asian region (Airy Shaw 1954; Whitmore 1973) and a valuable commercial timber species. Anderson (1964), reported it as a major component of forest type in PSF in Sarawak and also found in other PSF types except padang keruntum forest where the population is very low (Anderson 1972). Clarke (1964), reported that ramin regenerates poorly in natural and logged forests. According to Lee (2005), very limited studies were done to assess the biological requirement for the survival of the species. Sarawak is a major producer of ramin in Malaysia from the 1950s to 1970s and for a long time ramin has been the major timber extracted from the PSF for export together with *Dactylocladus stenostachys* (jongkong). Demand had hastened the exploitation of PSF for ramin and other timber species of high commercial value. In May 1980, the ban on the export of ramin logs from Sarawak came into effect although the export of timber products processed from ramin was not affected by the order (Anon. 1980). In 2005 ramin was up-listed from Appendix III to Appendix II of CITES at a meeting of COP in Bangkok.

This study only focused on the operational forests areas especially in the PC 1 where ramin is dominant. The main objective of the study is to collect data on the status and stocking of *G. bancanus* in the production forests of Sarawak.

Methodology
Study Sites
The selection of the study sites is based on the following criteria:

- the areas must be in PFE of Sarawak with occurrence of ramin in the PSF;
- the sites must be geographically separated; and
- the PSF should not be fragmented into small pieces of forests.

The locations of the two selected sites are as in Figure 2.

Kayangeran Forest Reserve (FR)

Kayangeran FR is situated in the Limbang Division and covers an area of 3,067 ha. The forest was logged in the early sixties with no silviculture treatment and the forest is open. The occurrence of fire in the north western part of the forest reserve in 1997 resulted in the growth of ferns notably *Stenochlaena palustris* and *Dicranopteris curranii*.

Saribas Lupar Protected Forest (PF)

Saribas Lupar PF has an area of 11,364 ha and is situated in the Betong Division. The forest was logged in the early sixties and has been treated silviculturally except in areas (mostly in forest types 3.6 and 3.7) where *Shorea albida* population exceeded more than 60% of the stand extracted. This site has very limited forest type 3.1 as most of the forest was under forest type 3.6 (Table 2).

Table 2 Forest type in PSF of Sarawak

Forest type	Description
3.1	Mixed Swamp Forest (MSF)
3.1E	Mixed Swamp Forest (part exploited)
3.12	Mixed Swamp Forest (high sepetir stocking)
3.2	Riparian Pulai Forest
3.6	Alan Forest
3.7	Alan Bunga Forest
3.8	Padang Alan
3.92	Padang Medang

Sampling Design

The methodology used was adopted from the Forest Department Sarawak in carrying out the diagnostic sampling, the establishment and enumeration of sample plots. The practice of linear transect samplings was followed which involved laying the base lines across the PSF and establishing randomised transects perpendicular to the base line. The locations of the base lines and length of transects were predetermined in the office. The transect started at 20 m from the river's edge or stream bank or immediately from existing rail lines. A sampling intensity of 1% was used due to the scant occurrence of forest type 3.1 and 3.1E in the two study sites and was calculated based on forest type 3.1 series alone. Along each transect, quadrats of 10 x 10 m were marked out. All living ramin stems within the quadrat were enumerated.

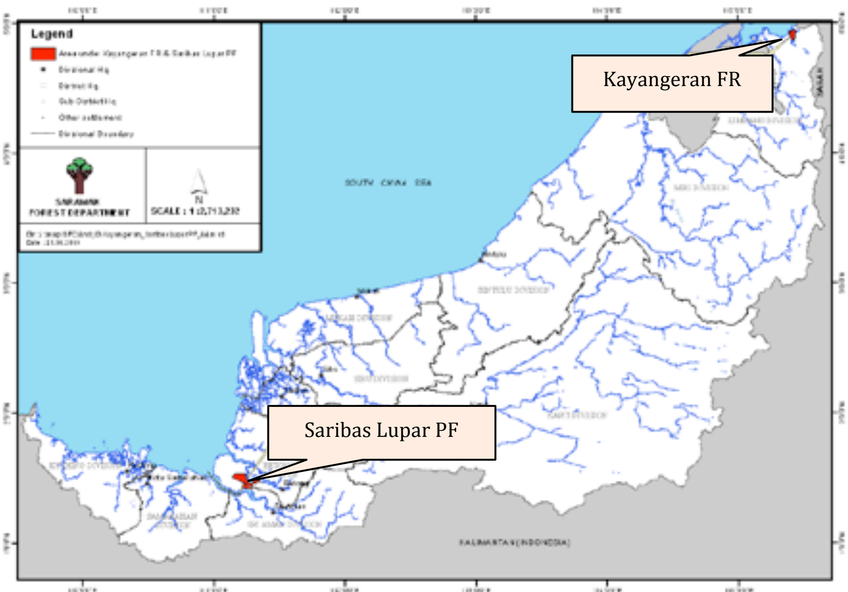


Figure 2 Location of Kayangeran FR and Saribas Lupar PF in Sarawak.

The ramin stems were categorised according to three groups:

i. Tree :- with stem diameter at breast height (dbh) ≥ 10 cm
ii. Sapling:- with dbh ≥1.0 cm but less than 10 cm
iii. Seedling:- height ≥20 cm but dbh less than 1.0 cm

A total of nine transects ranging in length from 100 to 150 m with a width of 10 m, and 38 transects each measuring 500 x 10 m were laid out in Saribas Lupar PF and Kayangeran FR respectively (Table 3). The length of transects in Saribas Lupar PF was not fixed due to limited distribution of the targeted forest type. A total of 22.05 ha were sampled in the two study sites with 3.05 ha in Saribas Lupar PF and 19.0 ha in Kayangeran FR.

Measurement of Parameters

The dbh was measured for all trees, saplings and seedlings with height > 1.3 m. Other parameters recorded were:

- tree and seedling height
- upper stem diameter of a tree
- stem identity class (SIC) of the tree, sapling or seedling
- crown illumination and crown form

This is in accordance with the procedure established by Tan (2002). The field parameters were recorded in standard field cards and the field data entered into MS Excel spreadsheets.

Table 3 Number of transects established in Kayangeran FR and Saribas Lupar PF

Sites	Total Area (ha)	Forest type 3.1 (ha)	Number of Transects	Total Area sampled (ha)
Kayangeran FR	3,067	2,384	38	19.0
Saribas Lupar PF	11,364	208	9	3.05
Total	14,431	2,592	47	22.05

Results and Discussion

Distribution of Seedlings, Saplings and Trees

Currently, there is no timber licensee operating in the Kayangeran FR. Figure 3 and Table 4 summarise the number of ramin stems recorded from the two areas, totalling 1,154 records of trees, saplings and seedlings. Eighty-two percent (82%) of the total stems were recorded from Saribas Lupar PF while the remaining 18% from Kayangeran FR. From Table 3, the logged-over forest in Saribas Lupar PF was better stocked with ramin seedlings and saplings. Saribas Lupar PF recorded 3.5 times more saplings than that of Kayangeran FR while for seedlings, it has 6.7 times more than Kayangeran FR. Saribas Lupar PF is estimated to have 310 ramin stems ha^{-1} whereas Kayangeran FR only 11 stems ha^{-1}. Figure 3 also shows that ramin seedlings and saplings found in Saribas Lupar PF outnumbered those in Kayangeran FR. The ramin assessment data were grouped into trees, saplings and seedlings to determine which diameter class dominates in terms of the number of stems or frequency of occurrence in the two sites. The groupings are as shown below:

G 1 = seedling height ≥ 20 cm but less than 1.3 m
G 2 = seedling height is > 1.3 m and dbh < 1.0 cm
G 3 = sapling between dbh 1.0 to 5.0 cm
G 4 = sapling between dbh 5.1 to 9.9 cm
G 5 = trees with dbh ≥ 10.0 cm.

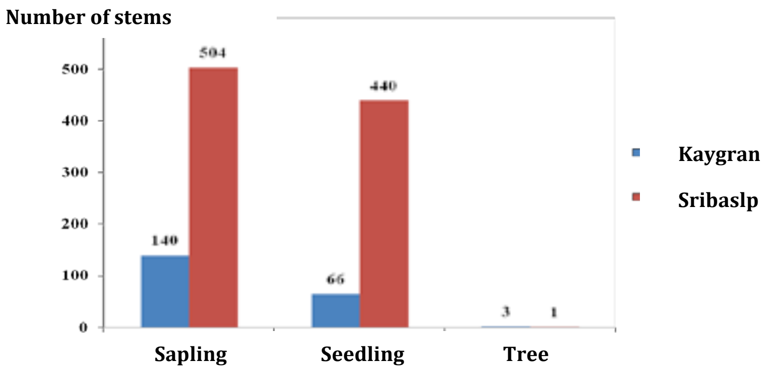


Figure 3 Numbers of ramin saplings, seedlings and trees in Kayangeran FR (KAYGRAN) and Saribas Lupar PF (SRIBASLP).

Table 4 shows that 644 saplings were assessed from the study areas of which 625 (96.9%) of them were in the lower diameter size (G 3) with dbh less than 5.1 cm as shown in Figure 4. In contrast, only 19 saplings (3.1%) were found with DBH from 5.1 to 9.9 cm (G 4). The distribution of the saplings is distinctly concentrated in the lower diameter range of 1.0 to 5.0 cm while a small fraction of saplings have dbh larger than 5.0 cm. From the result, it is noted that the trend of the diameter class distribution is the same for both sites. That is, saplings of the lower diameter group (1.0 to 5.0 cm) outnumbered those in the higher diameter group (5.1 to 9.9 cm). For seedlings, 506 seedlings were assessed from the two areas. Slightly more than half of these seedlings amounting to 273 (54%) were less than 1.3 m in height (G 1), while 46% or 233 seedlings were taller than 1.3 m but less than 10 mm in dbh (G 2) (Table 5). Saribas Lupar PF has slightly greater number of seedlings in G 1 (seedling < 1.3 m in height) than in G 2 (seedling > 1.3 m in height).

Table 4 Summary of ramin stems assessed in two selected PFE by transects

	KAY			KAY Total	SRL			SRL Total	Total stems
Row Labels	**SAP**	**SEED**	**TREE**		**SAP**	**SEED**	**TREE**		
1F					79	31		110	110
1G					31	37		68	68
2F					10	6		16	16
2G					159	149		308	308
3F					8	2		10	10
3G					148	204		352	352
4F					2	1		3	3
5F					2	3		5	5
PLOT1					65	7	1	73	73
T1	5	1		6					6
T11	5			5					5
T12	5	1		6					6
T13	5			5					5
T14	15	10		25					25
T15	9	5		14					14
T16	47	35	2	84					84
T17	10	5		15					15
T18	1	3		4					4
T19		1		1					1
T2		1		1					1
T20	12			12					12
T24	3			3					3
T25	1			1					1
T28	1			1					1
T3	3			3					3
T4	1		1	2					2
T6	4			4					4
T6-REG	12	4		16					16
T8	1			1					1
Grand Total	**140**	**66**	**3**	**209**	**504**	**440**	**1**	**945**	**1154**
% of total stems	**12.1**	**5.7**	**0.3**	**18.1**	**43.7**	**38.1**	**0.1**	**81.9**	**100**
ha^{-1}	**7.2**	**3.4**	**0.1**	**10.7**	**165.2**	**144.3**	**0.3**	**309.8**	

(KAY = Kayangeran FR; SRL = Saribas Lupar PF; SAP = Sapling; SEED=Seedling)
Note: Some transects with no record of ramin were not included in Table 4

Table 5 Summary of ramin stems according to diameter size classes

Locations	KAY		SRL			
Stem Group	**No. of stems**	**No. of stems/ha**	**No. of stems**	**No. of stems/ ha**	**Total no. of stems**	**% of Total**
SEEDLING	**66**	**3.38**	**440**	**144.26**	**506**	**43.8**
G 1: < 1.3 m ht	28	1.44	245	80.33	273	-
G 2: dbh < 1.0 cm	38	1.95	195	63.93	233	-
SAPLING	**140**	**7.18**	**504**	**165.25**	**644**	**55.8**
G 3: dbh 1.0-5.0 cm	135	6.92	490	160.66	625	-
G 4: dbh 5.1-9.9 cm	5	0.26	14	4.59	19	-
TREE	**3**	0.15	**1**	0.33	**4**	**0.4**
G 5: dbh≥10.0 cm	3	0.15	1	0.33	4	-
Grand Total	**209**	**10.72**	**945**	**309.84**	**1154**	**-**
% of Grand total	**18.1**	-	**81.9**	-	-	**100**

(KAY = Kayangeran FR; SRL= Saribas Lupar PF).

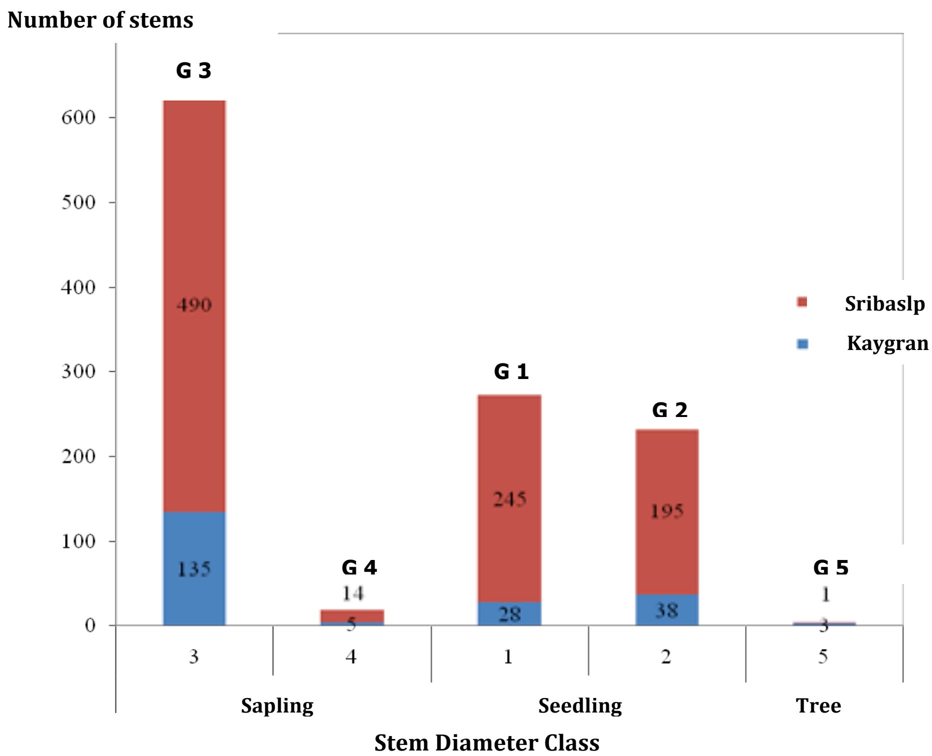


Figure 4 Number of ramin stems according to diameter classes at Kayangeran FR and Saribas Lupar PF.

Stem conditions

A total of 1,154 ramin stems were recorded at the two sites, 649 or 56.2% of the stems were deformed, defective, fallen or broken (Table 6). The chances for the stems to recover and grow to healthy trees are slim. 505 stems or 43.8% were considered as healthy stems. These stems may develop to mature trees provided the environmental conditions for growth remain favourable. The ultimate survival rate of these ramin stems - whether problematic or healthy - will need long-term monitoring and silvicultural treatment for them to grow to mature stands.

Table 6 Ramin stems conditions in Kayangeran FR and Saribas Lupar PF

No.	Stems conditions	Total	% of Total
1	Tree, alive and standing	4	0.3
2	Sapling, alive and standing	225	19.5
3	Seedling, alive and standing	276	23.9
	Sub-total of healthy stems	**505**	**43.8**
4	Sub-total of stems either fallen, deformed, defective, broken, etc.	649	56.2
	Total	**1,154**	**100**

Ramin stand density

The estimated stand densities per hectare, stocking and volume of ramin trees are shown in Table 7. By ratio of stand densities, for every 6.5 ha, there should be one ramin tree in Kayangeran FR. Likewise, in Saribas Lupar PF, it will take 3.05 ha to find one ramin tree. It is expected that there are 472 ramin trees in Kayangeran FR and 3,726 trees in Saribas Lupar PF. The ramin stocking densities of the study sites are considered significantly low in comparison to the size of the area of the selected PSF.

Table 7 Estimated stand density (dbh> 10 cm) and volume of ramin (dbh > 30 cm) for Kayangeran FR and Saribas Lupar PF .

Sites	Total Area (ha)	No. of ramin trees assessed	Area sampled (ha)	Stocking density per ha	Estimated stocking of ramin with DBH>10 cm	Estimated volume for ramin with DBH>30 cm
Kayangeran FR	3,067	3	19.5	0.1538	472	98.856 m^3
Saribas Lupar PF	11,364	1	3.05	0.3279	3,726	780.373 m^3

Tan (2008) reported that the occurrence of ramin trees ≥10.0 cm diameter was very low with one tree ha^{-1} in Sebuyau PF and Sedilu PF. Sia 2005, found that ramin stand density varied among the different localities with a relatively high density of 24 stems ha^{-1} at Naman FR to 1 stem ha^{-1} at Retus PF in the logged-over PSF of Sarawak. In addition, he noted that most localities had just 1 stem ha^{-1} (or lower) for the 10-20 cm dbh class.

Chai (1989) has earlier reported that ramin stand densities in the PSF in Kuching, Sibu, Bintulu and Miri Divisions were 9.6, 6.7, 0.8 and 8.6 trees ha^{-1} respectively during the diagnostic sampling study carried out in 1989 to determine the species compositions and the forest conditions (residual stands) after timber harvesting. These stand densities were much higher compared to those of Kayangeran FR and Saribas Lupar PF.

Volume Calculation

There were only four ramin trees recorded from the Kayangeran FR and Saribas Lupar PF sites during the study with the following dimensions:

	Tree 1	Tree 2	Tree 3	Tree 4
dbh (cm)	33.8	16.3	10.5	10.0
Trunk height (m)	18.3	15.0	7.0	5.3

The volume estimation was calculated based on the Smalian's formula (Smalian 2010). The volumetric formula used in log calculation is expressed as cubic volume:

$$V = [(B+b)/2]L$$

Where,
B = the cross-sectional area at the larger end of the log,
b = the cross-sectional area at the smaller end of the log, and
L = log length.

The dbh *(B)* used for volume calculation in this study is 30 cm, upper stem diameter (*b)* at 10 cm (the least allowable size), and trunk height *(L)* is 8.0 m. The volume of ramin was estimated at 0.628 m^3 per tree.

Volume stocking in Kayangeran FR

It can be implied from Table 6 that 472 ramin trees (>10 cm dbh) are expected to be available in Kayangeran FR. Of this, one third, about 157 trees, is estimated to be larger than 30 cm dbh. This assumption is based on reports indicating that the logged-over PSF consistently lack ramin trees of intermediate diameter size class. The remaining two thirds of ramin are expected to take another 25 years or more to grow from 20 cm to 30 cm dbh at the rate of 0.44 cm yr^{-1} at maximum (Sia 2005). The estimated stand density and volume stocking of ramin in Kayangeran FR from the 157 trees were 98.856 m^3 over an area of 3,067 ha. Such a low volume of ramin stocking is considered uneconomical for harvesting.

Volume stocking in Saribas Lupar PF

The same criteria used in estimating the ramin stand density and volume stocking of Kayangeran FR were used for Saribas Lupar PF. Of the total estimated 3,726 trees in Saribas Lupar PF (Table 5), one third (1,242 trees) are expected to be of dbh larger than 30 cm. This is equivalent to 780.373 m^3 over an area of 11,364 ha and is considered to be low at less than 1.0 m^3 ha^{-1}. Sia (2005) found that the volume from the yield plots established in PSF of Sarawak ranged from < 1 m^3 ha^{-1} in Retus PF to 30 m^3 ha^{-1} in Simunjan FR. For the two study sites, ramin should not be harvested as the mean stand density was below one tree ha^{-1} and the volume estimated was less than 0.33 m^3 ha^{-1}.

Conclusions

A total of 1,154 ramin stems were measured in 47 transects covering an area of 22.55 ha in Kayangeran FR and Saribas Lupar PF. Of the total stems, only four ramin trees were recorded. There were nearly equal numbers of saplings (644) and seedlings (505) in transects. In Saribas Lupar PF, the density of ramin seedlings and saplings is 144.26 and 165.25 ha^{-1} respectively while in Kayangeran FR it is about 3.4 and 7.2 ha^{-1} respectively. By comparison, Saribas Lupar PF is better stocked with saplings and seedlings than Kayangeran FR. When grouped into two diameter classes; 1.0 to 5.0 cm and 5.1 to 9.9 cm - 97.0% of the total saplings were found in the lower diameter group of 1.0 to 5.0 cm. Less than 3% of the total saplings were in the diameter size from 5.1 to 9.9 cm. Analysis of the stem conditions indicated that 56.2% of the total ramin stems measured had defects of some kind. It is unlikely that these could grow to become mature trees. The other 43.8% of the stems was considered healthy. As more than half of these ramin stems will not survive to mature trees, efforts on silvicultural treatment and reforestation in the logged-over PSF with ramin should be carried out. The stocking of ramin trees in the studied areas was very low with 0.15 tree ha^{-1} and 0.33 ha^{-1} in Kayangeran FR and in Saribas Lupar PF respectively. The total estimated ramin stands in Kayangeran FR are 472 trees and Saribas Lupar PF 3,726 trees. The total ramin stocking for stems with dbh ≥ 30 cm at Kayangeran FR would yield about 98 m^3 and Saribas Lupar PF about 780 m^3. With the mean ramin stand density at less than one tree ha^{-1} and the volume estimated at 0.33 m^3 ha^{-1}, the two selected areas are thus not economical for ramin harvesting.

Recommendations

The findings from the two sites showed a very low population of ramin trees, saplings and seedlings particularly for Kayangeran FR which could be related to the past logging intensity and the underlying ecological and environmental factors. It is recommended that a more intensive assessment be conducted to obtain a better understanding of the ramin stocking. The current data obtained from the two areas is not sufficient to compute the sustainable harvest quota for ramin in Sarawak and it is proposed that a more comprehensive assessment on ramin from other PSF in the PFE be carried out.

Implications for Practice

Both areas are rich in young seedlings and small saplings indicating abundance ramin regeneration. However with a mean annual increment of 0.44 cm yr^{-1} and only one tree of dbh ≥30.0 cm recorded, harvesting in Kayangeran FR and Saribas Lupar PF should be suspended until the forest recover with mature trees. Logging practice in PSF should be reviewed to ensure sufficient ramin mother trees remain in the logged-over forest.

Acknowledgements

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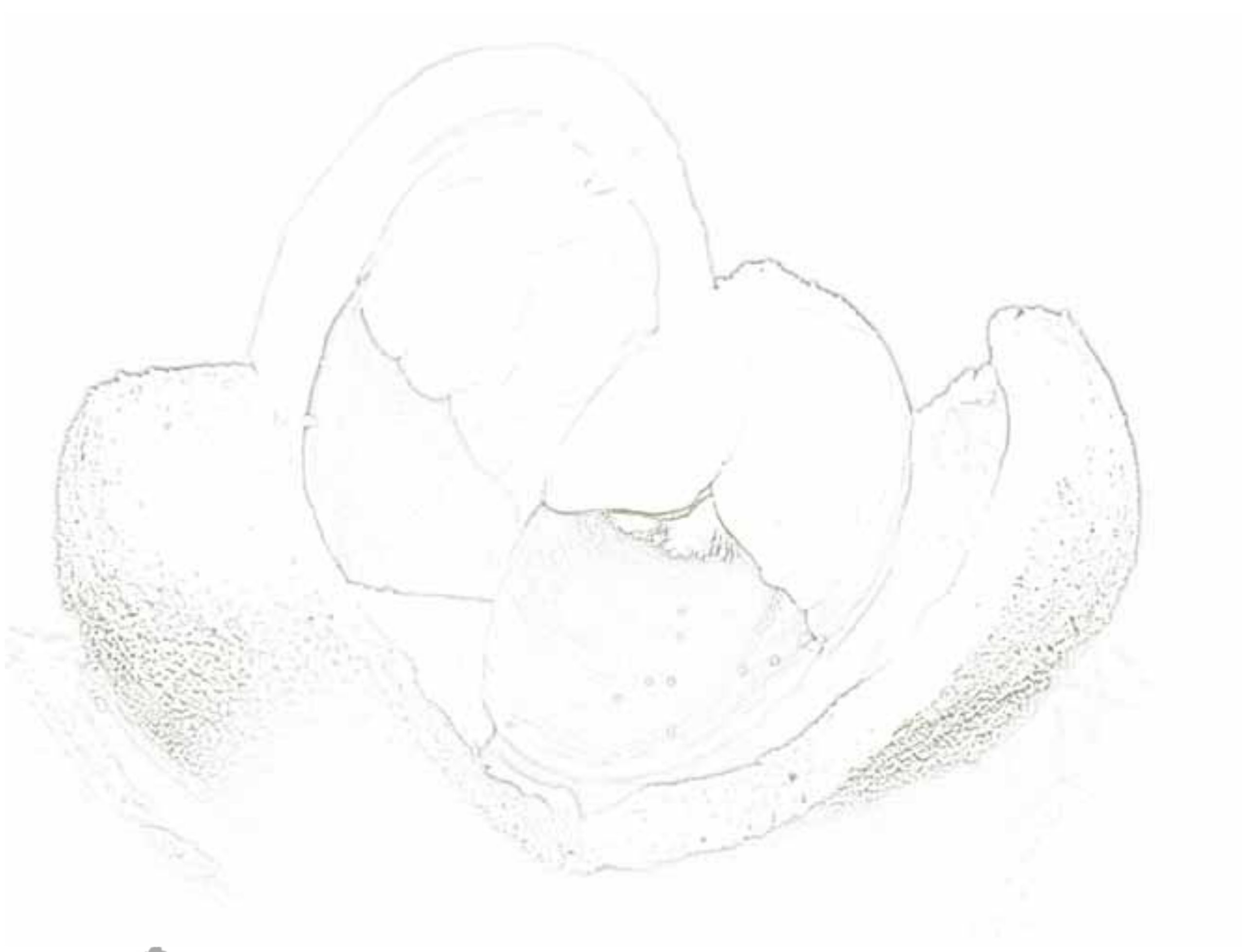

TECHNICAL PAPER 2

IMPROVING INVENTORY DESIGN TO ESTIMATE GROWING STOCK OF RAMIN (*GONYSTYLUS BANCANUS*) IN INDONESIA

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Abstract This study is dedicated for improving the inventory technique for estimating the standing stock of ramin (*Gonystylus bancanus*). The study was performed at two peat swamp forest, namely Sebangau National Park in Central Kalimantan, and the concession area of PT Diamond Raya Timber in Riau Sumatra. The improvements are focused on the techniques applied and their relative efficiencies as well as the sampling error produced. The sampling techniques examined in this study include double sampling, in which the plots on the first phase was taken at high resolution satellites imageries, while the second phase plots was created in the field. The medium resolution satellite imageries were also used to delineate the peat swamp forest. The stand variable measured at the first phase was crown closure (C), while the stand variables measured at the second phase in the field were tree diameter (dbh), tree height and ground crown diameter. This study concludes that the proposed double sampling technique examined provides better performance, having 301% relative efficiency, in comparison with techniques using either only ground survey or remote sensing technology. The proposed inventory technique using double sampling technique by combining high-resolution remotely sensed data and ground survey is 201% more efficient than using conventional simple random sampling.

Introduction

Indonesia is a tropical and archipelagic country that lies between two continents, i.e., Asia and Australia, and between two oceans i.e., the Indian and the Pacific oceans. Ecologically, Indonesia has rich natural resources of high biodiversity. A number of forest types are found in Indonesia which possess enormous richness of flora and fauna. One of the unique forest ecosystem is the peat swamp forest (PSF). Some fancy-wood species popular within the international community are found in the PSF. One of those tree species is ramin (*Gonystylus* spp.) which belongs to the Thymelaeceae family, grows naturally in peat swamp and lowland freshwater swamp forest. Since ramin wood is becoming the best selling wood species, its existence suffers extinction. In fact, since 1990s, ramin has been declared as rare wood. Based on various considerations, in order to maintain the existence of this very rare species, a proposal to include ramin in Appendix III of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) with zero quotas emerged. The proposal had been approved by CITES and a moratorium of logging and trading of ramin in Indonesia was declared in 2001.

The ecosystem of ramin is found in the forest area of Sumatra, Karimata Strait Islands and Kalimantan. In Sumatra, the species can be found in Riau, Bangka Belitung, and east coast of Sumatra and along the Musi River. In Kalimantan, ramin is found in West Kalimantan, Central Kalimantan and South Kalimantan. Ramin tree grows in podsoil, peat land and clay soil. In general, ramin tree has an upright shape and can reach up to 45 m in height, while the height of its branch is 20 – 25 m (Samingan 1980; Wiroatmodjo 1975). Another characteristic of ramin species is the ability to produce sap.

In forest management, a rapid collection of data and information for wide area in accurate manner is absolutely necessary. For a sound management of ramin, the availability of ramin information concerning the stand condition, distribution and its standing stock is definitely required. Recently, with the advent of high resolution satellite imageries coupled with their capability to record information in timely manner and wider area, the use of remote sensing techniques could be a good choice. Some studies related to the use of remote sensing technique showed that the use of remote sensing techniques is promising, having more efficient approach. The combination of remote sensing technology and terrestrial survey shows the most optimal option. The use of higher resolution satellite imagery provides better accuracy than the lower resolution or by using only terrestrial method. In this study, image identification was performed to obtain the most optimal data and information related to ramin standing stock. The spatial resolution and spectral resolution are major factors to be considered. Other factors considered, the image should be easily obtained at relatively low cost. To evaluate the proposed forest inventory technique, two study sites in Sumatra and Kalimantan areas were selected. The proposed technique used the combination of remote sensing technology and terrestrial inventory to estimate the standing stock of ramin.

Scope of the Study

The study covers development of inventory techniques devoted to estimate the standing stock of ramin in the PSF by using terrestrial and remote sensing approaches. The study was initially started by the identification of proper satellite imageries that can be used in the inventory of ramin standing stock. Other activities covered in the study were identification of the optimally and technically feasible method for the inventory of ramin standing stock, the development of estimation model of ramin standing stock, as well as evaluation of the efficiency level of employing double sampling technique by using satellite images. Ultimately, the estimation of the standing stock of ramin based on the available data for case studies in Riau and Central Kalimantan was performed.

Methods for Ramin Inventory in the Peat Swamp Forest

Peat ecosystem is very unique. In general, the accessibility of PSF area is low, hence the cost of terrestrial inventory activity in the PSF is very high. Data and information regarding peat characteristics to optimally support the growth of ramin species is unknown until recently. Ramin is commonly found in peat land area having depth from 120 cm to more than 600 cm. The thicker the peat layer, the more ramin is found. Ramin wood is not so dominant at a peat depth of 120 – 500 cm, while at a peat depth of > 500 cm, the ramin tree is dominant. In addition, the distribution pattern of ramin at a deep peat (> 500 cm) is uniform, while at shallow peat (< 500 cm), it is random. A stratified and structural analysis to estimate ramin standing stock is also performed under ramin inventory technique that employs a combination of remote sensing and terrestrial survey. The purpose of a stratified analysis is to observe the position of ramin relative to other tree types within certain habitat both vertically and horizontally. In relation to crown stratification, ramin tree usually occupies stratum A, but the tree is not the tallest tree. Ramin tree occupies a place below meranti batu (*Shorea uliginosa*) and kempas (*Kompasia malaccensis*) trees. A structural analysis of ramin standing is performed to observe the relationship between the number of tree per hectare (N/ha) and the diameter classes.

Up to now, the use of remote sensing technology to inventory ramin has not been specifically performed. The conventional method used is through detecting the presence of PSF ecosystem as habitat of ramin tree. Based on this consideration, it is recommended to use a combined method of satellite images and terrestrial method, particularly by using *phase sampling* method. The plot at the first phase was done at high resolution satellite imageries, while the second phase was performed in the field.

Preparation Method for Ramin Stock Estimation Model

The phase sampling technique was used in preparing ramin standing stock estimation model. In a medium resolution satellite image, the forest cover was delineated to derive information regarding forest and non-forest covers. This was done using Landsat image. The measurement of the secondary sample unit in the second phase was performed using high resolution satellite images. For ground measurement, standing variables measurement in the PSF, i.e. crown density (C) was performed using high resolution satellite images. The measurement of the tertiary sample unit is performed terrestrially or through field measurement in the PSF that occupies the same area as the measured cluster in high resolution satellite image (in secondary sampling unit). The variables measured among others are crown diameter (D_c), tree diameter (D), tree height (H), tree volume (V), and standing volume (Vst).

The field measurement of standing variables in the field was performed within the cluster location, as stated in the satellite image (secondary sampling unit). The initial point of field measurement started at where ramin tree was first found.

The variables measured in the satellite images and the stand volume measured using terrestrial methods were analysed using regression analysis. The models were selected on the basis of the degree of relationship between two variables measured in the satellite image and in the field. Among the stand variables measured, the crown density (C), was easily measured and provided accurate measurement. The use of crown density is expected to produce good estimation model for ramin standing stock in the PSF.

Sampling Design

Distribution of the sample plot was designed based on crown density classes shown in the image and the peat depth as illustrated in Figure 1. The sample plots layout was performed using systematic sampling with random start, taking into account the accessibility of the sample location. In the field measurement, the shape of plots used consisted of (1) four circular plots with a total area of 0.01 ha within one cluster and rectangular plots, 20 m x 125 m (0.25 ha).

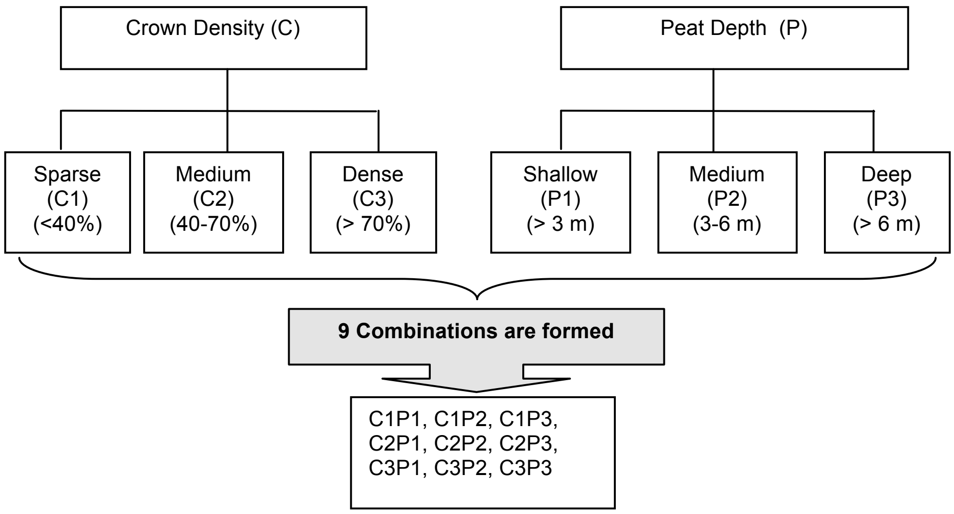
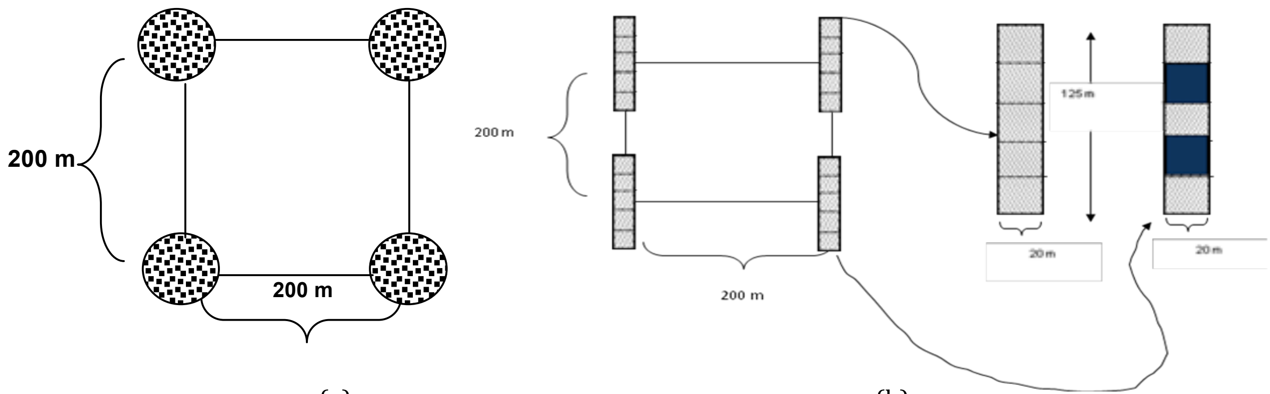


Figure 1 Sampling design



(a) (b)

Figure 2 Circular (a) and rectangular plots (b)

Interpretation of Crown Density in the Image

The crown density interpretation in the satellite imageries was measured in the plot of 0.04 ha. Each plot was further divided into 16 parts to get a more detail interpretation of crown frequency. The crown density value or crown closure is the ratio between the crown covered area and the plot area. This technique is frequently referred to as *tree creaming method.*

Modeling

Development of the estimation model for estimating standing stock is performed to minimise an error from unsystematic human error. Variables that mostly used to estimate the standing stock are (Jaya 2002), percentage of crown density (*C*), crown diameter (*Dc*) and the number of tree (*N*). Furthermore, the relationship function among the stand variables is as follows:

$V_T = f(C, D, N)$

A regression model to estimate the standing stock could be developed using one or more stand variables(s). The fewer variables there are, the better. A regression with only a single variable such as average of height, average crown diameter or crown closure is much expected. However, under certain circumstances, the use of average crown coverage is better. Therefore a test of correlation between variables in regression analysis is necessary. To select the best model for estimating the standing stock, the following are taken into considerations:

1. The estimation model being developed should be a simple model;
2. The variable used should be easily measured, either in the image or in the field as well as providing the relatively consistent result.
3. The selected model should be practical

Model Verification

The statistically selected models were verified using standing stock data obtained from the field survey. The criteria used to determine the acceptability of model verification were *the aggregate values of deviation* (Spur 1960) *average deviation*, *Root Mean Square Error* (RMSE), *bias* (e) and significant *different test* between the estimation result and the real volume base on Chi-squared test (Bustomi *et al.* 1998).

Relative Efficiency of a Two-Phase Sampling

The estimation of standing stock of ramin was performed by using a two-phase sampling, often referred to as double sampling. This sampling technique is composed of two phases, the first phase is called the main phase, while the second phase is a sub-sample of the first phase. The plot measurement during the first phase, i.e., in the high resolution imageries is usually performed on a large number of plots (*n)*. The number of plot measured in the field (m) during the second phase is usually smaller than those observed at the first phase ($m<n$). The efficiency of the two-phase sampling technique in comparison with the simple random sampling is highly determined by the optimum number of sample plots that should be observed in both the field and in the satellite imageries. The number of optimal sample plots is dependent on the correlation coefficient and the cost ratio between observation per plot in the image and in the field. The ratio of plot number in the image and in the field can be found in Paine (1981).

Implementation

In this study, the proposed inventory technique is a combination of terrestrial survey and image measurement. The method was tested at two sites, i.e. at the Sebangau National Park in Central Kalimantan and at the concession area of PT Diamond Raya Timber (DRT) in Riau Province, Sumatra.

The actual stand data such as tree height and diameter for Sebangau site were obtained from 35 clusters or 140 elements which is equal to 14 ha. The data were used to develop estimation model of standing stock of all ramin and non-ramin trees. For DRT study site, the number of sample plots obtained was 37 clusters or 222 elements that equals to 8.88 ha.

Results

Stands Structure

Based on the tree height, azimuth and the relative position of tree to the central point of its cluster element, a standing profile was created to figure out the vertical and horizontal structures of the stands in the sample plot. The standing profile was created by using the supporting system - extension Jaya-(2005) integrated with ArcView 3.2 software. The example of standing profile created is shown in Figure 3. The vertical and horizontal cross-section of each plot could be well depicted. With lower crown closure, fewer number of trees is projected.

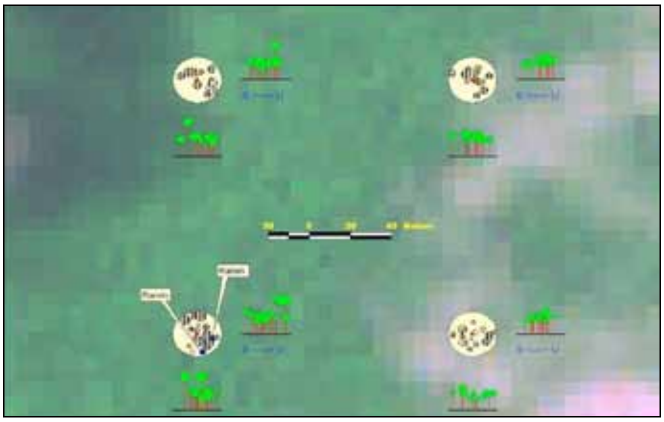


Figure 3 Standing profile with medium density at a peat depth of 3-6 m

Monogram

For practical and technical purposes, the simplest way to define the standing stock is by using a monogram. A monogram is a satellite image interpretation key visually displayed using pictures (Figures 4 and 5). In short, monogram is defined as an interpretation key that consisted of image hardcopy, presenting information on stands variables (object) in the image that can be measured or interpreted. Furthermore, by using such variables, information on the relevant stands can be displayed.

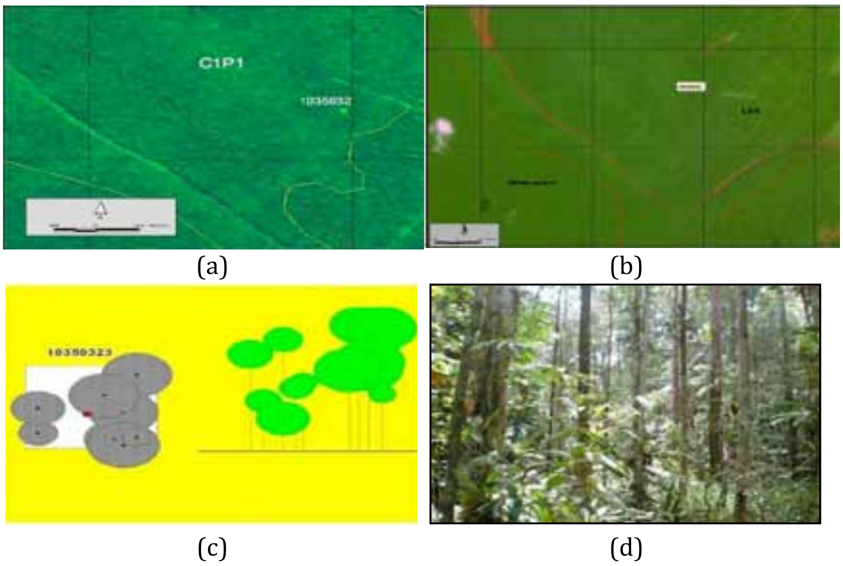
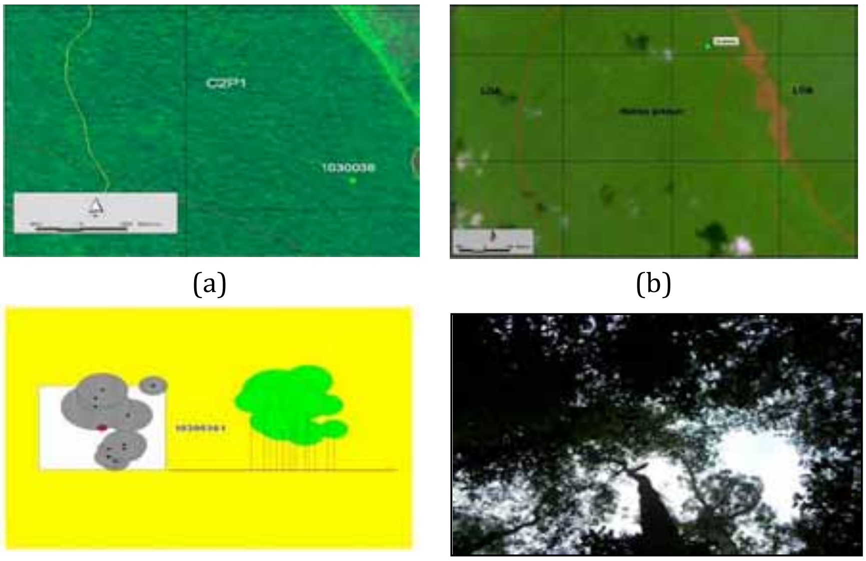


Figure 4 The Stand Condition of PSF Monogram at PT DRT in ALOS AVNIR (C1P1) Image (a), Identification of Land Coverage in the Landsat Image (b), Tree Profile (c), and Field Photo (d)



(a) (b) (c) (d)

Figure 5 Stand Condition of PSF Monogram at PT DRT in ALOS AVNIR (C1P1) Image (a), Identification of Land Coverage in the Landsat Image (b), Tree Profile (c), and Field Photo (d)

Ramin Standing Stock

From the analysis performed on the field measurement data, the standing stock of ramin in swamp forest of Riau is relatively low, i.e., only 5% of the total volume of all species. Small proportion of ramin is also found at the PSF in Kalimantan where the proportion of ramin is only 2.3% of the total standing stock. Meanwhile, the ratio of ramin trees and all species in swamp Forest in Riau and Kalimantan is 4.19% and 2.64 %, respectively (Table 1).

Table 1 Ratio of ramin tree volume and all species in PSF

Location	**Ramin**		**All species**		**Ratio (%)**	
	***N*/ha**	**m³/ha**	***N*/ha**	**m³/ha**	**Tree**	**Volume**
Riau	5.0	9.2	119.4	185.5	4.19	4.98
Central Kalimantan	4.0	2.0	151.4	97. 9	2.64	2.04

Based on the results of spatial analysis and volume-ratio as described above, the ramin stock in PSF either in Sumatra or Kalimantan can be estimated. Ramin stock is estimated by multiplying the size of forest coverage in each sample stratum by the estimation of ramin standing stock. The standing stock of ramin in Sumatra is about 193,154 m^3 to 386,308 m^3 in shallow peat, 1,351,712 m^3 to 5,406,849 m^3 in the medium deep peat and 0 to 1,879,247 m^3 in deep peat. Ramin standing stock in Kalimantan Island ranges from 2,464,576 m^3 to 5,750,678 m^3 in shallow peat, 1,244,608 m^3 to 2,901,159 m^3 in medium deep peat and 491,345 to 1,597,264 m^3 in deep peat. In terms of standing stock, the number of ramin trees in Sumatra island is estimated around 378,58 to 757,16 trees in shallow peat, 2,649,356 to 10,597,424 trees in medium deep peat, and 0 to 3,683,323 trees in deep peat. In Kalimantan, the estimated number of ramin trees range from 2,934,019 to 5,868,039 trees in shallow peat, 23,919,780 to 9,146,153 trees in medium deep peat, and 932,415 to 2,797,246 trees in deep peat.

Ramin Standing Stock Estimation Model

The estimation model of the standing stock in the PSF above is used to estimate ramin standing stock. The stock of ramin is derived by using certain correction factors which is a ratio between ramin volume and stands volume (of all types). The result of data analysis of field measurement indicated that the volume of ramin in peat swamp forest in Riau is 5% of the volume of all species, while in Sebangau National Park in Central Kalimantan its volume is 2.3% (Table1).

Relative Efficiency of a Two-Phase Sampling

The analysis using satellite images from 211 sample plots and field measurement from 99 sample plots PT DRT, provided the following mathematical model having coefficient of correlation of 0.7213 .

$\hat{V}_{dslr} = \overline{V}_{fm} + 0.4175 * (\overline{V}_{cn} - \overline{V}_{cm})$, with r value = 0.7213

From the standing stock estimation model using double sampling, the average standing volume is 180.84 m^3 ha^{-1} at 5% confidence level.

The relative efficiency of multiple sampling above is 301.07%, which means that the two-phase sampling yield is 201.07% more efficient than simple random sampling. For optimal allocation of plot numbers for the satellite images and field inventory, twice as many satellite images plots are required for every field plot observed. To obtain a low sampling error, more sample plots both in the field and for the images are required (Figure 6). The relative efficiency can be achieved when the cost per unit observation area in the image plot is cheaper.

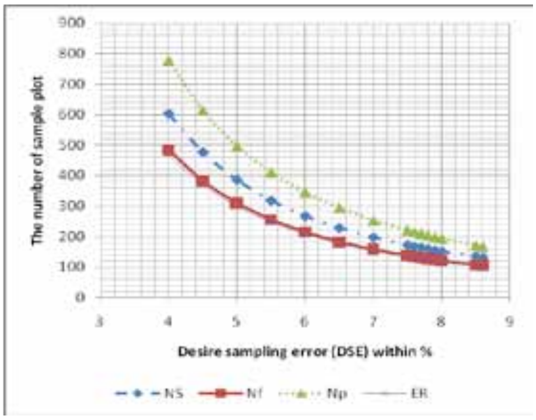


Figure 6 Relationship between the number of sample and the expected sampling error in double sampling (Note: Ns = number of n optimal, Nf = number of samples to be observed in the field, Np = number of samples to be observed in the image, and ER = expected error

Conclusions

The following conclusions are derived from the findings:

1) The use of double sampling technique by combining terrestrial inventory and remote sensing technique gave the most cost-effective and technically applicable method. The relative efficiency analysis indicates that a two-phase sampling is more efficient compared to conventional sampling.

2) The stand variables such as crown density and crown diameter from the satellite images can be used to estimate standing stock.

3) Ramin is a dominant species at the study area at a peat depth of 3 ~ 6 meter.

4) The size of ramin trees varies in diameter at breast height and tree height with no particular distribution pattern.

5) Estimation model based on crown density can be used to estimate ramin standing stock. The models have coefficient of determination of 55~70%. The best estimation model form is the exponential model.

6) The standing stock of ramin is estimated using a ratio of the volume of ramin and total volume of all tree species. The standing stock of ramin in Riau's PSF is 5%, while in Sebangau National Park in Central Kalimantan, the standing stock is 2.3%.

7) Based on the spatial analysis results, the standing stock of ramin in Sumatra is approximately 7,832,175 trees or 15,351,063 m^3, while in Kalimantan the standing stock is approximately 12,017,687 trees or 6,004,874 m^3.

Relative efficiency would increase if the procurement cost of satellite images is more affordable. The high resolution ALOS AVNIR satellite images with much lower cost can be used as an alternative to the current satellite images widely used in Indonesia.

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TECHNICAL PAPER 3

THE DISTRIBUTION OF DRY AND WET INLAND *GONYSTYLUS* SPP. (RAMIN), *AQUILARIA* SPP. (KARAS) AND *INTSIA* SPP. (MERBAU) IN PENINSULAR MALAYSIA

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Abstract There is a widespread concern on the distribution of *Gonystylus* spp. (ramin), *Aquilaria* spp. (karas) and *Intsia* spp. (merbau) due to the existing rate of exploitation and extraction in Peninsular Malaysia . Assessments on distribution of the three species were carried on 59 sampling units (SU) using NFI-4 data and consequently ten permanent sample plots (PSPs) were established for periodic monitoring on the growth, mortality and recruitment of *Gonystylus* spp. Enumeration on the 59 SU showed that only two species of *Aquilaria* were found, totalling 3.96 stems ha^{-1} and 92.08% concentrated in diameter classes 1.5m<10cm and 10 < 30cm. *Aquilaria hirta and Aquilaria malaccensis* recorded 2.8 and 1.16 stems ha^{-1} respectively. As for *Intsia* spp., the total number of stems per ha for *I. bijuga and I. palembanica* was 0.013 and 0.034 respectively. Six *Gonystylus* spp. were recorded in the enumeration namely *G. bancanus, G. affinis, G. macrophyllus, G. brunnescens, G. confusus* and *G. maingayi* with estimated 19.51 stems ha^{-1}. for all diameter classes. However, based on the diameter class 10cm dbh and above, the difference on the number of stems ha^{-1} is lessened to 3.5 stems ha^{-1}. For dry *Gonystylus*, it was 1.8 stems ha^{-1} and wet inland *Gonystylus (G. bancanus),* 1.73 stems ha^{-1}. Result on wet inland *Gonystylus* is comparable to the result on the enumeration of ten PSPs which recorded 1.6 stems ha^{-1} of *G. bancanus* but lesser number of stems ha^{-1} for dry *Gonystylus* or 0. 9 stems ha^{-1}. Other results on *Gonystylus* spp. *Aquilaria* spp. *and Intsia* spp. enumerated in the 59 SU, ten PSPs and NFI-4 are presented and discussed in this paper.

Introduction

Gonystylus spp. (ramin), *Aquilaria* spp. (karas) and *Intsia* spp. (merbau) are important tree species that are currently being utilised in Malaysia. There are widespread concerns about the rate at which these species are being exploited. This is accelerated by the introduction of mechanised harvesting, improved transport methods and land-use change from forest to agricultural land to support socio-economic development. Present concerns also include increasing demand for timber from industries, both local and international, and to a certain extent, the threats from illegal logging.

Given these concerns, the International Tropical Timber organization (ITTO) and Government of Malaysia (GOM) undertook this study to assess and analyse data on *Gonystylus* spp., *Aquilaria* spp., and *Intsia* spp. from multi-forested area in Peninsular Malaysia through the establishment of permanent sample plot (PSPs) and information gathered from the Fourth National Forest Inventory (NFI-4) (Anon. 2007). About RM293,625.00 spent were mainly for field work inventory, establishment and enumeration of ten PSPs, tree identification course to forestry department staff and contractor workers, as well as reporting and seminar. ITTO funded about 80% of the project cost. The PSPs were established to provide more reliable information on growth and population dynamics of these species in Peninsular Malaysia.

Objectives

The objectives of this project are:-

i. To collect information on the distribution, status and stocking of dry and wet inland *Gonystylus* spp. (ramin), *Aquilaria* spp. (karas) and *Intsia* spp. (merbau) based on the Fourth National Forest Inventory (NFI-4) information in Peninsular Malaysia;

ii. To establish ten (10) permanent sample plots (PSPs) to periodically monitor the growth, mortality and ingrowth of *Gonystylus* spp. (ramin) in Peninsular Malaysia.

Methodology

Study on the content and distribution of *Gonystylus* spp. was carried out based on the 1644 sampling units (SU) set up for enumeration in NFI-4. A total of 60 SU were selected that contained *Gonystylus* spp., as well as *Aquilaria* spp. and *Intsia* spp. Of these 60 SU, 59 still remain intact while one SU was seriously disturbed due to forest road construction.

The design of the sampling unit is shown in Figure 1 (Anon. 2002). The sampling design consists of a sample unit circular in shape with one sample plot each in every corner, with a total of four plots. Each sample consists of a 4-meter radius circle plot for enumeration of small size trees (trees 1.5 m height and < 10 cm dbh) and a point sample for big trees (trees ≥ 10cm dbh). The measurement of tree diameter at breast height (dbh) was carried out using a caliper. Bitterlish Relascope with Basal Area Factor of 4 was used in point sampling method, measured from the centre of the circular plot. As for the locations of the sampling units, GPS with accuracy of ±6 m was used.

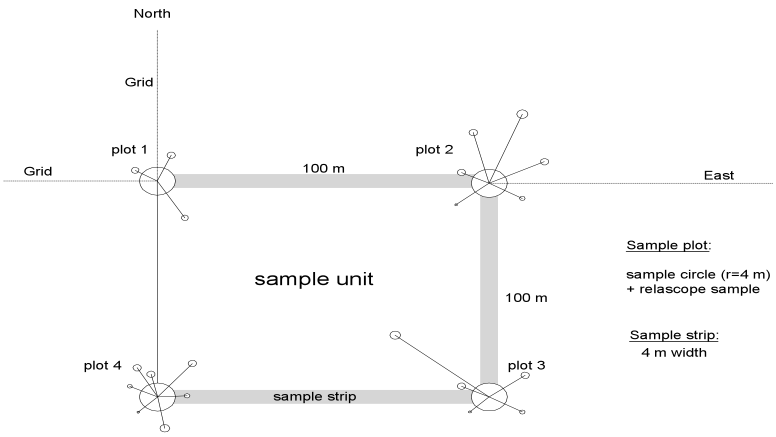

Figure 1 Sampling unit and sampling plots design used in the NFI-4

***Establishment of ten (10) Permanent Sample Plots (PSPs) for Gonystylus* spp.**

Ten (10) permanent sample plots (PSPs) were established to periodically monitor the growth, mortality and ingrowth of *Gonystylus* spp. The ten PSPs were selected based on the stand content of the 59 SUs. The design of the PSP is shown in Figure 2. The size of each PSP is one (1) hectare divided into 25 sub-plots of 20 x 20m and 9 sub-plots of 10 x 10m. *Gonystylus* spp. trees ≥ 10cm dbh were measured in the 20 x 20m sub-plots, while in the 10 x 10m sub-plots only trees of ≥ 1.5m height and < 10cm dbh were measured.

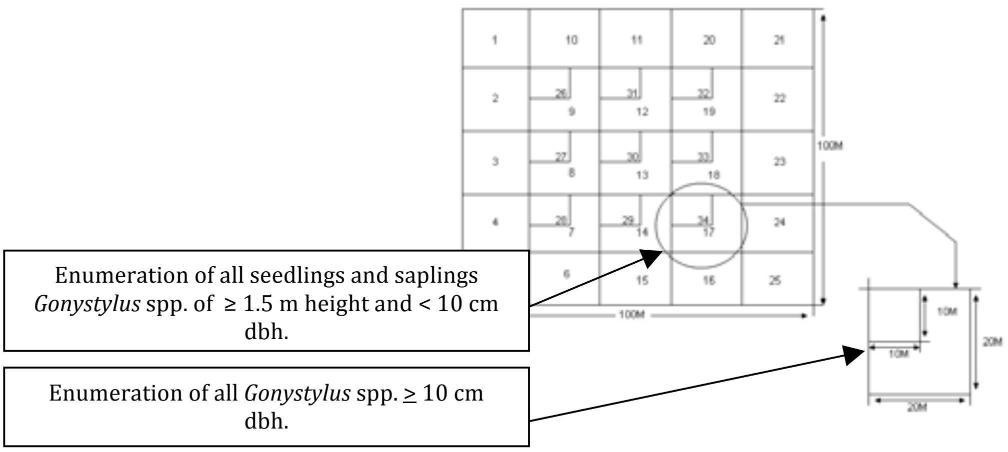

Figure 2 Permanent sample plot design

Results and Discussion

Stand Content for 59 Sampling Units

Based on the analysis, only 2 spesies namely *Aquilaria hirta* and *A. malaccensis* were found. The total number of stems recorded for both species was 3.96 stems ha^{-1}, i.e., 2.80 and 1.16 stems ha^{-1} for *A. hirta* and *A. Malaccensis,* respectively. Both species were concentrated in diameter classes <10cm and 10<30cm, comprising 3.64 trees ha^{-1} or 92.1% of the total stem number. Detail on the number of stems per hectare for each species in each diameter class is shown in Table 1. Both species *Intsia bijuga and I. palembanica* were recorded in the enumeration. The total number of stems per hectare for both species was 0.06, where *I. bijuga* recorded 0.01 stems ha^{-1} and *I. palembanica* recorded 0.03 stems ha^{-1}. Both species were only found in diameter class ≥ 60 cm dbh. Detail on the number of stems per hectare for each species in each diameter class is shown in Table 2. Six *Gonystylus* spp. were recorded namely *G. bancanus, G. affinis, G. macrophyllus, G. brunnescens, G. confusus* and *G. maingayi*. The total number of stems per hectare for all species was 19.51. The stems were mainly in the diameter class <10cm, contributing to about 82.2% of the total stem number or 16.01 stems ha^{-1}. *Gonystylus confusus* which is a dry inland *Gonystylus* spp. represents about 48.6% or 9.48 stems ha^{-1} of all the *Gonystylus* spp. *G. bancanus* or wet inland *Gonystylus* which is mainly found in the peat swamp forest recorded 5.94 stems ha^{-1} or 26.3% of all the *Gonystylus* spp. enumerated. The detail on the number of stems per hectare for each species in each diameter class is shown in Table 3.

Table 1 Number of stems per hectare of *Aquilaria* spp. by diameter classes

Species	Diameter class (cm)					Stems ha^{-1}
	< 10*	10<30	30<45	45<60	≥60	
Aquilaria hirta	0.8426	1.9571				2.7997
A. malaccensis	0.8426		0.2304	0.0826		1.1556
A. beccarania						0.0000
A. rostrata						0.0000
A. microcarpa						0.0000
No. of Stems/Ha	1.6852	1.9571	0.2304	0.0826	0.0000	3.9553

** Only trees ≥ 1.5 meter height*

Table 2 Number of stems per hectare of *Intsia* spp. by diameter classes

Species	Diameter class (cm)					Stems ha^{-1}
	< 10*	10<30	30<45	45<60	≥60	
Intsia bijuga	-	-	-	-	0.01277	0.01277
I. palembanica	-	-	-	-	0.03391	0.03391
No. of Stems/Ha	0.00000	0.00000	0.00000	0.00000	0.04668	0.04668

** Only trees ≥ 1.5 meter height*

Table 3 Number of stems per hectare of *Gonystylus* spp. by diameter classes

Species	Diameter class (cm)					Total
	< 10*	10<30	30<45	45<60	≥60	
Gonystylus bancanus	4.21322	0.83088	0.77133	0.09768	0.02705	5.94015
G. affinis	0.84264	0.51345	0.16196			1.51805
G. macrophyllus						0.00000
G. brunnescens	0.84264			0.10197	0.20500	1.14962
G. confusus	9.26908		0.11670	0.08987		9.47565
G. maingayi	0.84264	0.29599	0.28635			1.42498
Total	16.01024	1.64031	1.33634	0.28952	0.23205	19.50845

** Only trees ≥ 1.5 meter height*

Stand Content for Ten PSPs

Only four *Gonystylus* spp. were found in the ten PSPs. Three species are dry inland *Gonystylus* namely *G. maingayi*, *G. brunnescens* and *G. confusus* while one is a wet inland *Gonystylus* spp. *(G. bancanus).* The number of stems per hectare by diameter classes and species is shown in Table 4. *Gonystylus confusus* has the highest number of stems per hectare, however they were mainly confined in the lowest diameter class which is < 10 cm dbh. As for *G. bancanus*, which represents the wet inland *Gonystylus* spp., the number of stems per hectare was 1.6 and the total number of stems per hectare for the dry inland *Gonystylus* spp. was 3.9 stems ha^{-1}. The stem content indicated that *G. confusus* is the most prevailing species followed by *G. brunenscens* (1.5 stems ha^{-1}). Table 4 shows more than 62% or 1.0 stems ha^{-1} of *G. bancanus* is in the diameter class ≥ 30cm which represents the next potential tree crop. Overall content of *Gonystylus* species enumerated shows that the distribution of stem is very representative of various diameter classes and species for growth study.

Table 4 Number of stems per hectare of *Gonystylus* spp. by diameter classes and species

Species	Diameter classes (cm)					Total
	< 10*	**10<30**	**30<45**	**45<60**	**≥60**	
Gonystylus maingayi	-	0.1	-	-	-	0.1
G. brunnescens	1.1	-	-	0.1	0.3	1.5
G. confusus	2.2	0.1	-	-	-	2.3
G. bancanus	-	0.6	0.8	0.2	-	1.6
Total	**3.3**	**0.8**	**0.8**	**0.3**	**0.3**	**5.5**

** Only trees ≥ 1.5 meter height*

Stem Content Comparison between 59 Sample Units and NFI-4

Based on the NFI-4, the number of stems per hectare for *Gonystylus* spp. tree of size ≥ 10cm dbh in Peninsular Malaysia is 1.14 (Table 5). For 59 SUs with the same diameter class, 3.5 stems ha^{-1} of *Gonystylus* spp. were recorded. Table 6 shows the percentage distribution according to diameter classes where 16.21% of the total number of trees were in diameter class 10 < 15cm, 50.38% in class 15<30cm, 17.81% in class 30<45cm, 13.87% in class 45<60cm, and 1.73% in diameter class ≥ 60cm. Table 6 also shows the percentage distribution by diameter classes of the 59 SUs stem content.

Table 5 Number of stems per hectare of *Gonystylus* spp. in Peninsular Malaysia*

Species	Diameter classes (cm)					Total
	10<15	**15<30**	**30 < 45**	**45 < 60**	**≥60**	
Gonystylus spp.	0.232893	0.615503	0.168730	0.130940	0.016369	1.164435
G. bancanus	0.000000	0.108440	0.080870	0.068360	0.008545	0.266216
G. maingayi	0.000000	0.000000	0.006397	0.000000	0.000000	0.006397
Total	**0.232893**	**0.723943**	**0.255997**	**0.199300**	**0.024914**	**1.437048**

* According to the Fourth National Forest Inventory (NFI-4)

Table 6 Comparison on percentage distribution of stem content of *Gonystylus* spp. by diameter classes

Enumerations Methods	Diameter classes (cm)					Total
	10<15	**15<30**	**30 < 45**	**45 < 60**	**>60**	
NFI-4	16.21%	50.38%	17.81%	13.87%	1.73%	100%
59 SU	46.9%		38.2%	8.28%	6.63%	100%

For *Aquilaria* spp., the stem content of NFI-4 for tree ≥ 10cm dbh was 0.62 stems ha^{-1} and for the 59 SUs, 2.27 stems ha^{-1} (Table 7). Table 8 shows the NFI-4 stem content distribution by percentage where 47.57% of the total number of trees were in diameter class 10<15cm, 31.98% in class 15<30cm, 16.27% in class 30<45cm, 2.91% in class 45<60cm, and 1.27% in diameter class ≥ 60cm.

Table 7 Comparison on percentage distribution of stem content of *Aquilaria* spp. by diameter classes

Enumerations Methods	Diameter classes (cm)					Total Stems ha^{-1}
	10.1-14.9	**15.0-29.9**	**30.0-44.9**	**45.0-59.9**	**>60**	
NFI-4	47.57	31.98	16.27	2.91	1.27	100%
59 SU	86.21		10.15	3.64	-	100%

Table 8 Number of stems per hectare of *Aquilaria* spp. in Peninsular Malaysia*

Species	Diameter class (cm)					Total
	10.1-14.9	**15.0-29.9**	**30.0-44.9**	**45.0-59.9**	**>60**	
Aquilaria spp.	0.29475	0.19812	0.1008	0.01803	0.00787	0.61957
Total	0.29475	0.19812	0.1008	0.01803	0.00787	0.61957

* According to the Fourth National Forest Inventory (NFI-4)

The NFI-4 shows the stem content for *Intsia* spp. was 0.81 stems ha^{-1} (Table 9). Based on the same diameter class (≥10 cm dbh), the stem content for the 59 SUs was 0.047 stems ha^{-1} and confined to diameter class ≥60cm. The distribution percentage of the stem content of NFI-4 for the *Intsia* spp. is shown in Table 10. The table shows that 2.15% of the total number of trees were in diameter class 10<15cm, 52.6% in class 15<30cm, 26.2% in class 30<45cm, 11.1% in class 45<60cm and 8.0% in diameter class ≥60cm. The stem content of the 59 SUs was confined to diameter class ≥60cm.

Table 9 Number of stems per hectare of *Intsia* spp. in Peninsular Malaysia*

Species	Diameter class (cm)					Stems ha^{-1}
	10.0-14.9	**15.0-29.9**	**30-44.9**	**45-59.9**	**>60**	
Intsia spp.	0.01750119	0.42783986	0.212714	0.089942	0.065027	0.813025
Total	0.01750119	0.42783986	0.212714	0.089942	0.065027	0.813025

* According to the Fourth National Forest Inventory (NFI-4)

Table 10 Comparison on percentage distribution of stem content of *Intsia* spp. *a*ccording to diameter classes.

Enumerations Methods	Diameter classes (cm)					Total Stems ha^{-1}
	10.1-14.9	**15.0-29.9**	**30.0-44.9**	**45.0-59.9**	**>60**	
NFI-4	2.15	52.63	26.16	11.06	8.00	100%
59 SU	-		-	-	100	100%

Conclusions

The study shows that the 59 SUs selected in this study were sufficient to set growth plots for *Gonystylus* spp. *and Aquilaria* spp. since they closely reflected stem distribution by diameter classes of the NFI-4 stand content. For *Intsia* spp. however, further selection of the NFI-4 sampling units is required for setting growth plot. The study also indicates the reliability of NFI-4 SUs data for locating species. To better manage *Gonystylus* spp. (ramin), *Aquilaria* spp. (karas) and *Intsia* spp. (merbau) to species level, data regarding the content and distribution of the species should be further improved through identification to species level in the next national forest inventory.

Acknowledgements

This work was made possible by a grant from ITTO under its collaborative program with CITES to build capacity for implementing timber listings. Donours to this collaborative program include the EU (primary donour), the USA, Japan, Norway, New Zealand and Switzerland. The roles played by the Ministry of Natural Resources and Environment, Malaysia (NRE) as the executing agency, as well as FRIM and the forestry departments in Malaysia as implementing agencies of the ITTO-CITES project are also greatly appreciated.

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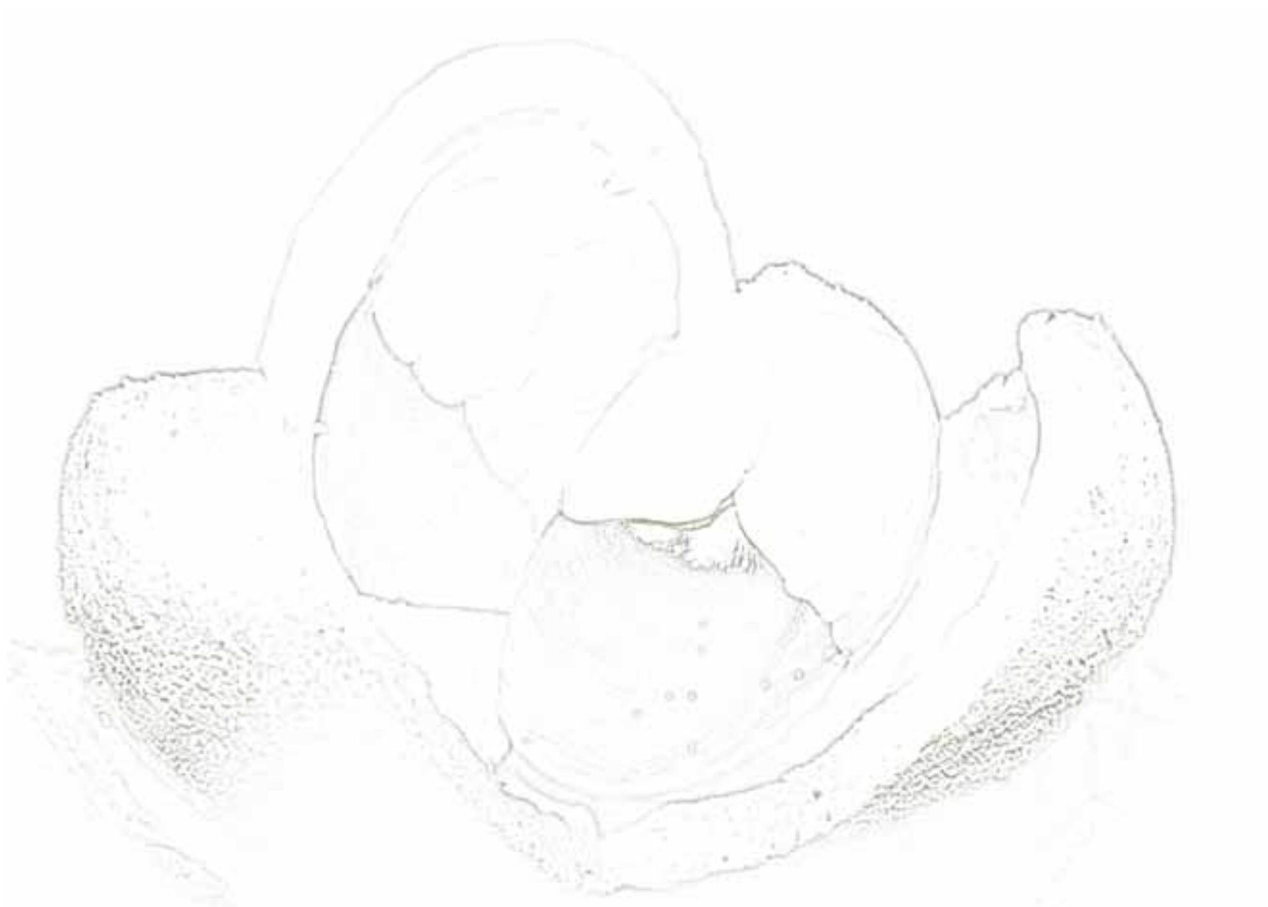

TECHNICAL PAPER 4 **GENERATION OF SPATIAL DISTRIBUTION MAPS OF *GONYSTYLUS BANCANUS* (RAMIN) USING HYPERSPECTRAL TECHNOLOGY**

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Abstract Peat swamp forest (PSF) is the largest of the wetland forest in Malaysia and consist of some of Malaysia's endangered tree species. Ramin (*Gonystylus bancanus*) which grows in the PSF is one of the species that has been listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Due to lack of spatial distribution of this species, in addition to high market demand, the species population is now decreasing very rapidly and threatened in some areas. Development of airborne hyperspectral remote sensing technique has provided new opportunities on mapping the individual tree species in a landscape scale such as the PSF. The main objective of this paper is to present the findings of a study to generate spatial distribution maps of ramin using the Spectral Angle Mapper (SAM) sub-pixel classification method in analysis of airborne hyperspectral imaging at the canopy level. HySpex VNIR-1600 airborne hyperspectral data with the spatial resolution of 0.5 meter and spectral range of 400 nm to 1000 nm were used in this study. About 6.25 ha of the PSF at Pekan Forest Reserve, Pahang was selected as the study plot. Sampling plots with the size of 30 x 30 m were established in the study area and all ramin with the diameter 20 cm and above were inventoried. The inventory data were used as a sampling point to generate a spectral signature of ramin using the SAM processing technique. It was found that the density of ramin within the study area is about 21 trees ha^{-1}. All of these trees were able to be mapped using the hyperspectral data with an error of about ± 4 trees ha^{-1}. Verification on the ground indicated that the map accuracy is about 86%. The results showed that by combining individual ramin signature sampling from HySpex data in SAM appears to have a high accuracy for discriminating individual ramin canopy in the PSF. It was also found that the HySpex airborne hyperspectral data have good capability to discriminate individual canopy layer tree species in mix peat swamp forest. The availability of accurate information on ramin population from this study can be used to assist in designing rehabilitation and conservation programs in order to conserve and sustainably manage the ramin population in the PSF.

Introduction

ITTO Expert Meeting on the Effective Implementation of the inclusion of *Gonystylus* spp. to Appendix II of CITES, 16 – 19 May, 2006 held in Kuala Lumpur, Malaysia recommended that biological and ecological studies of *Gonystylus* spp. be undertaken to ensure *G. bancanus* conservation (ITTO 2007). *Gonystylus bancanus* or ramin is an important forest tree species that is currently being exploited in Malaysia. Due to lack of spatial distribution and non-spatial information on this species, in addition to high market demand, population of this species is now decreasing very rapidly and threatened in certain areas. In order to conserve and sustainably manage this species, a detail and accurate information on its population, biological and ecological status should be made available. The information will help to determine sustainable level of harvests and assist in designing rehabilitation and conservation programs.

One of the complexities in managing mixed tropical forest is the uncertainty of the spatial distributions of the species at the landscape level which led to difficulties in assessing the status and changes of growing stock. Assessment of timber resources has been based on the traditional field forest inventories. The sampling intensities of each inventory depend on the size of the area. For example, at regional level of Peninsular Malaysia, a low level sampling was adopted. The intensity is much lower than the stand level inventory such as pre-felling inventory which is conducted at compartment level. The ideal way is to sample the whole population, but this will be very expensive to implement in the field. Mapping the spatial distribution of individual species is an important ecological issue that requires continued research to coincide with advances in remote sensing technologies. In theory, the remote sensing technology is more economical than traditional field inventories over a large land area. The success of the method is when the addressed parameters are well correlated with the information visible in images from above.

With the advancement of new technology in remote sensing such as high resolution and multi-spectral images, discrimination of forest species using this technology is emerging. Several efforts have been initiated and demonstrated the potential of using the hyperspectral images of tropical rain forest tree species identification while others have used aerial photographs and high spatial resolution multispectral data such as IKONOS (1 m and 4 m) and Quickbird (0.7 m and 2.8 m). We present here the research and development undertaken to discriminate individual ramin in the peat swamp forest using hyperspectral imagery. Hyperspectral imagery is a significant technology used in remote sensing and plays an important role in the success of image classification as it provides valuable spectral information of the materials of interest. Based on the PSF profile, ramin can be classified as a canopy layer tree (Khali *et al*. 2009). This profile gives an advantage to delineate ramin using airborne hyperspectral data. The main objective of this study is to discriminate the individual ramin tree at the canopy level using airborne hyperspectral image analysis.

Materials and Methods

Study Area

The study area is located at *600,012.25* E and *387,730.34* N, Compartment 77 of Pekan Forest Reserve (FR) in the Southeast Pahang PSF, Pahang (Figure 1). The project area experiences a relatively drier period lasting eight months from February to September, followed by four months of heavy rain between October and January, with peaks in December and January (Abdul Rahim *et al*. 2007). The existing primary PSF of Pahang is now very much restricted to the permanent forest reserves set aside for sustainable timber production.

The Pekan FR contains 106 species of trees belonging to 72 genera and 32 families (Abdul Rahim et al. 2007). The dominant families, in terms of relative numbers in the reserve are Guttiferae (bintangor), Myrtaceae (kelat), Myristicaceae (penarahan) and Burseraceae (kedondong). Other important families are Leguminonasae (kempas), Thymelaeaceae (ramin), Ebeneceae (kayu arang) and Annonaceae (mempisang). In term of basal area, *Calophyllum ferrugineum (*bintangor gambut*)* recorded the highest, followed by *Gonystylus bancanus* (ramin), *Tetramerista glabra* (punah), *Koompassia malaccensis* (kempas) and *Durio carinatus* (durian paya).

Figure 1 Location of Compartment 77, Pekan FR, Southeast Pahang PSF.

Acquisition of Airborne Hyperspectral Data

The HySpex sensor is an airborne hyperspectral sensor produced and operated by the company Norsk Elektro Optik (NEO). The HySpex VNIR-1600 airborne hyperspectral data acquired on 15 January 2010 were used as the primary input for this study. By using the pushbroom scanner technique, the image is scanned in lines. In the VNIR mode, HySpex acquires radiance in 160 bands, ranging from 400 nm to 1000 nm. The range of wavelength covers the entire visible spectrum and the near infrared region, each with a bandwidth of 3.7 nm. The HySpex sensor specification is shown in Table 1.

Table 1 HySpex sensor characteristics VNIR module

Specifications	Characteristics
Module	VNIR-1600
Spectral range	400 nm – 1000nm
Spatial pixels	1600
Pixel FOV across track/ along track	~0.185 mrad / 0.37 mrad
Spectral sampling	3.7nm
Spectral bands	160
Digitization	12bit

Tree Inventory

In this project, ramin tree inventory data were collected from field survey activity in the study area. Plot block with an area of 30 x 30m were established in the study area and within this block, the x and y locations, diameter at breast height (dbh), total height, first branch height and crown width of all ramin trees with dbh above 20 cm within the study area were measured and recorded. The development of a ramin tree distribution database from field survey activity was done through a GIS database.

Data Pre-Processing

Before carrying out the analysis of the hyperspectral data, some pre-processing works were applied to the images. Two image pre-processing routines namely geometric and radiometric correction were performed on the HySpex hyperspectral images. All of the images were geometric corrected and rectified, and conformed to Malaysian Rectified Skew Orthomorphic (RSO) projection system. A subset of the hyperspectral imagery is shown in Figure 2.

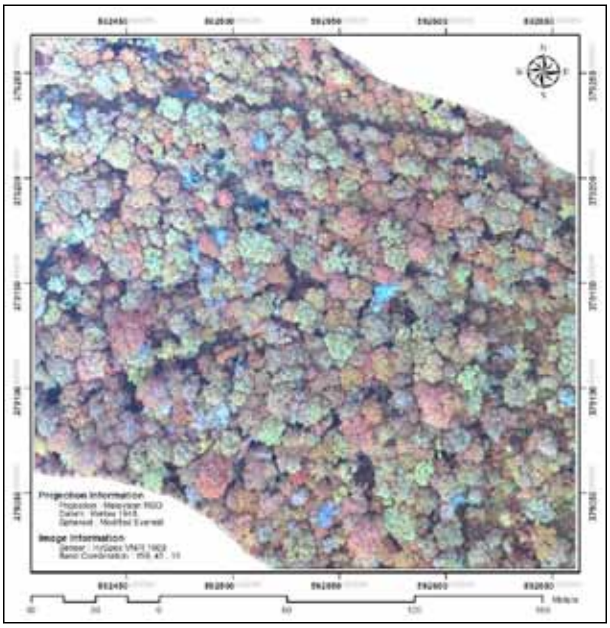

Figure 2 HySpex VNIR-1600 airborne hyperspectral data in the study area

With 160 different channels of hyperspectral imagery, it was necessary to do some data reduction prior to classification and analyses. The reduction of the dimensionality of the hyperspectral data is based on a forward MNF (Minimum Noise Fraction) Rotation. The uses of MNF Rotation transform are to determine the inherent dimensionality of image data, to segregate noise in data, and to reduce the computational requirements for subsequent processing. The reduction of the channels was based on threshold of 2 and reduced the 160 bands to 23 bands with an acceptable noise ratio and variability.

Data Processing

Spectral Angle Mapper (SAM) technique was used to classify ramin in the study area (refer to Figure 2). SAM technique is a physically-based spectral classification that uses an n-dimensional angle to match pixels to reference spectral (Shafri et al. 2007). The algorithm determines the spectral similarity between two spectrals by calculating the angle between the spectrals, treating them as vectors in a space with dimensionality equal to the number of bands.

SAM compares the angle between the end member spectrum vector and each pixel vector in n-dimensional space. Smaller angles represent closer matches to the reference spectral. Pixels further away from the specified maximum angle threshold in radians are not classified. In this process, identified pixels that represent patterns of individual ramin species were selected with the help of the ramin position information from field survey activity. In this method, knowledge on tree species classes is desired and must be acquired for a successful classification process. The selected ramin tree that has been identified will be used as a sample point to generate ramin spectral signature in SAM classification technique. By identifying spectral signature pattern, the computer system will then be programmed to identify pixels with similar characteristics.

Result and Discussion

Spectral Curves

Analysis of the vegetation spectral curves was the first stage undertaken to assess tree species separability. Figure 3 shows the spectral curves of five selected PSF features: water, understory, bintangor gambut, meranti paya and ramin. This demonstrates that the selected spectra exhibit minimal variability in terms of magnitude in the visible wavelengths and a large rise in variability as the wavelengths increased towards the near-infrared wavelengths, especially the bands between 0.75 µm and 0.850 µm. A distinct separation between the other features and ramin sample is shown at 0.55 µm.

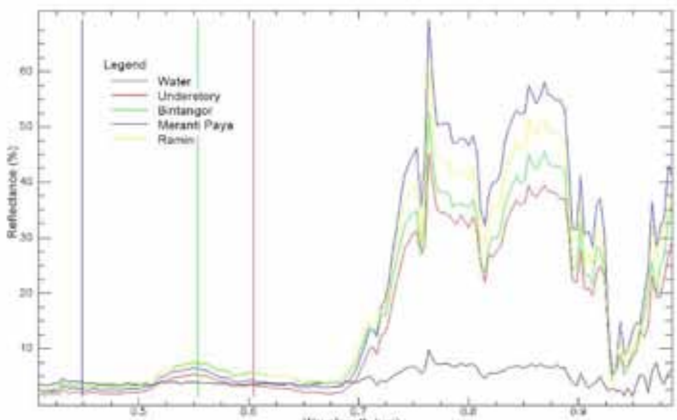

Figure 3 Spectral signatures of selected PSF species

Ramin Classification

The end member spectra of ramin used by SAM technique in this study were obtained from the selected ramin signature sample from HySpex images that has been identified from the field survey. Strong spectral differences between ramin and other tree species classes were the main factors used to discriminate this species in mix PSF using SAM technique. However, in this study, each of the selected ramin signatures that has been identified in hyperspectral data was treated as an individual end member in SAM classification technique. In other words, it contains only one representative spectrum per target as ramin trees in the area were in various blooming stages during the data acquisition. The different blooming stages of ramin in the study area resulted in the variation of reflectance magnitude of some ramin trees in hyperspectral data. Instinctively, this could explain some of the difficulties in distinguishing ramin in the PSF in this study.

With 160 different channels of hyperspectral imagery, it was necessary to conduct some data reduction before the classification and analyses. The Minimum Noise Fraction (MNF) differentiates the spectral bands that are dominated by noise from the bands that contain important information, contributing to the overall variance in the dataset. MNF reduces the dimensionality of the dataset and retains the small number of noise-free components. After the MNF transformation, the standard SAM classification was performed. To clean up the initial classification result, a standard majority 3x3 filter was applied. This filter uses a 3x3 pixels kernel and replaces the centre pixel in the kernel with the class value that the majority of the pixels in the kernel has. Figure 4 shows the result of ramin tree classification after post-classification clean up by a majority 3x3 filter.

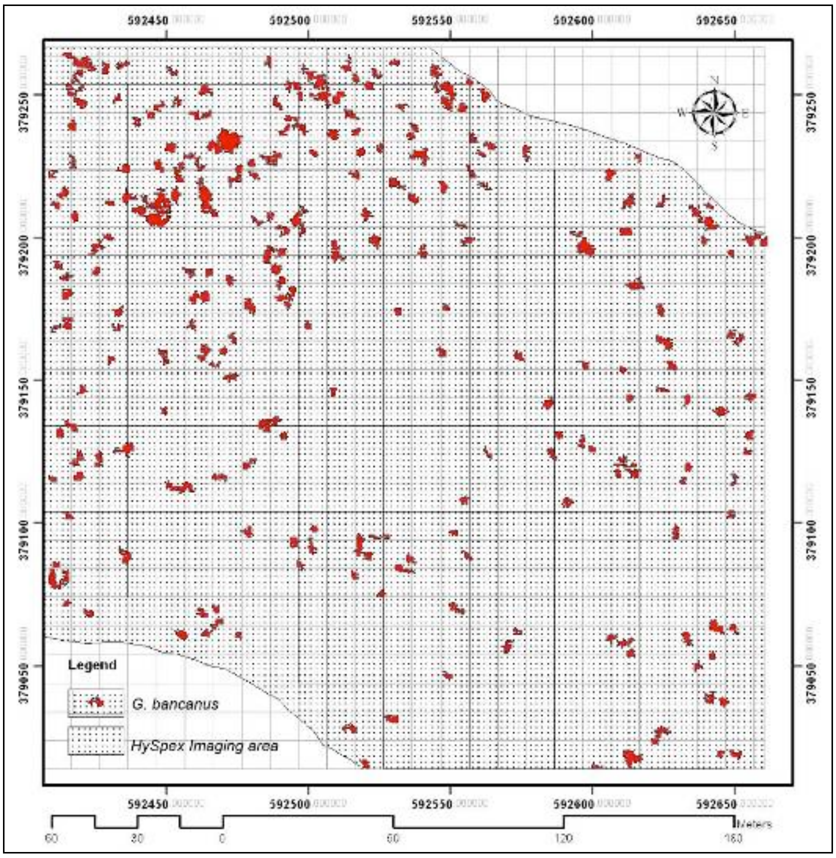

Figure 4 Ramin classification using hyperspectral data

Validation and Verification

In order to validate the results, 37 systematic plots within the study area were established. An absolute accuracy was calculated for the resulted ramin tree distributions from hyperspectral data. Absolute accuracy is a measure of the error between a derived/predicted ramin tree from airborne hyperspectral image and the actual ramin tree measured on the ground. In this study, absolute accuracy (as shown in Table 2) is expressed as the vertical root mean square error (RMSE). It was found that the distribution of ramin trees within the study area is about 21 trees ha^{-1}, with an accuracy of 92.8% or ± 4 trees ha^{-1}.

Table 2 Accuracy of the predicted *G. bancanus* tree

Plot Number	Number of Tree (*G. bancanus*)		Magnitude of errors	Mean square errors
	Predicted (b)	Measured (b')	(b - b')	$((b - b')-\mu)^2$
1-3	0	0	0	0.02
1-4	1	1	0	0.02
1-5	1	3	-2	3.46
1-6	1	1	0	0.02
2-0	2	1	1	1.30
2-1	2	2	0	0.02
2-2	2	8	-6	34.35
2-3	2	4	-2	3.46
2-4	2	1	1	1.30
2-5	1	0	1	1.30
2-6	0	0	0	0.02
3-1	1	3	-2	3.46
3-2	2	2	0	0.02
3-3	0	0	0	0.02
3-4	1	1	0	0.02
3-5	1	0	1	1.30
3-6	4	4	0	0.02
4-0	1	4	-3	8.19
4-1	2	0	2	4.57
4-2	2	0	2	4.57
4-3	0	0	0	0.02
4-4	1	4	-3	8.19
4-5	2	1	1	1.30
4-6	0	1	-1	0.74
5-0	3	3	0	0.02
5-1	1	0	1	1.30
5-2	5	2	3	9.85
5-4	0	6	-6	34.35
6-0	3	5	-2	3.46
6-1	6	0	6	37.69
6-3	4	2	2	4.57
6-5	0	2	-2	3.46
6-6	4	5	-1	0.74
7-0	4	4	0	0.02
7-2	6	2	4	17.13
			μ = 0.14	**RMSE = ± 4.1 tree/ha**

Conclusions

From the classification of HySpex hyperspectral image in the study area, it was found that the ability to discriminate ramin as an individual canopy from the PSF was high. Strong spectral differences between ramin and the other tree species classes were the main factor to discriminate this species in mix PSF using SAM technique. Spectral library of the ramin trees has been developed and can be used as reference spectral library for future research project. In this study, the ramin spectral signature has been developed using 160 HySpex hyperspectral bands. By using this spectral signature, ramin trees can be identified faster using HySpex hyperspectral data with acceptable mapping accuracy. To further increase the accuracy, some suggestions are put forward. First, the need to improve the geometric accuracy of ramin sampled from field survey activity as wrongly selected sample will lead to bad classification performance. The selected area of interest (AOI) for development of spectral signature need to be manually collected to make sure the selection is correct and corresponds to ground survey data. There are three main factors that determine the quality of ground survey data:

the complexity of the classes and the landscape, the amount of survey data taken, and the amount of errors made when collecting the ground survey data.

Second, the use of Individual Tree Crown delineation could be another method to improve classification results. This approach delineates individual trees from aerial or satellite images and classifies the tree species. Individual Tree Crown functions best on not-too-dense forest, which means no overlapping crowns. The tree crowns should be large and dense enough to be detected, but this is mainly dependant on the image characteristics. Furthermore, LiDAR (Light Detection and Ranging) data and optical images form a powerful combination. Optical images are best for classifying tree species and vegetation health, while LiDAR is best for measuring heights and densities. These two sensor types complement each other and could improve a part of the classification errors encountered in this study: the confusion of ground vegetation, bushes and mixed tree crowns. Incorporating height classes from LiDAR data would reduce these problems.

A large proportion of the tree crowns in the field which are single individual stands were reflected as combined species in the HySpex image. This could explain some of the difficulties in distinguishing ramin species in the PSF. One of the more interesting results arising from this study was the effectiveness of species discrimination of individual ramin using only a few spectral bands of airborne HySpex hyperspectral data. The distribution of ramin within the study area was about 21 trees ha^{-1}, with an accuracy of 86% or ± 4 trees ha^{-1}. This study demonstrated that Hyspex data can be used to classify an individual species as well as to distinguish ramin tree crowns from mixed PSF. The discrimination of ramin using SAM technique was robust with consistently high classification accuracies. The availability of accurate information on ramin population derived from remote sensing as reflected in this study can be used to assist in designing rehabilitation and conservation programs in order to conserve and sustainably manage this species.

Acknowledgements
This work was made possible by a grant from ITTO under its collaborative program with CITES to build capacity for implementing timber listings. Donours to this collaborative program include the EU (primary donour), the USA, Japan, Norway, New Zealand and Switzerland. The roles played by the Ministry of Natural Resources and Environment, Malaysia (NRE) as the executing agency, as well as FRIM and the forestry department in Malaysia as implementing agencies of the ITTO-CITES project are also greatly appreciated.

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TECHNICAL PAPER 5 **GENETIC DIVERSITY STUDY OF *GONYSTYLUS BANCANUS* AND GENETIC RELATIONSHIP BETWEEN *GONYSTYLUS* SPP.**

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Abstract *Gonystylus bancanus* (ramin) is the most valuable timber species in peat swamp forests. It has high potential as plantation species since planting material can be raised easily either through seeds or vegetative propagation. Over harvesting and illegal logging had decreased the potential of the species. Thus conservation of the species becomes a very crucial activity to be carried out. In order to conserve the species effectively and efficiently, information on genetic diversity, distribution and genetic relationship between populations are very important. In this study, 72 loci from 18 RAPD primers were used to investigate genetic diversity of ramin using ten populations distributed in Kalimantan and Sumatera. Mean genetic diversity of ten populations of *G. bancanus* was 0.329 and mean genetic distance between populations of *G. bancanus* was 0.061. Distribution of genetic diversity within population was higher (94%) than between populations (6%). Based on cluster analysis, ten populations of *G. bancanus* were divided into two groups: Sumatera populations and Kalimantan populations. *Ex-situ* and *in-situ* conservation of *G. bancanus* should be based on that information. Genetic relationship of ramin (*Gonystylus* spp.), a CITES-listed genus subject to illegal international trade, was examined using ITS rDNA (ITS3) and three chloroplast non-coding regions samples representing nine different ramin species. No variation within species was recognised among the nine species, including three unidentified *Gonystylus* spp. Based on ITS3 sequence, the nine species were divided into three clades. The first clade was *G. bancanus*, the second clade consisted of five species, *G. brunnescens*, *G. velutinus* and three unidentified *Gonystylus* spp., and the third clade consisted of three species, *G. consangineus*, *G. keithii* and *G. macrophyllus*. However, using combination of ITS3 and three chloroplast non-coding regions, the nine species were divided into four groups. The first group was *G. bancanus* and *G. macrophyllus*; the second group was *G brunescens*, *G. consangineus*, *G. velutinus* (two samples) and one unidentified *Gonystylus* spp., the third group consisted of *G. velutinus* (two samples) and two unidentified *Gonystylus* spp., and the final group, *G. keithii*.

Introduction

Ramin (*Gonystylus* spp.) is a tropical hardwood tree found primarily in the PSF of Indonesia and Malaysia. The genus *Gonystylus,* consisting of about 30 species, is distributed throughout the Malesian area (Indonesia, Malaysia, the Philippines, Papua New Guinea, Singapore and Brunei Darussalam) with the majority of species found in Borneo. Ramin has been heavily depleted throughout its range to supply international markets for ramin timber and processed wood products. Six species (*G. affinis, G. bancanus, G. forbesii, G. macrophyllus, G. maingayi* and *G. velutinus*) are known to be commercially valuable, of which *G. bancanus* is the most heavily traded. Fifteen species in the genus, including *G. bancanus*, are classified as vulnerable in the IUCN's Red List of Threatened Species due to observed, inferred or projected habitat loss and over-exploitation. Logging - selective and clear-cutting - is recognised as the major threat to these species (IUCN 2004). The decline is mainly due to the naturally slow generation process of ramin, thus the slow recovery of its natural populations. Much of Indonesia`s remaining ramin is found in national park and protected areas that provide vital habitat for many other threatened species. Although the species current listing on Appendix II has provided important enforcement benefits in a number of areas, these benefits are being undermine by illegal logging operations and laundering activities, and thus do not accord adequate protection for the species. Therefore, conservation effort is urgently required and several are being implemented to support sustainable use of ramin.

Ramin has been targeted by illegal loggers since the early 1990s with illegal cutting soaring in recent years as civil order and law enforcement has eroded. In 2001, in response to declining ramin population levels, Indonesia introduced a total ban on exports of ramin logs, sawn timber and veneer sheets. Despite this ban, the international trade continues to thrive; supplied and facilitated by illegal harvesting in Indonesia and illegal trade of Indonesian ramin through Malaysia and Singapore to, for example, the European Union and the United States. Ramin has been depleted within most forest concession areas and is classified as a vulnerable tree species by the World Conservation Union (a status applied to species facing a high-risk of extinction in the wild in the medium-term). Those who benefit from the sale of this valuable species log live within these protected areas, including national parks or are using expired concessions.

Molecular data are often considered to be more reliable than morphological data when inferring phylogenetic relationships at lower taxonomic levels. For recently diverged taxa in which morphological characters are prone to phenotypic plasticity, molecular characters, such as DNA sequences may provide greater resolution of phylogenetic relationships. The internal transcribed spacers (ITS) of nuclear ribosomal DNA are frequently used for phylogenetic analysis at the species level. Although nuclear ribosomal DNA is multicopy in large arrays of repeats, it is useful for phylogenetics as the copies are usually highly homogenous due to concerted evolution. RAPD (random amplified polymorphic DNA) analysis is one of the most effective tools of DNA based fingerprinting techniques applied to analyse genetic diversity. RAPD analysis that is based on PCR (polymerase chain reaction) with 10-mer random oligonucleotide primer is relative easier than any DNA markers and could be carried out using simple instrument.

Genetic diversity is fundamental to the overall survival mechanism of any species. Regeneration of degraded natural stands therefore should also use genetically diverse trees. By conserving diverse genetic resources of ramin, the supply of plant materials for future use can be secured, especially for genetic conservation. The aim of this study is to elucidate genetic relationship of nine species of *Gonystylus* spp. and to investigate genetic diversity, distribution and genetic relationship between populations of *G. bancanus* (ramin) in Kalimantan and Sumatera populations using RAPD markers.

Materials and Methods

Plant materials and DNA extraction

Leaves of individual trees were selected from nine different species. In order to identify sequence variation within species, two to five different individual trees from different species were used. Detail of species collected and list of samples used in this activity is shown in Table 1. Three species, namely *G. maingayi*, *G. fornesii* and *G. affinis*, could not be analysed because the leaves were already decomposed upon arrival at the DNA molecular laboratory. In order to elucidate genetic diversity of *G. bancanus*, leaves of individual trees were collected from ten populations distributed in four different provinces. Table 2 shows details of *G. bancanus* samples.

Table 1 List of *Gonystylus* spp. collected

1*	*Gonystylus maingayi* Hk.f.
2*	*G. forbesii* Gilg
3*	*G. affinis* A. Shaw
4	*G. velutinus* A. Shaw
5	*G. keithii* A. Shaw
6	*G. macrophyllus* A. shaw
7	*G. brunnescens* A. Shaw
8	*G. malacensis*
9	*G. consanguineus*
10	*G. bancanus*
11	*Gonystylus* spp.
12	*Gonystylus* spp.
13	*Gonystylus* spp.

* = decomposed leaves species

Table 2 List of samples for this study

No.	Population	Province	No. of samples
1	Mesukuh I	West Kalimantan	8
2	Mesukuh II	West Kalimantan	8
3	Pakilat I	West Kalimantan	8
4	Pakilat II	West Kalimantan	6
5	Kanarakan	Central Kalimantan	12
6	Nyarumenteng	Central Kalimantan	12
7	PT. Diamond Raya	Riau (Sumatera)	12
8	Kuok A	Riau (Sumatera)	6
9	Kuok B	Riau (Sumatera)	6
10	TN. Berbak	Jambi (Sumatera)	18
	Total		**96**

Total genomic DNA was extracted using a modified Cetyl Trimethyl Ammonium Bromide (CTAB) protocol reported by Shiraishi and Watanabe (1995). The DNA was purified using GENECLEAN III (BIO101) as a template for further analyses.

Sequencing of ITS and spacer regions of chloroplast DNA

PCR of ITS3 and three chloroplast non-coding regions (the *trn*L intron, the intergenic spacer between *trn*L - *trn*P, and *trn*D - *trn*Y) was performed in a total volume of 20 µl containing 4 ng of genomic DNA, 0.25 µM of each primer, 10 mM Tris-HCl (pH 8.3), 50 mM KCl, 3.0 mM $MgCl_2$, 200 mM of each dNTP, and 0.25 unit/10µl *Ex Taq* DNA polymerase. DNA amplification was performed with a Gene Amp PCR System Model 9600 (Perkin-Elmer) programmed as follows: 95^{o}C for 90 s, 30 cycles of 30 s at 94^{o}C, 30 s at 55^{o}C, and 90 s at 72^{o}C, followed by 60 s at 72^{o}C. The PCR product was separated by electrophoresis in 1.5% agarose gel and the target fractions were excised from the gel. DNA was recovered from the gel particles and was purified using QIAEX II Gel Extraction (QIAGEN). The sequence reaction was carried out using a Thermo Sequenase fluorescent labeled primer cycle sequencing kit (Amersham Pharmacia Biotech), the template DNA, and -21M13 (TGTAAAACGACGGCCAGT) / M13Rev (CAGGAAACAGCTATGA-CC) sequence primer 5'-labeled with Texas Red fluorescent dye (Amersham Pharmacia Biotech). The sequence was analysed with an ABI 3100 DNA Sequencer.

RAPD analysis

RAPD analysis was performed in a reaction containing 10 mM Tris-HCl (pH 8.3), 10 mM KCl, 3.0 mM $MgCl_2$, 0.2 mM each of dNTPs, 0.5 unit/10µl AmpliTaq DNA polymerase, a Stoffel Fragment (Perkin-Elmer), 0.25 µM each of primers, and 10 ng/10µl template DNA. The condition of amplification was 94°C for 1 min., 45 cycles of 30 s at 94°C, 30 s at 37°C, and 90 s at 72°C, followed by 7 min. at 72°C. The amplification products were separated by electrophoresis in 1% agarose gel with ethidium bromide and detected with a 302-nm UV transilluminator. One hundred and sixty (160) RAPD primers were tested for screening polymorphic RAPD primers which will be used in the study of genetic diversity. All the RAPD primers were from Operon Technologies.

Some criteria have been identified to select polymorphic RAPD primers in the screening. These criteria were a) number of polymorphic loci, b) clear bands between 200 - 800 bps, and c) reproducibility of the locus. The presence (1) or absence (0) of the polymorphic fragments attained from electrophoresis was noted as 1/0 data. Based on this data, the genetic similarity (S) and genetic distance (D = 1 - S) among all individuals were calculated using a simple matching coefficient (Sokal and Michener, 1958). A dendrogram was constructed using the UPGMA method from the matrix of genetic distance among individuals.

Results and Discussion

Sequence variation within and between species

A total of 85 bases from four regions (ITS3 and 3 chloroplast non-coding regions) were recognised as insertions/deletions and substitutions among the nine species of *Gonystylus*. No sequence variation was within species for internal transcribe spacer (ITS3) region. Thirty two (32) bases of ITS3 can be used to differentiate the nine species. Internal transcribe spacer is very useful to identify species because almost no variation within species and different species possesses different ITS sequence.

Chloroplast non-coding regions have high variability within and between species. Therefore, these regions were used to elucidate genetic variation within species. In this research, three (3) non-coding regions of chloroplast DNA were used, namely the *trn*L intron, the intergenic spacer between *trn*L - *trn*P, and *trn*D – *trn*Y. A total of 53 different bases were variables among the species. Within and between species sequence variations were found. Among the nine species, *G. macrophyllus*, *G. brunnescens* and *G. velutinus* have high sequence variation within species. Only *G. bancanus* did not reveal sequence variation within species.

Genetic relationship among species

Genetic relationship of 24 samples of *Gonystylus* spp. was revealed by dendrogram (Figure 1) based on sequence of the four regions. All four samples of *G. bancanus* were grouped together because no variation was found within this species. *Gonystylus keithii* was separated with another eight species. *G. bancanus* was closely related to *G. macrophyllus*, and *G. consangineus* was closely related to *G. velutinus*. Similar relationship was revealed by three *Gonystylus* spp. Two of the species were closely related to *G. velutinus*, and the other *Gonystylus* spp. was closely related to *G. brunescens*. The dendrogram divided the nine species into three groups.

The first group consisted of *G. bancanus* and *G. macrophylla*, the second group *G. keithii*, and the other six species were placed into the third group. The third group can be separated into three small clades: *G. brunescens* and *Gonystylus* spp (Clade I), *G. consangineus* and *G. velutinus* (Clade II), and *G. velutinus* and two *Gonystylus* spp. (Clade III). Genetic relationship between the nine *Gonystylus* species is important to support genetic conservation strategy of these species (*in-situ* or *ex-situ*). Study on the genetic diversity of these species is a crucial task that should be carried out in the near future to effectively and efficiently support the conservation activity.

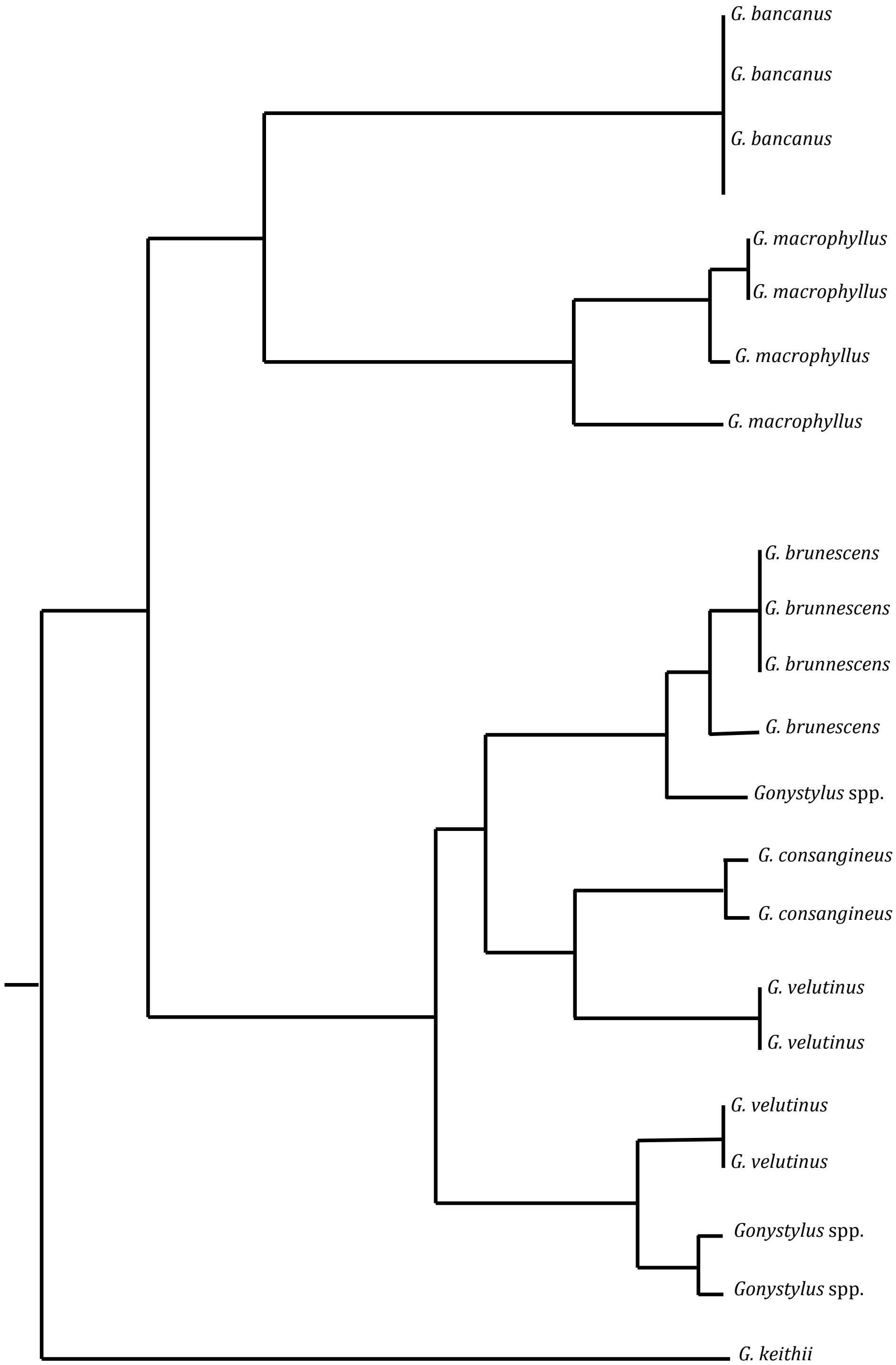

Figure 1 Dendrogram of *Gonystylus* spp. based on sequence of ITS-3 and cpDNA non-coding regions.

Genetic Diversity of Gonystylus bancanus

Based on the selected RAPD markers, genetic variation of populations of *G. bancanus* was range between 0.268 and 0.368 (Figure 2). The highest genetic diversity was revealed by Mesukuh II (0.368), followed by Pakilat I (0.361), and the smallest, Kuok B (0.268). Mean genetic diversity of the ten populations of ramin was 0.329, higher than *Pinus attenuata* (0.011), *P. radiata* (0.08), *P. sylvestris* (0.022), *P. menziesii* (0.050), *Gyrinops verstegii* (0.288) and *Alstonia scholaris* (0.247).

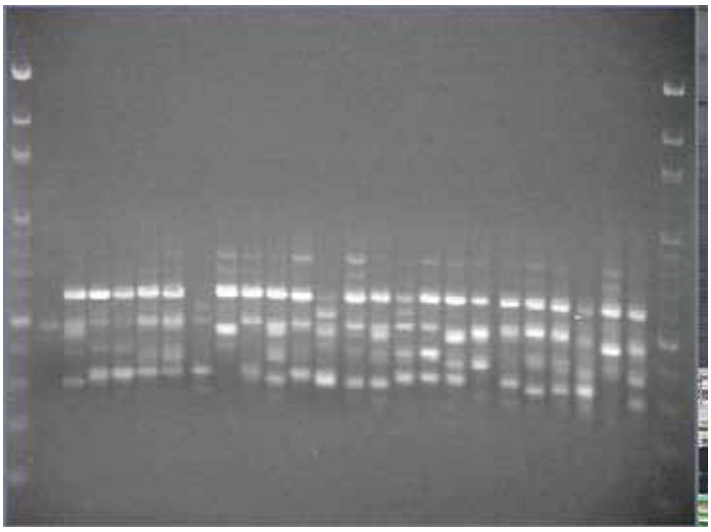

Figure 2 Profile of two selected RAPD primers (OPD-03)

Even though the number of individual trees in some populations has decreased, the populations still have high genetic diversity. This could be attributed to the following: high genetic diversity base of the populations, high cross pollination between individual trees within a population, and the level of exploitation of the population in recent years.

Genetic Relationship between Populations

To clarify the relationship among species, a UPGMA dendrogram was constructed from these genetic distances (Figure 3). The highest mean genetic distance between populations was recognised between Pakilat II and Kuok B (0.157), and the close relation between two populations was shown by Kanarakan and Nyarumenteng (0.004).

Two distinct clusters were also identified. The first cluster comprised populations from Kalimantan Island (Mesukuh I and II, Pakilat I and II, Kanarakan and Nyarumenteng) and Sumatera Island (PT. Diamond Raya, Kuok A and Berbak). The genetic distances between the two clusters were 0.061 ± 0.024. These results suggest that the two clusters can be genetically different according to geographic position. Population Kuok B should have been included into the Sumatera Island group instead, but this population was separated into a different cluster. Condition of the populations such as number of trees and degradation time could be the reasons for the clustering.

According to the above analyses, almost 94% of genetic diversity was distributed within the population and the remaining 6% distributed between populations. This could be caused by evolution and adaptation process of the species and its populations. Populations within the island are large, and cross pollination and gene flow between small populations are high. This condition decreases the genetic distance between populations within an island. Sumatera and Kalimantan have distinct characteristics such as rain fall, soil condition, and other environmental characters that can affect adaptation and evolution process of *G. bancanus*. This condition will eventually increase the genetic distance between populations of both islands.

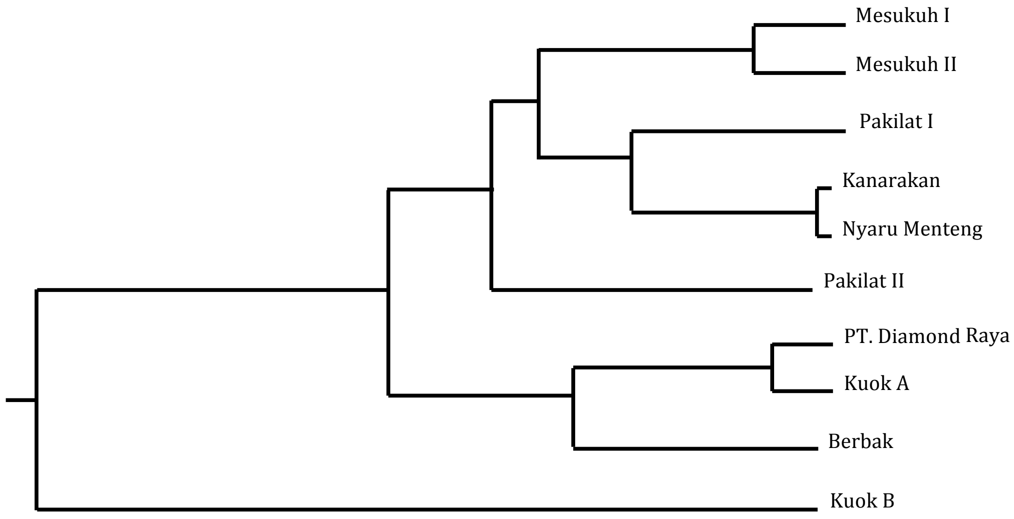

Figure 3 Dendrogram of ten populations of *G. bancanus* based on cluster analysis

Implification for G. bancanus Conservation Program
Information on genetic diversity and distribution, as well as genetic relationship between populations is important to develop strategy of conservation and breeding program of the species. From ten populations used in this study, diversity of ramin is still high which means the species can be conserved genetically and improved to obtain better individual trees. The population and the number of individual ramin trees are on the decrease every year due to exploitation. Thus, information made available from *Gonystylus* spp. genetic diversity study can be applied for genetic conservation of the species.

Three important results can be derived from this study. First, the genetic diversity of ramin is still high. Second, there exist proportion of distribution of genetic diversity, and third, there exist clustering of populations in different islands. For *ex-situ* conservation program, genetic materials should be collected from many samples in one population, and each province at least be represented by one population. Genetic materials should be collected from each island where ramin is distributed. For *in-situ* conservation program of the species, select population with the highest genetic diversity and establish conservation effort in each island. In *in-situ* conservation area, big trees (mother trees) should remain standing, and for genetic enrichment of the area, collect genetic materials from inside the area or from other populations in the same island.

Conclusions

1. Based on ITS3 sequencing, nine *Gonystylus* species were divided into three clades. The first clade consists of *G. bancanus*; the second clade consists of five species, *G. brunescens*, *G. velutinus* and three *Gonystylus* spp., and the third clade consists of three species, *G. consangineus*, *G. keithii* and *G. macrophyllus.* Each species could be differentiated using this region.

2. The nine species analysed were separated into four groups based on sequence combination of ITS3 and three chloroplast non-coding regions. The first group, *G. bancanus* and *G. macrophyllus*; the second group, *G brunnescens*, *G. consangineus*, *G. velutinus* (2 samples) and one *Gonystylus* spp and the third group, *G. velutinus* (2 samples) and two *Gonystylus* spp. *G. keithii* is placed in a different group.

3. Mean genetic diversity of ten populations of *G. bancanus* was 0.329. Mesukuh II has the highest genetic diversity (0.368) and the lowest was Kuok B (0.268).

4. Mean genetic distance between populations of *G. bancanus* was 0.061. The closed related populations were Kanarakan and Nyarumenteng (0.004). Population Pakilat II and Kuok B revealed the highest genetic distance (0.157).

5. Distribution of genetic diversity within population was higher (94%) than between populations (6%) from ten populations distributed in Sumatera and Kalimantan.

6. Based on cluster analysis, ten populations of *G. bancanus* can be divided into two groups, Sumatera populations and Kalimantan populations. Kuok B is is separated from both groups even though the population is located in Sumatera.

Acknowledgements

This work was funded by ITTO PROJECT PD 426/06 Rev.1 (F), "The Prevention of Further Loss and the Promotion of Rehabilitation and Plantation of *Gonystylus* spp. (ramin) in Sumatera and Kalimantan" and ITTO-CITES Project. Gratitude of thanks to Ir. Tadjudin, MSc, Coordinator of the project for the funding and all researchers and technicians of Genetic Molecular Laboratory of Center for Biotechnology and Tree Improvement Research for technical support.

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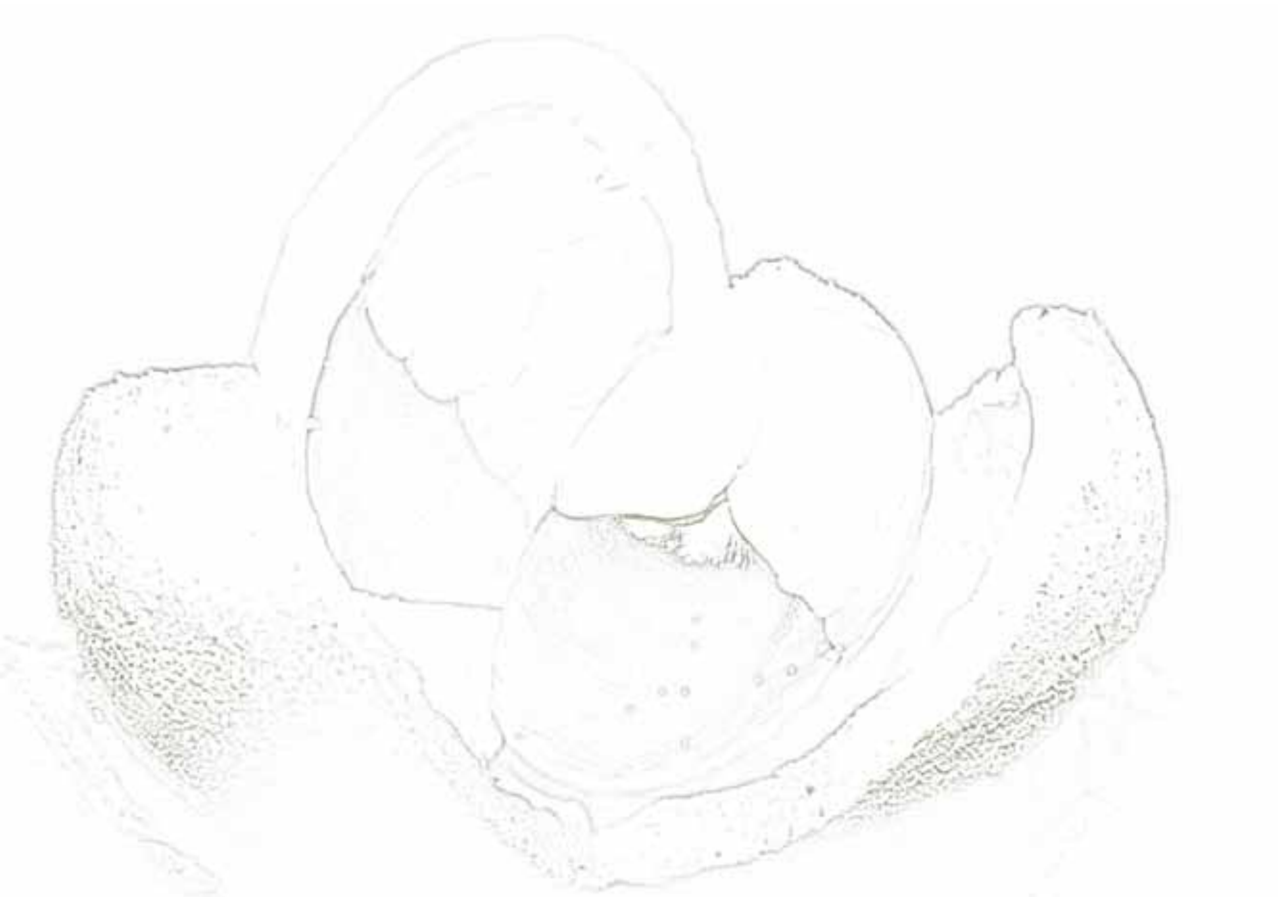

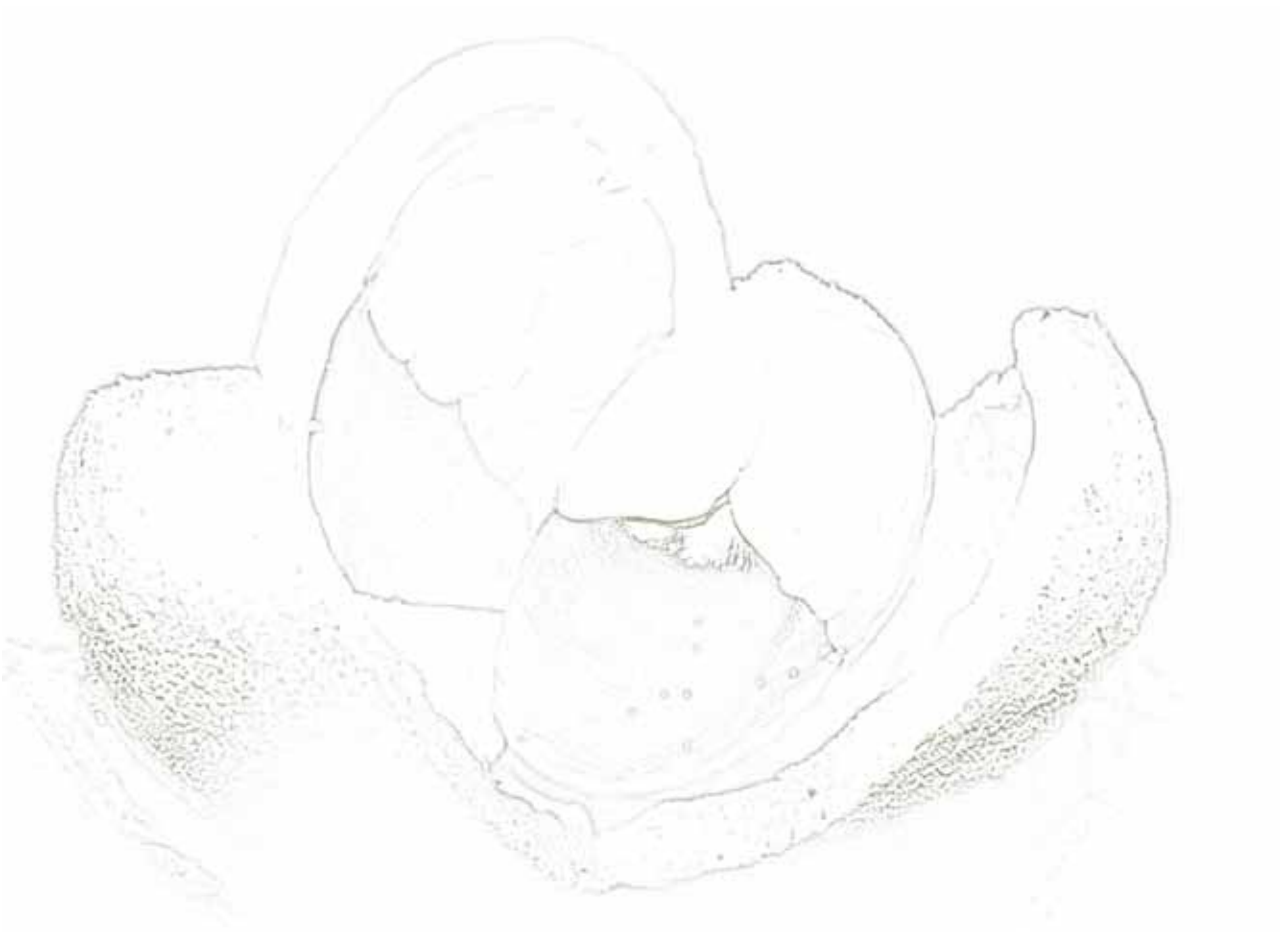

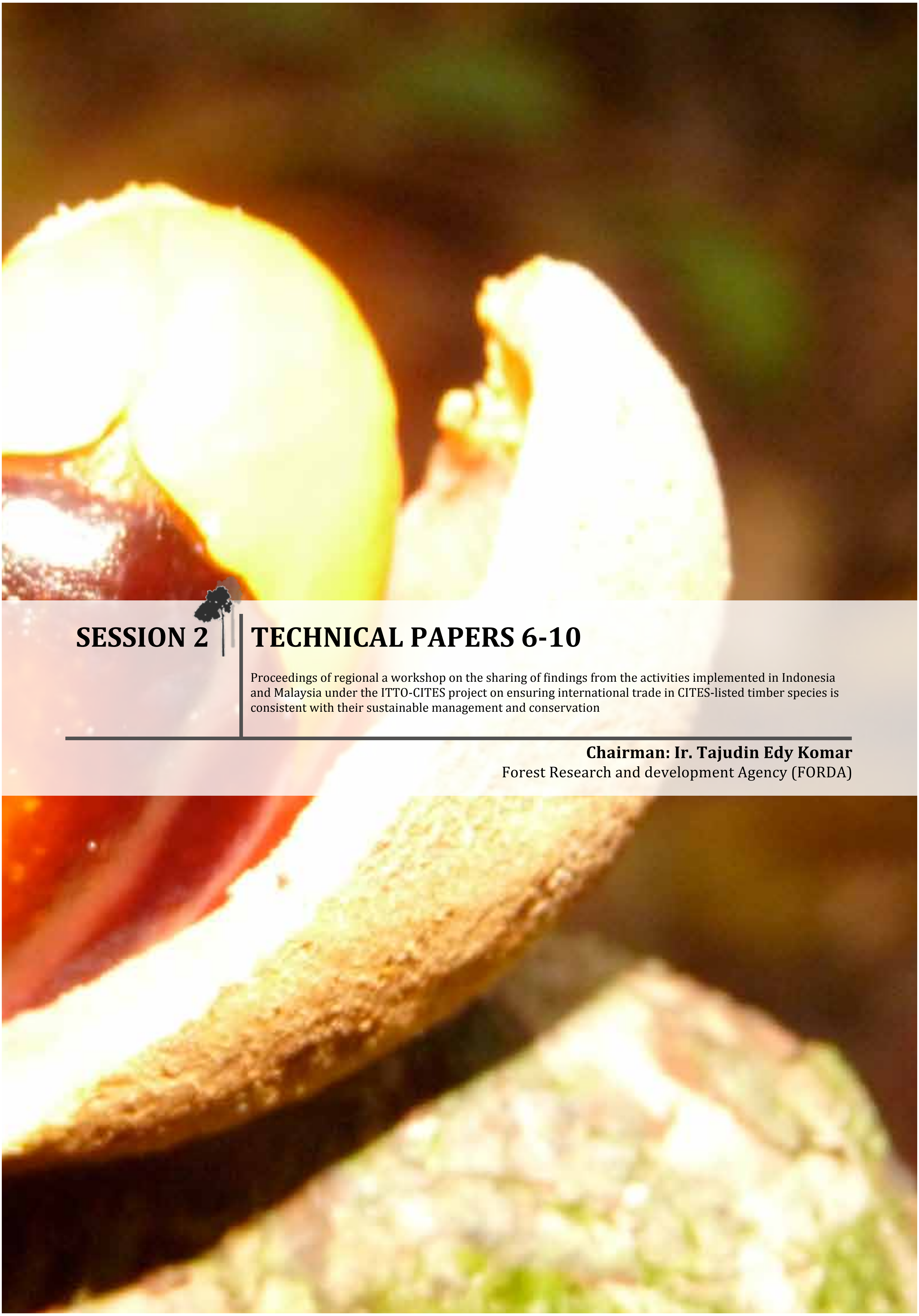

SESSION 2 TECHNICAL PAPERS 6-10

Proceedings of regional a workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Chairman: Ir. Tajudin Edy Komar
Forest Research and development Agency (FORDA)

TECHNICAL PAPER 6

POPULATION DYNAMICS AND OPTIMUM HARVEST OF *GONYSTYLUS BANCANUS* IN PRODUCTION FORESTS OF PENINSULAR MALAYSIA

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Abstract Accurate estimation of population dynamics, growing stock, cutting cycles and allowable harvest which are biologically sustainable is important in achieving sustainable forest management in production peat swamp forests. Currently, the peat swamp forests in Peninsular Malaysia are managed under a modified Selective Management System (SMS), which is basically a system designed for the management of dry inland forests. As the peat swamp forest is a unique forest type with silvicultural characteristics that are rather different from that of the dry inland forests, it is hoped that through this project, suitable silvicultural and management practices could be formulated so that the peat swamp forests can be managed in a sustainable manner. This project is Component 2 of the main Activity of FRIM's ITTO-CITES Project entitled 'Generation of spatial distribution maps of *Gonystylus bancanus* (ramin) using hyperspectral technology and determination of sustainable level of harvest of ramin in production forests of Peninsular Malaysia'. The general objective of Component 2 is to enhance conservation by determining sustainable level of harvest for *G. bancanus* in production forests of Peninsular Malaysia. Study site for this project is Pekan Forest Reserve, Pahang. Methodology for this project was based on two specific objectives. In order to determine the population dynamics of *G. bancanus,* assessment of stocking and population dynamics of *G. bancanus* was carried out by using ecological plots established in the study site. Meanwhile, assessment of growth projection model and existing growing stock in determining the sustainable level of harvest was conducted in order to project sustainable harvest levels of *G. bancanus* in natural forest stands. This paper elaborates findings of the project based on the two specific objectives.

Introduction

Since *Gonystylus bancanus* (ramin) was up-listed to Appendix II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the species is subjected to non-detrimental finding (NDF) report before they can be traded internationally. In the preparation of the NDF report, it is important to investigate the current stocking of the species and its population dynamics to enable exploitation of the species be carried out in a sustainable manner (Ismail *et al.* 2010). In timber production forest, sustainable level of harvest can be determined by projecting future growth from the current stocking of species in natural forest stands. Projection can be done manually or by preparing a computer simulation model to determine the optimum sustainable level of harvest that does not jeopardise the species sustainability in the nature.

This paper reports on Component 2 of a main project entitled 'Generation of spatial distribution maps of *Gonystylus bancanus* (ramin) using hyperspectral technology and determination of sustainable level of harvest of ramin in production forests of Peninsular Malaysia'. The main objective of Component 2 is to enhance conservation by determining sustainable level of harvest for ramin in the production forests of peat swamp forest (PSF) in Peninsular Malaysia.

Methodology

The study was undertaken in two aspects namely population dynamics and optimum harvest as follows:

1) Determination of population dynamics of G. bancanus.

The determination of population dynamics was done by conducting a re-measurement of three ecological plots established in study site at Pekan Forest Reserve (FR). The ecological plots located at Compartments 100, 156 and 200 of Pekan FR represent high, moderate and poorly stocked *G. bancanus* areas.

2) Optimum harvest of G. bancanus.

In this aspect, the study involved three major parts as follows:

Part 1: Analysis of permanent sample plot

In early 2008, a study was undertaken to decollate and reanalyse growth and yield data from a permanent sample plot established in 1998 under the UNDP-GEF-Danida project. The plot is located at Compartment 99 Pekan FR (Figure 1). Measurements of the plot were done in 1998, 1999, 2000, 2003 and 2006. The design of the plot was a one ha plot per treatment, replicated twice. The treatment given is as indicated in Table 1. The amount of timber removed from the original forests is shown in Figure 2. Analysis was done to estimate diameter growth or increment, annual mortality rate and annual ingrowth for different diameter classes and species group (i.e. Dipt. (Dipterocarp) meranti, Dipt. non-meranti, Non-dipt. light hardwood, Non-dipt. medium hardwood, Non-dipt. heavy hardwood, Non-dipt. misc., ramin and bintangor). For the purpose of the study, calculation was done for all trees equal and greater than 15 cm diameter at breast height (dbh).

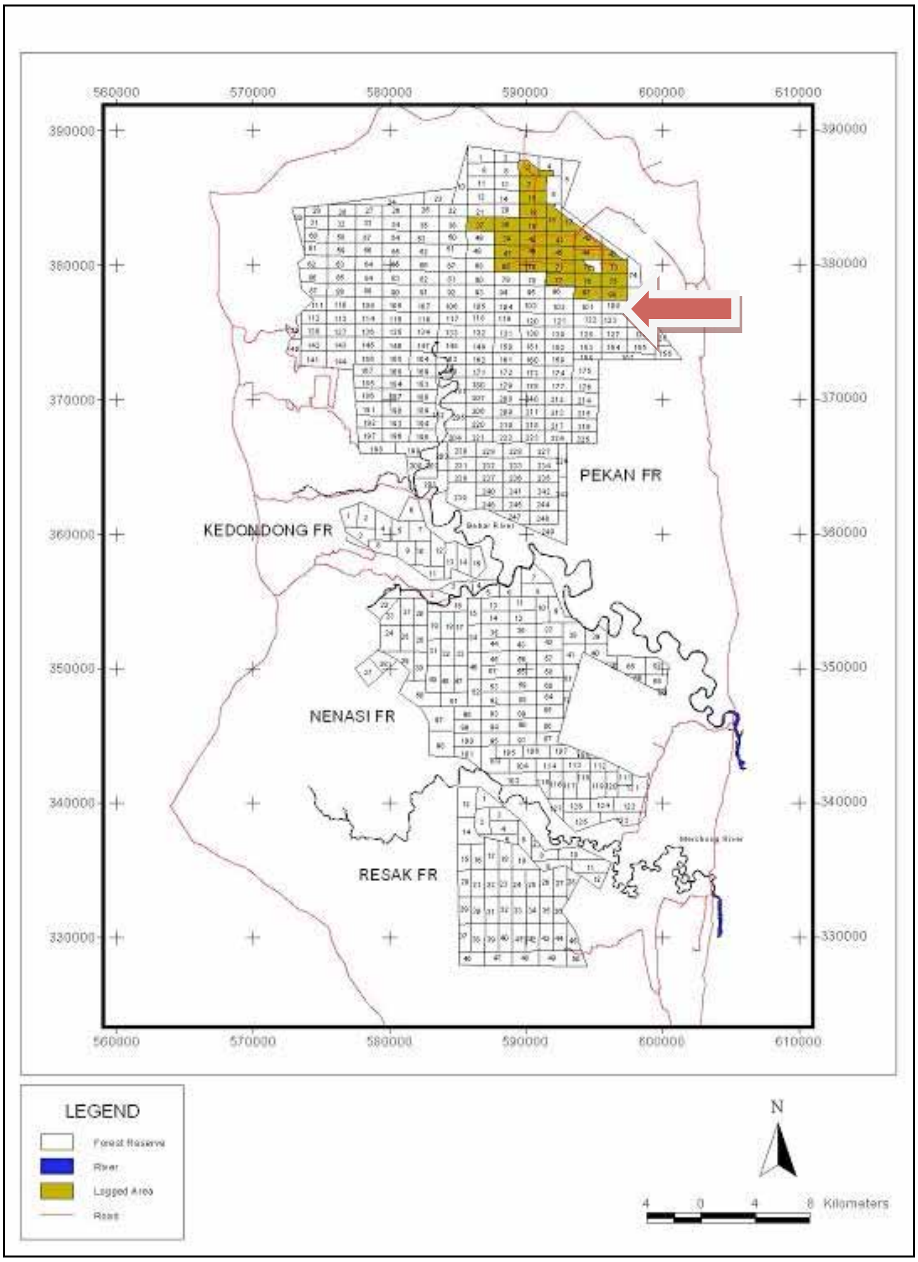

Figure 1 Location of study area

Table 1 Plot treatment

Treatment	Abbreviation
High cutting intensity [cut all trees 30 cm diameter at breast height (dbh) and larger] – 36%	T1
Medium cutting intensity [cut all trees 45 cm dbh and larger] – 20%	T2
Low cutting intensity [cut all trees 60 cm dbh and larger] – 29%	T3
Medium cutting intensity with selective cutting by diameter classes (30 cm dbh and larger) - 21%	T4
Control (minimal cutting) – 9.5%	T5

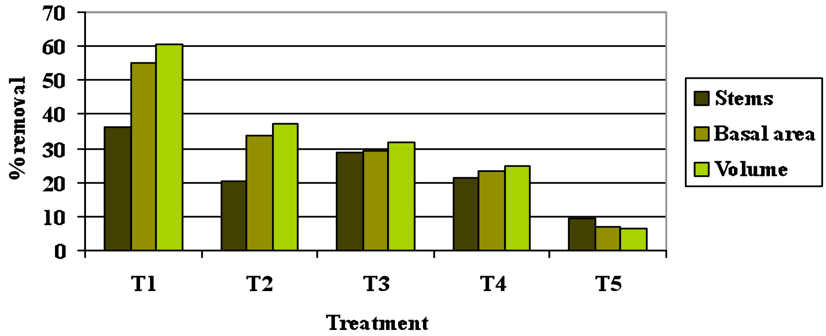

Figure 2 Timber removal from plots

Part 2: Development of Yield Projection Model
This part of the study was carried out to develop a stand projection model using growth parameters obtained in Part 1. The model was constructed based on MYRLIN which was developed in 2000 by Alder et al. (2002). Some modifications were done to MYRLIN on the diameter increment and species grouping, where species were grouped into eight species group namely dipterocarp meranti, dipterocarp non-meranti, non-dipterocarp heavy hardwood, non-dipterocarp medium hardwood, non-dipterocarp light hardwood, non-dipterocarp partly commercial, non-dipterocarp non-commercial and pioneer. In 2007, a modified model - Growth and Yield Model for Mixed Tropical Forest (GYMMTF) - was developed by Ismail (2007) who later came up with Growth and Yield Model for Tropical Peat Swamp Forest (GYMTPSF) in 2008. The model was written using MS Office Access with the ability to save output data into MS Excel. The structure of the model consisted of three main modules i.e., Database preparation, Simulation and Outputs. The outputs were then used in the later part of the study.

Part 3: Determination of optimal cutting cycles
The method used in this study to determine optimal cutting cycles was by calculating mean and current annual increments (MAI & CAI). The optimum cutting cycle was determined when MAI was equal to CAI.

Results and Discussion
1) Results on population dynamics
Re-measurements of the three ecological plots at Pekan FR were conducted with information collected as shown in Figure 3 and Table 2. The plot in Compartment 100, which has the highest number of *G. bancanus* stands had deeper peat depth - an average of 7.0 m - compared with the plots in Compartments 156 and 200 with peat depth of about 3.5 m and 1.3 m, respectively. This corresponds with the findings of Istomo (1997) who found *G. bancanus* in Central Kalimantan occupying areas with

peat depth of 1.2 m to 6.0 m. In addition, naturally, more *G. bancanus* can be found in areas with deeper peat and dominates at peat depth of more than 5.0 m.

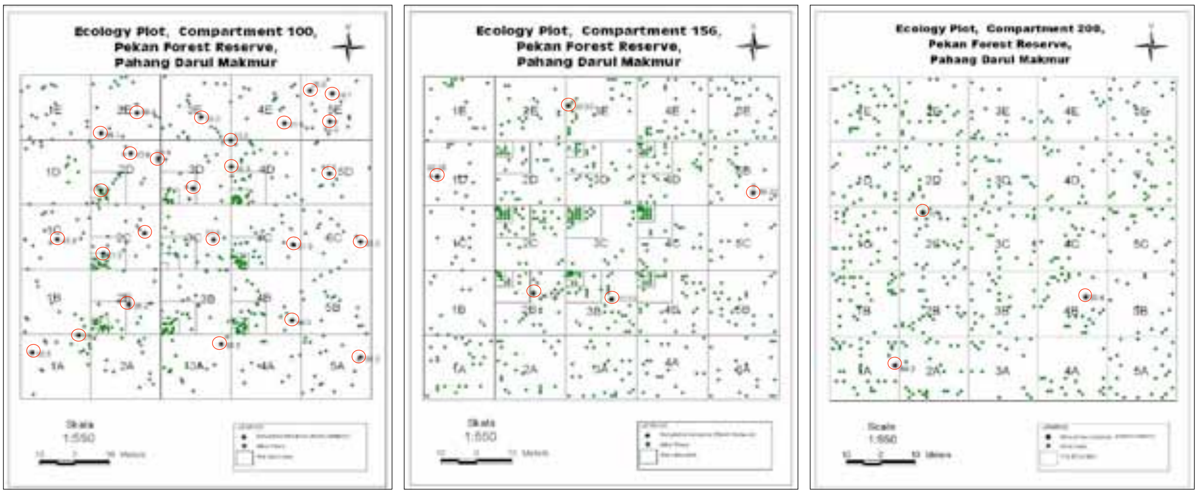

Figure 3 *Gonystylus bancanus* distribution in three ecological plots representing different density at Pekan FR.

Table 3 Summary of *G. bancanus* density in three ecological plots.

Compartment	Description	Stocking ha^{-1}	Basal area ($m^2 ha^{-1}$)	Volume ($m^3 ha^{-1}$)
100	Rich	25	5.6	72.4
156	Medium	5	1.2	18.8
200	Poor	3	0.4	5.2

2) Results on optimum harvest

Diameter increment

Results indicated that the overall diameter growth of trees in the PSF including *G. bancanus* is slower than other inland species. *G. bancanus* recorded a diameter growth of 0.28 to 0.51 cm yr^{-1} depending on the total basal area (TBA). The average mortality and ingrowth was recorded at about 2% per year. The statistic of diameter increment is shown in Table 3.

Table 3 Diameter increment of all species in the PSF (cm yr^{-1})

No	Count	Min	Max	Mean	Std. Error of Mean	Std. Dev.
1	270	.000	5.500	.574	.032	.518
2	366	.000	3.588	.517	.024	.451
3	357	.000	6.300	.596	.028	.532
4	355	.000	6.413	.626	.037	.693
5	456	.000	3.750	.499	.022	.470

For the purpose of modelling, a series of diameter increment functions were developed as shown in Table 4. The diameter increment function for *G. bancanus* over total basal area is shown in Figure 4. The species recorded an average diameter increment of 0.28 to 0.51 cm yr^{-1}.

Table 4 Diameter increment functions for all species group in PSF

Species Group	Diameter increment functions
1. Dipterocarp meranti	$D_i = \exp^{(-0.15539-0.011392*TBA)} - 0.2$
2. Dipterocarp non-meranti	$D_i = \exp^{(-0.191158-.0112268*TBA)} - 0.2$
3. Non-dipterocarp light hardwood	$D_i = \exp^{(-0.27367-0.0135317*TBA)} - 0.2$
4. Non-dipterocarp medium hardwood	$D_i = \exp^{(-0.107701-0.0150806*TBA)} - 0.2$
5. Non- dipterocarp heavy hardwood	$D_i = \exp^{(-0.03232-0.0204071*TBA)} - 0.2$
6. Non- dipterocarp miscl.	$D_i = \exp^{(-0.087761-0.0112406*TBA)} - 0.2$
7. *G. bancanus*	$D_i = \exp^{(-0.26537-0.0147317*TBA)} - 0.2$
8. Bintangor	$D_i = \exp^{(-0.25867-0.01475217*TBA)} - 0.2$

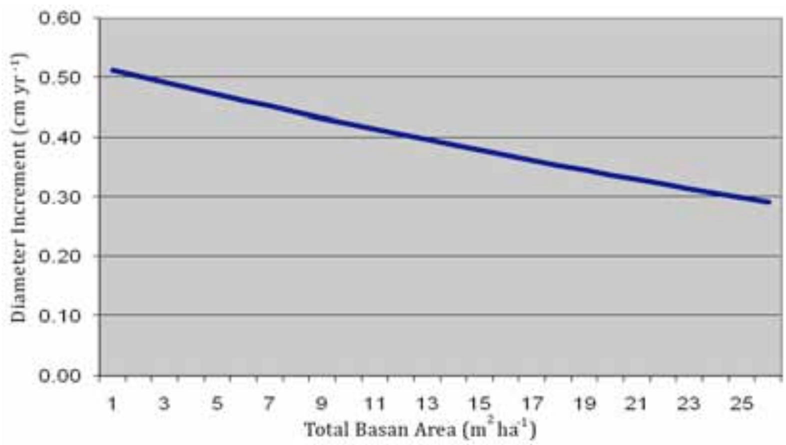

Figure 4 Diameter increment function for *G. bancanus*

Mean annual volume growth

Mean annual volume increment for *G. bancanus* was recorded at an average of 0.215 m^3 ha^{-1} yr^{-1} out of the total MAI of 1.8 m^3 ha^{-1} yr^{-1} for all species greater than 15 cm dbh (Table 5). The results also indicated that medium and high cutting limits produce better future growth response especially for Block 3: 60/50/45 and Block 4: 65/55/50.

Table 5 Mean annual volume increment for all species and *G. bancanus* in PSF

Mean Annual Increment	Block 1	Block 2	Block 3	Block 4
All species (m^3 ha^{-1} yr^{-1})	1.84	1.88	1.75	1.80
G. bancanus only (m^3 ha^{-1} yr^{-1})	0.212	0.199	0.234	0.213

Optimum cutting cycle and initial growing stock

Using the GYMTPSF, the projected volume using all residual stands indicated that option 4 produced the highest volume growth response as compared to other options. (Table 6 and Figure 5). The 120-year projection was done using data from FRIM study area. The projection for total trees and volume for *G. bancanus* is shown in Figures 6 and 7.

Table 6 Volume projection after felling

Year	Block 1	Block 2	Block 3	Block 4
0	73.97	68.92	102.80	107.49
5	84.14	79.63	114.22	116.20
10	94.17	89.39	120.35	124.95
15	104.88	100.15	131.56	138.29
20	116.11	111.17	142.64	150.88
25	127.46	122.26	153.72	162.93
30	138.58	133.16	164.57	174.30
35	149.26	143.68	174.90	184.83
40	159.41	153.69	184.53	194.44
45	168.93	163.11	193.36	203.13
50	177.78	171.90	201.34	210.91
55	185.94	180.07	208.51	217.86
60	193.41	187.61	214.89	224.04
65	200.21	194.56	220.56	229.53
70	206.37	200.93	225.56	234.41
75	211.92	206.75	229.98	238.74
80	216.93	212.06	233.87	242.59
85	221.44	216.88	237.30	246.01
90	225.48	221.25	240.32	249.05
95	229.09	225.20	242.97	251.76
100	232.32	228.76	245.30	254.16
105	235.20	231.96	247.35	256.29
110	237.75	234.82	249.15	258.17
115	240.01	237.37	250.71	259.82
120	241.99	239.63	252.08	261.28

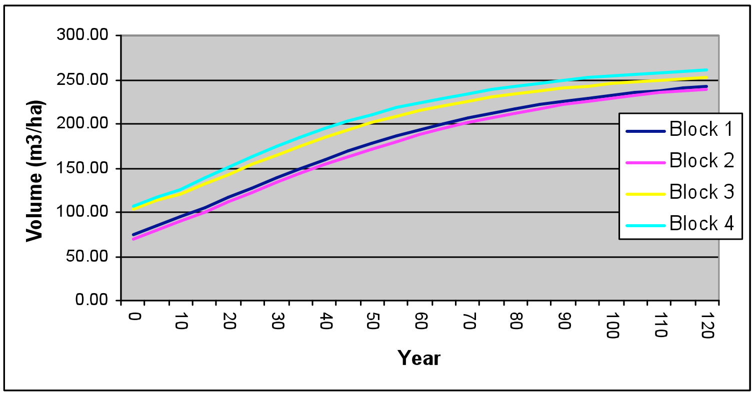

Figure 5 Volume projections after felling

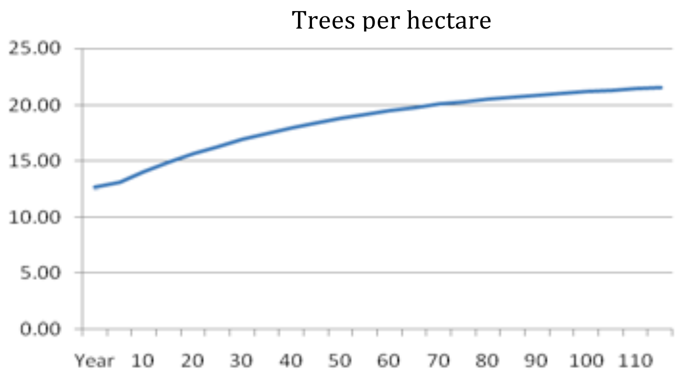

Figure 6 Projected numbers of *G. bancanus* stands

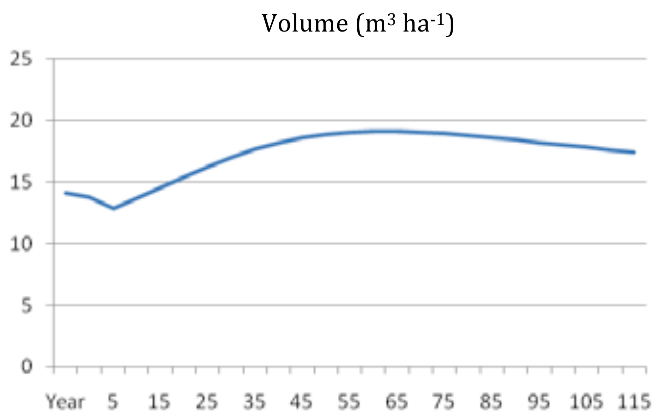

Figure 7 Projected volume of *G. bancanus* trees

The results also indicated that the optimum cutting cycle for the whole stand is estimated at about 40 years with a projected volume increment of about 1.8 m^3 ha^{-1} $year^{-1}$ as indicated in Table 6. The initial growing stock after felling that has to be retained in the forest is at 100 m^3 ha^{-1} (≥ 15 cm dbh) for all species. If the stand is to be managed at a cutting cycle of 40 years, the maximum gross harvestable volume for the whole stand is projected to be at 72 m^3 ha^{-1} of which 8.9 m^3 ha^{-1} is of *G. bancanus*.

Table 6 Mean volume increment and optimum cutting cycle

Parameter	Blok 1	Blok 2	Blok 3	Blok 4
Mean volume increment (m^3 ha^{-1} $year^{-1}$)	1.84	1.88	1.75	1.80
Optimum cutting cycle (year)	35-40	35-40	35-40	35-40

Conclusions

Overall, trees in the PSF are growing at a slower rate than the inland forest with an average diameter of between 0.2 to 0.6 cm yr^{-1}. The study also indicated that the medium removal (20-30%) produced a better diameter, basal area and volume growth. In this study, a projection model - GYMTPSF - was successfully developed. GYMTPSF is a simple, accurate and user friendly model. The study also indicated that the volume MAI for the whole stand in the PSF is about 1.8 m^3 ha^{-1} yr^{-1} for all trees greater than 15 cm dbh. It can also be concluded that the medium and high cutting limits produced a better future growth response. From the management point of view, it is also suggested that the optimum initial growing stock after felling should be at least 100 m^3 ha^{-1} (15 cm dbh). The optimum cutting cycle is projected at 40 years with a gross harvestable volume at 72 m^3 ha^{-1} for all species and 8.9 m^3 ha^{-1} for *G. bancanus*.

Acknowledgements

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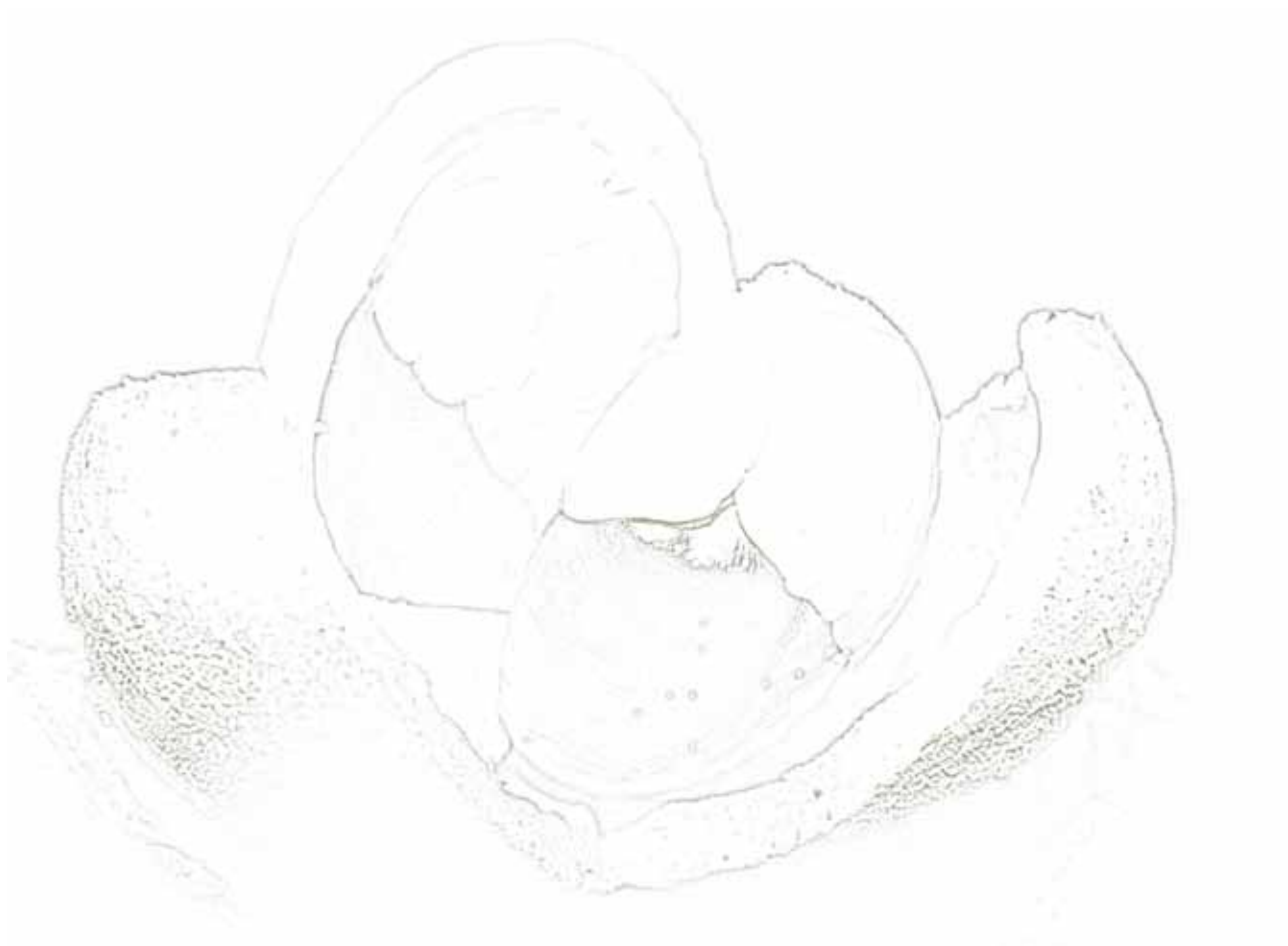

TECHNICAL PAPER 7 ASSESSING SILVICULTURAL SYSTEM ON RAMIN: REVIEW ON CURRENT PRACTICES

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Abstract Silvicultural system which is applied in this natural peat swamp forest is a selective cutting system, which cuts only commercial trees with a certain diameter limit and leaves a number of core trees for the next cutting cycle. The objective of preparing this report is to evaluate the implementation of silvicultural system in peat swamp. To achieve this objective, numerous laws, regulations and concepts which focus on peat swamp forest silvicultural system and its implementation in the field were studied. The absence of a specific silvicultural system for ramin together with the high rate of ramin logging has drastically reduced the number and regeneration of ramin trees. The difficulty to manage ramin which naturally grow in waterlogged peat swamp forest calls for the need to establish an environmentally friendly and efficient system for harvesting and transporting ramin. Improvement of silvicultural system of peat swamp forest needs to consider the present condition of production forest in the peat swamp. In primary forest and logged over forest of active concession forest area, there could be application of selective cutting silvicultural system with improvements on several important aspects using uneven-aged forest stand (natural forest) approach. In the peat swamp forest of ex-concession forest area in the form of mixed secondary forest or scrubland, there could be application of rehabilitation silvicultural system in the form of strip cutting and planting.

Introduction

Silvicultural system which is applied in this natural peat swamp forest (PSF) is a selective cutting system, which cuts only commercial trees with certain diameter limit and leaves a number of core trees for the next cutting cycle. The silvicultural system of Indonesian Selective Cutting (TPI) was first applied in year 1972. In 1989, TPI was changed to silvicultural system of Indonesian Selective Cutting and Planting (TPTI). A change was made in 1996 on diameter limit for cutting and the cutting cycle. The initial cutting diameter limit for ramin was ≥ 35 cm dbh, while that for non-ramin commercial species was ≥ 50 cm dbh with cutting cycle of 35 years. The cutting diameter limit was changed to ≥ 40 cm dbh with cutting cycle of 40 years.

The Forestry Minister issued a Regulation Number: P.11/Menhut-II/2009 on 9 February 2009 concerning the silvicultural system within area of Business Permit for Wood Forest Product Utilisation in Production Forest Territory. The regulation reduces the diameter limit for cutting to ≥30 cm for swamp forest.

The absence of a specific silvicultural system for ramin together with the high rate of ramin logging has drastically reduced the number and regeneration of ramin trees. The difficulty to manage ramin which naturally grows in waterlogged PSF calls for the need to establish an environmentally friendly and efficient system for harvesting and transporting ramin.

There are external and internal factors which contributed to the unsustainable forest management, particularly that of ramin. The external factors among others were:

- high demand for ramin which resulted in high intensity of logging
- weak supervision and law enforcement that led to rampant illegal logging and timber smuggling
- increased rate of natural forest conversion to plantation forest and oil palm plantation, and
- natural disaster in the form of forest and land fire.

The three main internal factors were:

- weak control by the government as the authority of forest management
- poor commitment of the permit holder for sustainable utilisation of forest/forest products, and
- uneffective management of PSF.

The objective of preparing this report for International Tropical Timber Organization (ITTO) is to study and evaluate the implementation of silvicultural system in the PSF. To achieve this objective, numerous laws, regulations and concepts which focus on the PSF silvicultural system and its implementation in the field were studied. There was also information collection in the form of interviews and consultations with relevant stakeholders. In addition, there were field visits and data collection in management unit of IUPHHK PT. Diamond Raya Timber (PT. DRT) in the Province of Riau and ex-forest concession area of PT. Sanitra Sebangau Indah (SSI) in Central Kalimantan.

Materials and Methods

Evaluation of the PSF silvicultural system was studied using two approaches, namely studying secondary data from literature, and field survey. Study on literature sources and secondary data comprised studies on law and regulations which were related with silvicultural system for the management of the PSF in Indonesia. It also involved literature reviews on studies that were related to the evaluation of silvicultural system implementation in the PSF (including problems and constraints being faced in the efforts to achieve sustainable management of production forest (PHPL)).

Evaluation of silvicultural system through field survey has the objectives of verifying and validating problems and constraints in implementing PHPL in the PSF which had been revealed by the study of secondary data during the attempt to improve silvicultural system of the PSF. Field survey was conducted by interview and direct measurement in the field. Interview was conducted with decision makers in the central and local region of the country, management unit of concession forest area (IUPHHK) holders, researchers and observers of sustainable management of production forest (non-governmental organisation), and workers in the forest. Field visit and data collection were conducted in management unit of IUPHHK PT. DRT in the Province of Riau, and ex-forest concession area of PT. SSI in South Kalimantan.

The objectives and targets of field survey were validation and verification of constraints in achieving PHPL (sustainable management of production forest) in the PSF on the basis of existing and valid regulations (in this case, those which are related with the silvicultural system) and results of evaluation of their implementation.

Results and Discussion

Specific feature which distinguishes the PSF ecosystem from other forest ecosystem is the condition of the PSF which is saturated with water and organic in nature (peat soil) with low fertility. The tree species in this ecosystem is unique like ramin (*Gonystylus bancanus*) which grows only in the PSF. Because of the low fertility of the soil, the trees are not big and grow slowly.

Factors which influence, either directly or indirectly to the sustainable management of the PSF are, among others (Istomo 2006):

1. No appropriate silvicultural system for PSF (particularly ramin) on the basis of characteristics/provisions in TPTI such that utilisation and regeneration of ramin did not parallel.

2. Absence of certainty in land use; presence of threat for converting forest territory into other uses (for instance plantation), forest land encroachment, fire and illegal logging activity.

3. No government policy concerning rehabilitation of degraded PSF (for instance reforestation or afforestation practice) or supporting fund (for instance reforestation fund) for research, planting and salvation of endangered species, such as ramin, to achieve sustainability.

There are several important aspects which need to be considered in implementing ramin silvicultural system, which are not regulated in the provisions of TPTI silviculture (Istomo 2009):

1. Activities for ramin utilisation/business constitute a unity with other species within PSF.

2. In determining the allowable cut for ramin and non-ramin species, there should be a balance between the number of potential trees to be logged and the core trees to retain. Therefore, there is a need to determine the minimum number of core trees for ramin and non-ramin trees which should be retained for the next cutting cycle.

3. There is a need to determine the proportion (percentage) of ramin trees to be logged and to retain as compared to other commercial trees.

4. The basis for determining the allowable cut for ramin and non-ramin should take in to consideration the data of residual stand growth and ability of planting / rehabilitation in open areas of logged-over areas. Measurement of permanent plot should be conducted to obtain valid growth data.

Analyses on stand potency data on the PSF before and after logging are shown in Tables 1 and 2, and Figures 1 and 2. Based on 113 permanent sampling plots (PSP) with a total size of 40.68 ha, the number of allowable trees to be cut (diameter 40 cm dbh and above) is 5.05, 12.56 and 21.62 trees ha^{-1} for ramin species, meranti group and mixed species group, respectively. After logging, the number of trees for ramin, meranti group, mixed species group which are allowed to be cut (dbh 40 cm and above) decreases to 1.61, 6.44 and 18.65 trees ha^{-1}, respectively.

Therefore, the average number of trees that can be cut is 3.43 trees ha^{-1} (ramin), 6.12 trees ha^{-1} (meranti), and 2.97 trees ha^{-1} (mixed species group), totalling to 12.92 trees ha^{-1}. On the other hand, the number of core trees (dbh class of 20-39 cm) for ramin species, meranti group and mixed species group are respectively 3.64, 13.01 and 92.38 trees ha^{-1}. As the number of trees is still less than the number of core trees, the logging intensity being practiced by PT. DRT in compartments of PSP is still within the limit of the forest ability to recover.

Table 1 Average number and volume of trees per ha before logging in PT. DRT, Riau.

	dbh Classes (cm)					
	19-Oct		**20-39**		**40 up**	
Species Group	**N**	**V**	**N**	**V**	**N**	**V**
Ramin	1.11	0.17	3.64	3.07	5.05	16.71
Meranti group	2.55	0.26	13.01	8.53	12.56	36.05
Other Com.	49.61	4.5	92.38	48.26	21.62	47.85
Total	**53.27**	**4.93**	**109.03**	**59.86**	**39.22**	**100.61**

N : number of trees ha^{-1}; V : tree volume m^3 ha^{-1}, Other Com. = Mixed species group

Table 2 Average number and volume of trees per ha after logging in the area of PT. DRT, Riau.

	dbh Classes (cm)					
Species Group	**19-Oct**		**20-39**		**40 up**	
	N	**V**	**N**	**V**	**N**	**V**
Ramin	0.59	0.07	3.09	2.77	1.61	4.19
Meranti Group	1.79	0.2	10.67	7.27	6.44	17.93
Other Com.	28.93	2.7	74.89	40.33	18.65	39.57
Total	**31.31**	**2.96**	**88.66**	**50.36**	**26.7**	**61.69**

N : number of trees ha^{-1}; V : tree volume m^3 ha^{-1} , Other Com. = Mixed species group

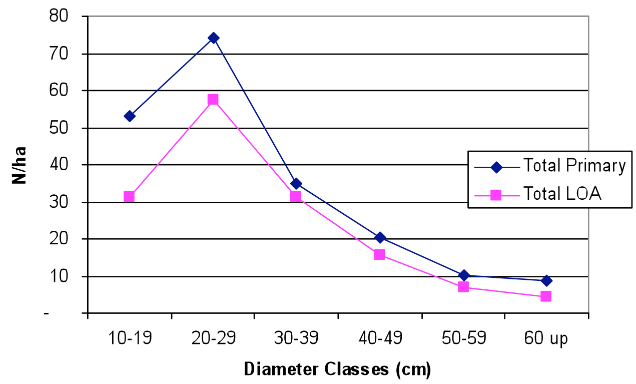


Figure 1 Number of trees for all species in primary and logged-over forests

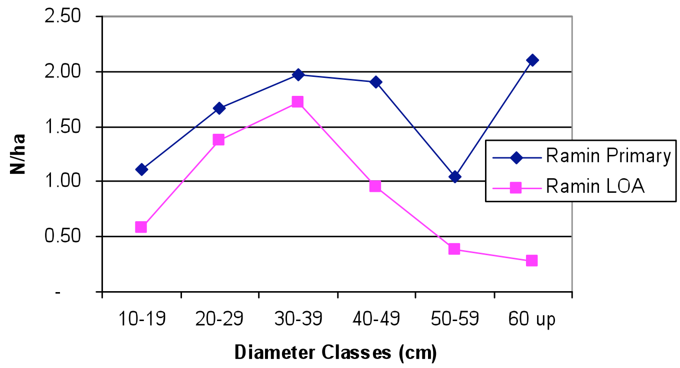


Figure 2 Number of ramin trees in primary and logged-over forests

According to Istomo (2009), to sustainably maintain ramin population, the proportion of trees to be cut and to retain for ramin and non-ramin needs to be regulated. These regulations are in conformity with method of yield regulation on the basis of number of trees approach. For adopting such approach, those proportions should be calculated to determine annual logging quota for ramin. Figures 3, 4 and 5 show the proportion of number and volume of each species group at IUPHHK of PT. DRT.

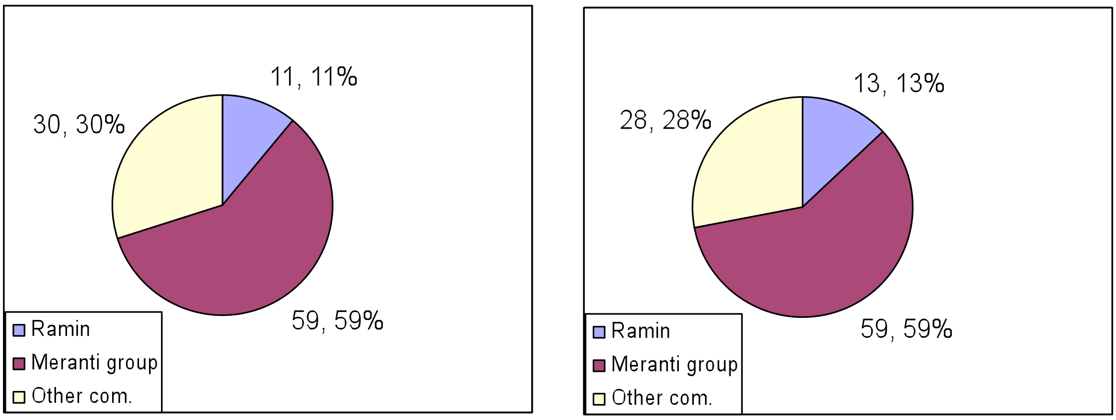


Figure 3 Proportion (percentage) of number of trees by species group for all trees (>20 cm dbh) and for trees which are allowed to be cut (>40 cm dbh).

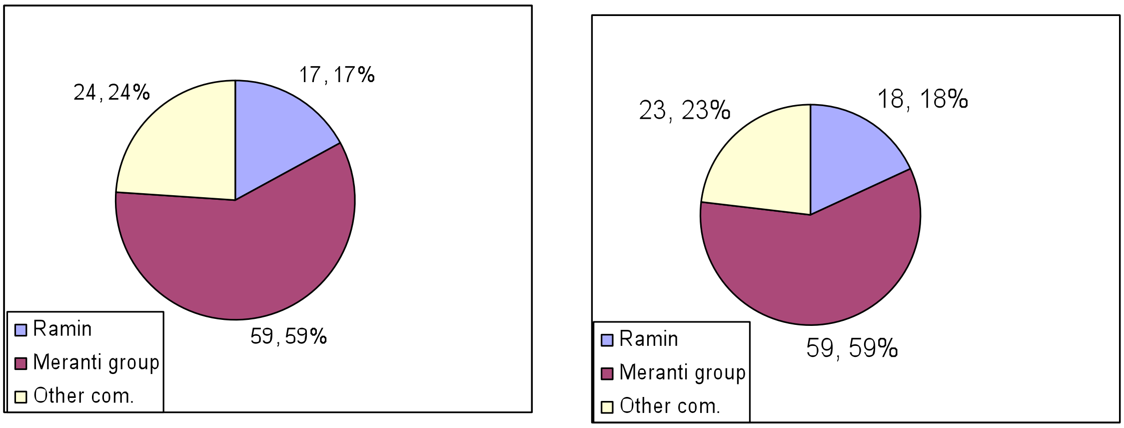


Figure 4 Proportion (percentage) of volume of trees by species group for all trees (>20 cm dbh) and for trees which are allowed to be cut (>40 cm dbh).

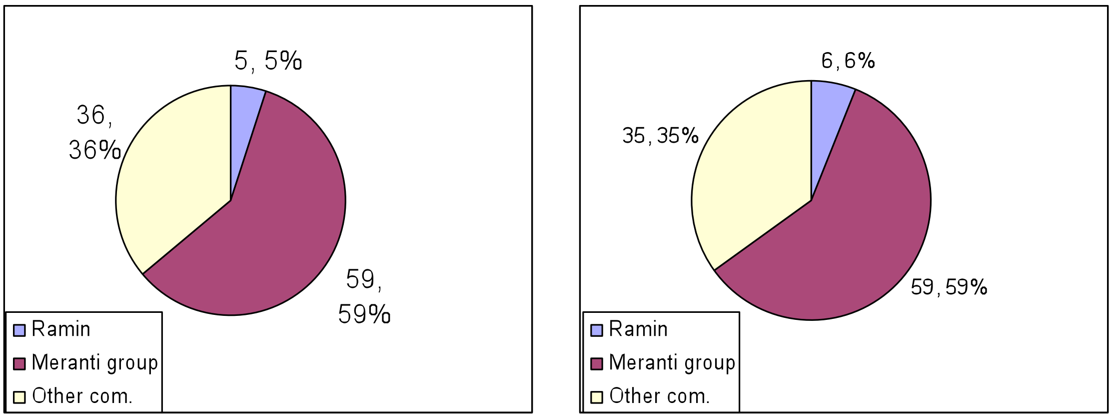


Figure 5 Proportion (percentage) of number and volume of core trees (dbh class 20-39 cm) by species group.

Based on Figures 3, 4 and 5, it can be seen that ramin trees constituted 11% of trees with >20 cm dbh, or 13% of trees which are allowed to be cut (>40 cm dbh). In terms of volume, ramin constituted 17% of trees with >20 cm dbh, or 18% of trees which are allowed to be cut (>40 cm dbh). Percentage of ramin trees is higher in >40 cm dbh if compared with all trees, and there are more ramin trees in large diameter class (Istomo 2009).

Data analysis on diameter increment in 113 compartments of PSP of PT. DRT, Riau shows that the average increment of ramin species, meranti group and mixed species group with >10 cm dbh is 0.46, 0.55 and 0.61 cm yr^{-1} respectively, or 0.54 cm yr^{-1} for all species. However, if the dbh increment is categorised into dbh classes, the figures become greater. Diameter increment of core trees (20-39 cm dbh) for ramin is 0.62 cm yr^{-1} and meranti group 0.68 cm yr^{-1}, or 0.64 cm yr^{-1} for all species. In the >40 cm dbh group of logged trees, diameter increment for ramin is 0.31 cm yr^{-1}, meranti group 0.41 cm yr^{-1} and for all species 0.44 cm yr^{-1}.

Table 3 Diameter increment by class diameter in PSF at PT. DRT, Riau

Species Group	Diameter Increment (cm yr^{-1}) on each dbh Classes (cm)					
	10 - 29	**20-39**	**10 up**	**20 up**	**30 up**	**40 up**
Ramin	0.68	0.62	0.46	0.43	0.68	0.31
Meranti Group	0.69	0.68	0.55	0.52	0.69	0.41
Other Com.	0.61	0.61	0.61	0.61	0.61	0.6
Average	**0.66**	**0.64**	**0.54**	**0.52**	**0.66**	**0.44**

Evaluation could be conducted on silvicultural system in the PSF based on the increment data obtained in this study, particularly for ramin. If average increment of ramin core tree diameter (dbh 20-39 cm) is established as 0.62 cm yr^{-1}, with a cutting cycle of 40 years, core trees initially with 20 cm dbh could reach 50.2 cm dbh and are ready to be logged. Likewise, meranti species with an average diameter increment of 0.68 cm yr^{-1} could reach 52.2 cm dbh after 40 years. As such, for all species, with increment of 0.64 cm yr^{-1}, after 40 years, core trees with 20 cm dbh could gorw to 45.6 cm dbh. Therefore, with logging set at >40 cm dbh, cutting cycle of 40 years, and core tree diameter of 20-39 cm, the condition of the PSF has been in accordance with growth ability of logged-over stand to reach sustainable forest production management.

Increment data obtained in this study are comparable with results of other literature review. Prasetyo and Istomo (2006) reported that ramin diameter increment in dbh class 20-39 cm was 0.42 cm yr^{-1}, whereas for diameter class of >40 cm dbh was 0.34 cm yr^{-1}. Istomo (2002) reported that the average increment of ramin diameter in PT DRT was 0.44 cm yr^{-1}. Data analysis on Permanent Measurement Plot by the research group from Research and Development Center for Forest and Nature Conservation showed similar results, i.e, the average increment of ramin diameter was 0.42 cm yr^{-1} in Sumatera and 0.53 cm yr^{-1} in Kalimantan (Machfudh & Rinaldi 2006).

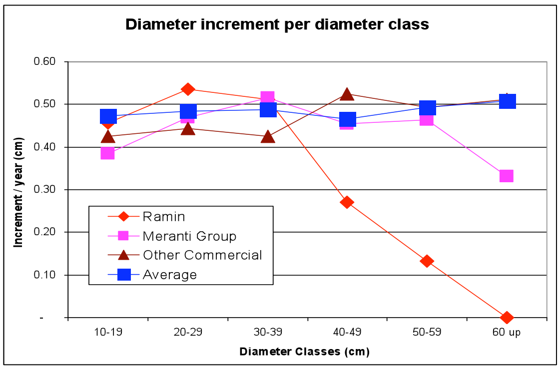


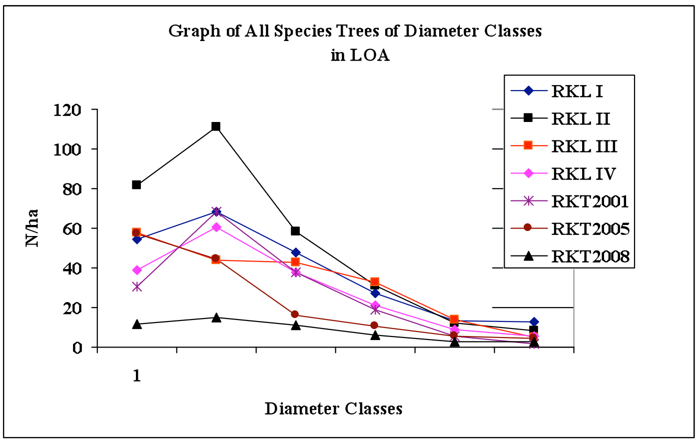
Figure 6 Diameter increment based on dbh class

If diameter limit of logging is decreased from 40 cm to 30 cm dbh (on the basis of Forestry Minister Regulation, Number : P.11/Menhut-II/2009) , there will be more trees logged and creates imbalance between the number of logged and core trees, particularly for ramin species. In this case, crown openness and damage of residual stand will be greater, and subsequently will create opportunity for more rapid weed growth in the PSF (palas, pandan and sempayo). Logging small diameter trees is also not efficient. Table 4 shows that if the diameter limit for logging is >40 cm dbh for ramin species, there will be opportunity to cut on average as many as 5.05 trees ha^{-1}, but if the diameter is limited to >30 cm dbh, there will be 10.65 trees ha^{-1} that can be logged.

Table 4 Number and volume of trees by diameter classes in primary forest before logging, based on data of Permanent Measurement Plot in PT. DRT, Riau.

	Diameter Class (cm)							
Type	**10 - 29**		**30 up**		**20-39**		**40 up**	
Species	**N ha^{-1}**	**V ha^{-1}**	**N ha^{-1}**	**V ha^{-1}**	**N ha^{-1}**	**V ha^{-1}**	**N ha^{-1}**	**V ha^{-1}**
Ramin	2.78	1.02	10.65	22	3.64	3.07	5.05	16.71
Meranti	10.05	3.52	31.08	49.84	13.01	8.53	12.56	36.05
Mix	114.7	28.25	141.29	120.62	92.38	48.26	21.62	47.85
Total	**127.53**	**32.79**	**183.03**	**192.47**	**109.03**	**59.86**	**39.22**	**100.61**

Analysis on the monitoring results of the PSP in IUPHHK-HA PT DRT shows that there had been dynamics of stand/forest regeneration in logged-over area, ranging from the youngest logging residual stand (2008) to the oldest one with a five-year work plan (RKL) I (1978 logging) (Figures 7 & 8). In general, forest regeneration in logged-over area (succession) occurs positively, particularly for mixed total species. Abnormality of ramin distribution based on diameter classes occurs not only in primary forest, but also in logged-over forest, ranging between RKL I-VI. There is no clear pattern in the dynamics of ramin stand structure, although it could be suggested that the number of ramin trees is greater in middle class diameter, particularly at diameter class 20-50 cm dbh. The number of ramin trees in old logged-over area is higher than in recently logged-over forest. However, in general, development process of logged-over forest recovery has been positive. Regeneration development in the form of seedlings/saplings observed in logged-over forest shows positive trend. Number of seedlings and saplings for ramin and non-ramin species increased after logging. Shoot cuttings of ramin derived from natural seedlings planted as trial, at age of five years old in area of PT. DRT, Riau, have reached average diameter of 7.23 cm dbh and height of 3.6 m.



Notes: RKL (five-year work planning), RKT (annual work planning)

Figure 7 Number of all species per ha in logged-over forest of PT. DRT on the basis of Permanent Sample Plot.

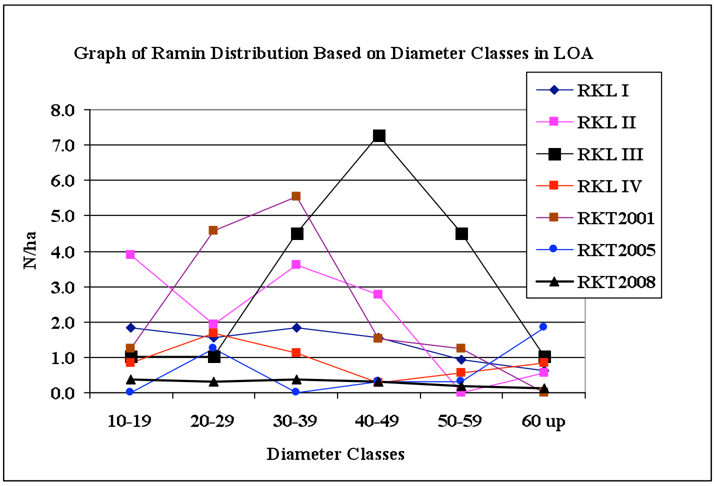


Figure 8 Number of ramin trees per ha in logged-over forest of PT. DRT on the basis of Permanent Sample Plot.

Other consideration in a silvicultural system of the PSF is the transportation system. Problems which often arise in relation with transportation system are:

1. Manpower (not many are willing to work as timber skidders)
2. Working efficiency which is categorised as low (limitation of human power), limited trips and loading capacity of lorry (obstacles on the road due to unstable lorry road), and
3. Work safety for skidders and lorry workers.

Another aspect that should be considered thoroughly in transportation system is the use of heavy equipment (*logfisher*) which damages residual stand and subsequently, forest stand. Compacted track due to the *logfisher* movement causes difficulty in tree regeneration and growth of cover plants.

Therefore, the improvement of silvicultural system in the PSF, particularly for ramin conservation should be related to the following:

1. Silvicultural system chosen should be selective cutting silvicultural system which is specific for PSF.
2. Cutting cycle remains at 40 years with diameter limit for logging for all commercial species should be 40 cm dbh and above.
3. At least 25 core trees of commercial species should be left for the next cutting cycle and spread evenly in every hectare, with a diameter of 20-39 cm dbh.
4. The number of ramin trees that can be logged should be smaller or similar to the number of core trees left. The maximum number of ramin trees which are allowed to be cut is three trees per ha.
5. If the Forestry Minister Regulation Number P.11/Menhut-II/2009 with logging diameter limit of 30 cm dbh and above is adopted, there should be further regulations of logging intensity per diameter class. Only 50% of the total number of trees is allowed to be cut per diameter class.

Results of field survey in the PSF in ex-forest concession PT. Sanitra Sebangun Indah indicated that on average there were 8 ramin trees ha^{-1} at diameter < 40 cm, but for diameter class of >40 cm dbh, no ramin trees were found (Table 5). Tree density of all species at diameter class of 20 cm dbh and above was 158 trees ha^{-1}. The volume of ramin trees at diameter class of 20-39 cm dbh was around 5.79 m^3

ha^{-1}, whereas tree volume for all species at >20 cm dbh was 143.58 m^3 ha^{-1}. No ramin and meranti group trees with diameter of >40 cm dbh was found, whereas for mixed species group, the average volume was 73.5 m^3 ha^{-1}.

Table 5 Number of trees per diameter class in secondary forest in ex-forest concession (HPH) in Central Kalimantan.

	Number of Trees per Diameter Class (cm) per Hectare					
Species Group	**20-29**	**30-39**	**40-49**	**50-59**	**60-69**	**60 up**
Ramin	6	2	0	0	0	0
Meranti Group	33	1	0	0	0	0
Other Com.	93	9	5	5	2	2
Total	**132**	**12**	**5**	**5**	**2**	**2**

A prerequisite for developing a rehabilitation silvicultural system is to know the degradation rate and identify the cause. It was observed that there are several levels of degradation in the PSF, ranging from light to heavy degradation. Three kinds of damage related to the PSF are logged-over secondary forest, ex-burnt and logged-over secondary forest, and scrubland. Rehabilitation of degraded PSF has been conducted by various parties in ex-concession areas. In heavily degraded areas, there is a need to plug canal as it creates better precondition environment for regeneration. To accelerate the rehabilitation process, replanting or regreening programme is required. Tree species that could be planted include belangeran (*Shorea balangeran),* pulai (*Alstonia* spp.*)* and *pantung (Dyera lowii).* These species were found to grow naturally with the presence of mother trees. For heavily degraded PSF, species suggested are tumih (*Combretocarpus rotundatus*) and geronggang (*Cratoxylon arborescens*).

Conclusions

1. In active logged-over primary PSF, application of selective cutting silvicultural system can be used with improvements on several important aspects using approach for uneven-aged forest stand (natural forest).
2. In logged-over PSF with mixed secondary forest or scrubland, application of rehabilitation silvicultural system could be in the form of strip cutting and planting.
3. Improvement of TPTI silvicultural system for PSF should include determination of the number of core trees of logged species, proportion of core trees and logged trees in each species group, diameter limit for cutting, and cutting cycle.
4. Cutting cycle in productive PSF with TPTI silvicultural systems should remain at 40 years, logging diameter limit of 40 cm dbh and above, and a minimum of 25 core trees with a diameter of 20-39 cm dbh.
5. The number of ramin trees that can be logged should be less or equal to that of ramin core trees, with a maximum of 3 trees per hectare.
6. If logging diameter limit of 30 cm dbh and above is adopted, further regulation where only 50% of the total number of trees is allowed to be cut per diameter class is recommended.

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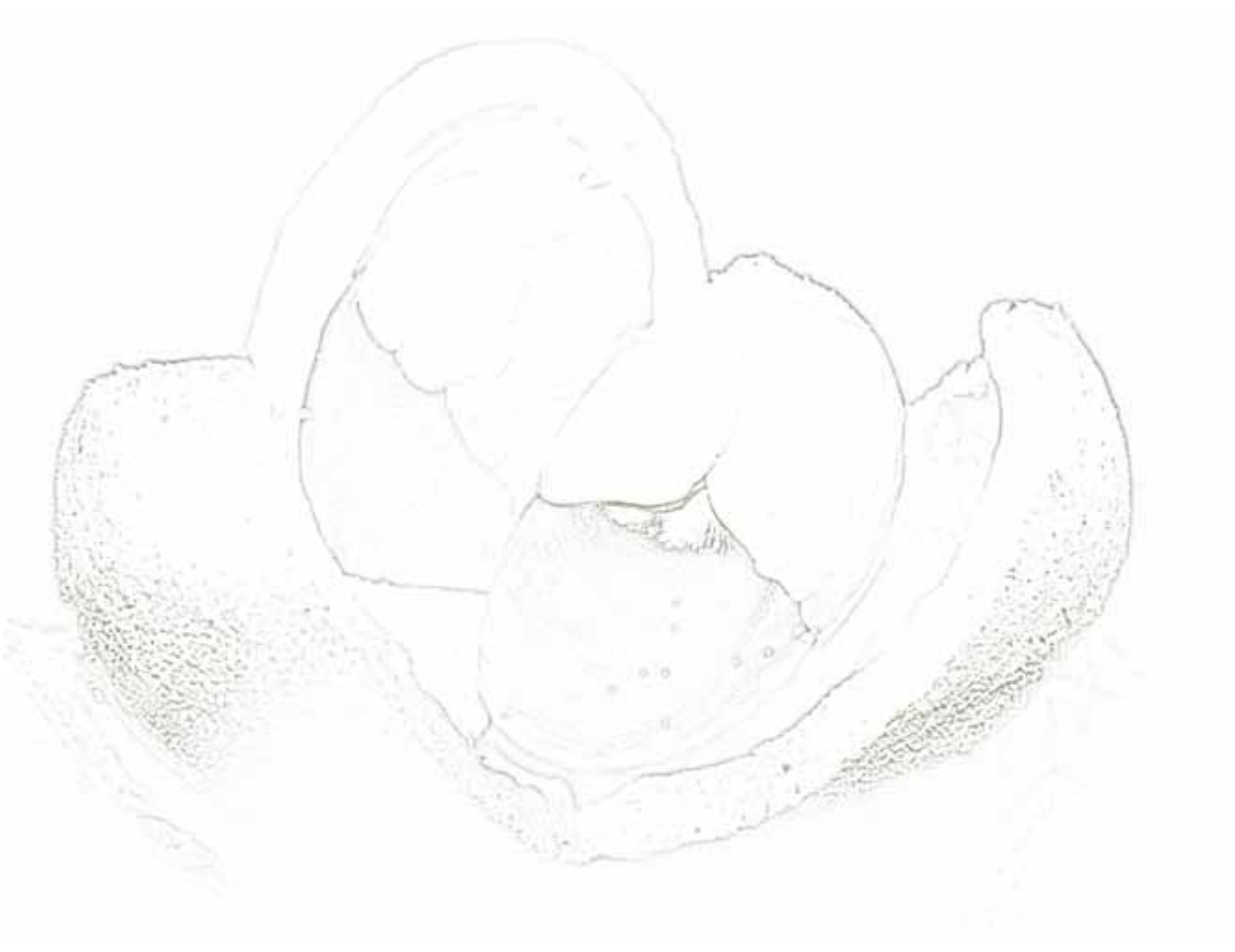

TECHNICAL PAPER 8

THE DEVELOPMENT OF *GONYSTYLUS* SPP. (RAMIN) TIMBER MONITORING SYSTEM USING RADIO FREQUENCY IDENTIFICATION (RFID) IN PENINSULAR MALAYSIA

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Abstract Ramin (*Gonystylus* spp.) is one of the most important peat swamp forest tree species currently being utilised in Malaysia. There are widespread concerns about the harvesting rate of this species due to increasing demand from the timber industries, both local and international. There are also concerns that the ramin trees are under considerable threats from illegal logging and tax evasion that causes the government to lose lucrative forest revenues. Tree marking is one of the measures carried out by Forestry Department Peninsular Malaysia to address these problems. It also serves to regulate the harvestable number and volume of trees as well as to monitor incompliance of forest operation such as the felling of mother trees, buffer zone and protection trees from logging areas. The project embarked on the use of radio frequency identification (RFID) technology instead of the manual timber tagging activities in the harvesting of peat swamp forest area, in particular ramin species. It aims to develop a customised cost-effective *Gonystylus* spp. (ramin) timber monitoring system using radio frequency identification (RFID) in Peninsular Malaysia. This project is very essential to promote sustainable utilisation towards the conservation of ramin in production forests of Malaysia.

Introduction

The current major area of RFID applications include data synchronisation, transportation and distribution, and security and law enforcement. In view of this, it is envisaged that RFID technology can be integrated into the existing Forestry Department Peninsular Malaysia (FDPM) computer system. It also can be used as the basis of a new coding system for one of FDPM's core business applications, such as its tree marking system in logging operation. These features will help to resolve obstacles that FDPM are facing in controlling timber supply that are in compliance with the Malaysian Criteria and Indicator (MC&I) 2002 timber certification programme, chain-of-custody scheme and monitoring revenue collection.

It is apparent that barcodes have been widely used for more than 30 year. However, the technology has reached its peak performance due to a number of limitations, such as easily being damage, its reader operations can be affected by moisture, and clear line of sight (no obstacles). The reader is not able to read every barcode if it moves at high speed and it does not have the ability to read/write, and information could not be added or written on a printed barcode. Hence, in this project, timber tagging system will be replaced with RFID chip. The chip will be implanted into logged trees and stumps in logging areas to determine the source of any specific logging licensed area, tree diameter, species, forest compartment and logging contractor among others. RFID chip in FDPM application can also be used as a permit for the transfer of logs from one area to another. Logs without identification will enable the forest officers to immediately alert the Department to take prompt and immediate action.

The system consists of several components, such as RFID chips, hand-held RFID readers and tag programming stations. In the implementation of this project, trees to be logged will be surveyed to identify the species and diameter size, as well as to estimate the number of logs from each tree. All felled trees that are cut into logs, as well as tree stumps will be tagged with RFID tag. The tag contains a transponder with a digital memory chip that is given a unique electronic identification code. The reader - an antenna packaged with a transceiver and decoder - emits a signal activating the RFID tag so that it can read into it. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing. RFID hand-held device will transmit signal to detect the RFID tags in a given location. Once the signal detects the tags, it will store the information in the hand-held device and later all the daily information will be synchronised with the RTRfid system at the FDPM headquarters and state forestry department offices. RTRfid System will provide effective timber movement tracking and audit illegal timbers, as well as effectively providing timber and logging information. The system will allow FDPM and logging offices to connect, allowing applications and data to be shared across all sites. File and content delivery services will allow for delivery of information and content to multiple sites at the same time, enabling simultaneous access to the same information across different office locations. Broadband connectivity will be used to allow two-way delivery of internet traffic and in providing different bandwidth sizes and usage profiles.

RTRfid system works as a package and can be divided into three major components, namely, a Mobile System; a Gateway System; and a Base System. The Mobile System is a data logger that is responsible for collecting identification information about logs. Information gather via the Mobile System will be fed into the Gateway System. The Gateway System acts as a proxy for data transfer and serves to add speed, reliability and security throughout the system. Data captured from the Gateway System is securely transmitted to the Base System that can be considered as a central repository bank to store all log-in real-time information, such as forest revenues collected, alerting security and GPS maps.

Objectives
The activities were carried out in Compartment 74 A, Pekan Forest Reserve, Pahang. The main activities carried out were demarcation of boundary, pre-felling inventory, tree tagging and felling. The project will contribute significantly in ensuring the detection of non-compliance of timber harvesting procedures and to achieve sustainability of the ramin timber species that is consistent with the sustainable forest management practices currently being implemented in Peninsular Malaysia. As such, the objectives of the project are as follows:

i. Development of a customised cost-effective *Gonystylus* spp. (ramin) Timber Monitoring (RTRfid) System using radio frequency identification (RFID) in Peninsular Malaysia.
ii. Development of automated detection and notification mechanism for tracing non-compliances using hand-held computers with RFID scanner system in Peninsular Malaysia.

Problems to be addressed
Illegal logging issues have tarnished Malaysia's image and have affected Malaysia's market share in some of the global markets that require timber products to be sourced from forests that are legal and sustainably managed. It also costs the government to lose forest revenues through non-compliance of forest regulations, such as over-harvesting, harvesting of unspecified trees species, illegal transport of timber, forest tax evasion and the high cost to rehabilitate degraded forest. In addition, there are also global concerns about the rate at which the ramin is being harvested as a result of increasing demand for timber by the industries, both local and international. One of the solutions identified to mitigate the problems is to capture log movement, production and sales by implementing RFID technology that has been used effectively, among others, in airport baggage handling, electronic payment, retail theft prevention, library systems, automotive manufacturing, parking system, as well as in the postal services. The main features that make the RF-based technology such an attractive option include identification without visual contact, read/write capabilities to store and change data, and its ability for cluster reading in order to simultaneously read many tags. In fact, RFID is an acronym that refers to small electronic devices that consist of a small chip and an antenna. The chip typically is capable of carrying 2,000 bytes of data or less. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or an ATM card and it provides a unique identifier for that object. Similar to a bar code or magnetic strip which must be scanned to get the information, the RFID device must also be scanned to retrieve the identifying information. However, the advantages of RFID as compared to other scanning devices are that RFID requires no line-of-sight requirement, able to read longer range, can stand harsh environment, has more storage capability and possesses real-time tracking capability. These features are the principal characteristics which enter the strategic decision taken by the FDPM to implement RFID-based technology and its applications, notably in its forest harvesting operations.

Intended situation after Project completion

The project is very critical to FDPM in its efforts to modernise its timber tagging system that is currently being used. As there are short-comings in the current tagging system, the electronification of timber identification and monitoring will act as a check-and-balance system to control ramin harvesting from a logging area in terms of timber species, size, collectable taxes, etc. The project will also enhance the enforcement procedures and activities to be carried out as forest officers will be able to ensure that the ramin timber harvested are from legal sources and be reported to forest offices of any non-compliance on a real-time basis. This is very crucial to ensure effective forest revenues collection and to boost the morale of forest officers.

Target beneficiaries

At the end of the project, the results will assist the various forestry departments in Peninsular Malaysia and the relevant agencies to address the issue of non-compliance of forest harvesting procedures, illegal logging and tax evasion. The results of the project are also important to the FDPM as they form the basis for more knowledge-based decision making, especially in the formulation of cost-effective and efficient forest operation systems based on the principles of sustainable forest management. The results will enable timber exporters to demonstrate to their buyers that the ramin timber is sourced legally and hopefully they will fetch higher prices in the global market.

Risks

There will be challenges to the foresters as the usage of this system is still at its infancy in the forestry sector in Peninsular Malaysia. It will challenge the foresters to quickly adapt and operate the system that involves not only information but also communication technology. However, this will not have any significant negative impacts on the success of the project to achieve its objectives.

Experience and Observation

The RTRfid has proved its capability in transmitting and output data in real time, enabling the maximum visibility and detection of non-compliance timber harvesting procedures for all project stakeholders. The system has provided a fully documented ramin inventory and documented evidence of timber moving from the PSF through the supply chain, therefore the legality of ramin moving through the chain of custody. Given the complexities of the processes involved at concessions, the difficult tropical environment in the PSF and the wide ranging background and skills of forest operators, trying to provide solutions in the forestry sector, especially an RFID technology, can be a challenge. Hence, it is important that the sense of ownership, role and responsibilities of this RTRfid are acquired by all stakeholders involved. Their committed involvement is crucial for raising awareness, capacity building and acceptance of the system. Besides, a well and in-depth study of the most appropriate RFID form is equally important in the tree marking and tracking processes. If the system is extended by integrating all sectors of the timber industry and monitoring the associated wood flows, the RTRfid can assists in addressing illegal logging by eliminating entry points for unlawful timber into the legitimate supply chain.

Outputs

The expected outputs of the project are to strengthen and improve the efficiency of tree marking operations and forest revenue system, as well as to expedite the issuance of removal passes during the transport of timber from logging areas to mills using a customised cost-effective RFID-based timber monitoring system. It will also improve the efficiency of forest enforcement activities and non-compliance detection using customised cost-effective electronic data logger in Peninsular Malaysia.

Activities

i. Output 1: To strengthen and improve the efficiency of tree marking operations and forest revenue system, as well as to expedite the issuance of removal passes during the transport of timber from logging areas to mills using a customised cost-effective RFID-based timber monitoring system.

   a. Documentation and procedures to appoint FDPM RFID system consultant.
   b. Acquisition of computer peripherals, including servers, computers, printers and other related hardware.
   c. RTRfid system peripherals rental, including, satellite (VSAT) communication system and broadband.
   d. Issuance of logging license.
   e. Inventory work and electronic tree marking in the field.
   f. Forest harvesting activities.

ii. Output 2: To improve the efficiency of forest enforcement activities and non-compliance detection using cost-effective computerised hand-held data logger with RFID scanner.
   a. RFID chip acquisition.
   b. Computer hardware, and power cabin and gentry structures rental.
   c. Forest monitoring and enforcement.
   d. Report and documentation.

Conclusions

Based on the results and the success of implementing the present project, some follow-up activities could be considered to further deepen the experience of the FDPM and the various state forestry departments in managing and monitoring the forestry sector through the RTRfid and the RFID technology. It is recommended that the project scope is expanded to a larger scale project, i.e. covering a full state operation by including the processing mills to further extend the traceability along the chain of custody; analysing the most appropriate form of RFID for the forest environment and the integration of RTRfid with FDPM current computer system, as well as state revenue collection system to provide a wider range of monitoring and scrutiny.

Acknowledgements

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TECHNICAL PAPER 9 SURVEY AND INVENTORY OF *GONYSTYLUS* SPP. IN EAST KALIMANTAN

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Abstract Field survey and inventory for *Gonystylus* spp. in East Kalimantan were conducted from June until December 2009 at five locations: Malinau Research Forest of PT. Inhutani II Concessions, Sungai Wain Protection Forest (HL-SW), Bukit Bangkirai and Samboja Research Forest-Balikpapan, PT. ITCI Concession areas and Gunung Lumut Protection Forest-Paser District. Results of the survey showed that from the above five locations, six *Gonystylus* spp. were found: *G. affinis, G. brunnescens, G. consanguineus, G. forbesii, G. keithii* and *G. velutinus.* The species grow naturally in primary forest with flat to hilly topography, with altitude ranges from 20 to 500 m above sea level, on sand clay soil type with pH between 5.1-6.8, and soil moisture between 20% -75%. Among those five species, only *G. brunnescens* was found in abundance and with better natural regeneration, especially in Sungai Wain Protection Forest, Bukit Bangkirai and PT. ITCI concession area. The other five species were found in small population ranging from one to five individuals.

TECHNICAL PAPER 10 THE DEVELOPMENT OF DNA DATABASE FOR *GONYSTYLUS BANCANUS* IN SARAWAK

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Abstract The government of Malaysia and CITES control measure on ramin could not guarantee no illegal trading of ramin. The current project was developed to probe the use of DNA for tracing and tracking of ramin timber origin and species verification in order to combat illegal trading. The DNA was extracted from leaves and bark samples that were collected from nine populations throughout Sarawak using cetyltrimethyl ammonium bromide (CTAB) with modification. Eighteen microsatellite markers were selected to amplify the DNA and thus used to generate alleles frequencies for database. From the database, a total of 67 unique alleles were detected providing useful information for tracing the population origin of ramin. The genetic diversity measured was generally high for most populations except for Kayangeran Forest Reserve and Loagan Bunut National Park. Cluster analysis based on Nei's genetic distance revealed that the populations were clustered into two geographical regions. In order to determine if the populations were significantly distinguishable from one to another, a pair wise comparison of populations test was conducted. The results based on *Fst* values showed that most populations were significantly differentiated except for populations located at the tributaries of Batang Lupar (Lupar River). This indicated that most likely gene flow has occurred along waterway. Unique alleles detected and cluster analysis indicated the ability and usefulness of microsatellite markers selected for tracking and tracing of ramin populations. However for effective and accurate use of microsatellite markers, application should be based on many loci and complete database covering all ramin populations throughout other states and neighbouring countries.

Introduction

Gonystylus bancanus – locally known as ramin telur in Sarawak - belongs to the family Thymelaeaceae and is a native species of the fragile peat swamp forest (PSF). The wood is creamy yellow in colour with moderately fine and even texture, is easy to saw, bore and turn, and has smooth planned surface. It is one of the most valuable tropical hardwoods and highly sought after for decorative cabinet timber, furniture, squash court flooring and interior decorative work (Lim *et al*. 1999).

The largest importer of ramin sawn timber and products are China including Hong Kong, the United States and Japan (Table 1). From January to November 2009 the reported production and export of ramin for Sarawak were 2,591 m^3, a decline compared to production in 2008, 2007 and 2006 (Table 2). The decline in ramin production for 2009 as reported by Malaysia during the fifty-ninth CITES meeting at Doha (Qatar) on 12 March 2010 was the result of global economic recession faced by the timber sector since late 2008.

Table 1 Export destinations for ramin products (January to November 2009) for Sarawak

Export destination		**Ramin products**	
Market	Volume (m^3)	Products	Volume (m^3)
China (including Hong Kong)	623	Sawn timber	1,153
USA	454		
Japan	448	Dowels/mouldings	1,438
Others	1,066*		
Total	**2,591**	**Total**	**2,591**

Source: CITES, (2010)

Table 2 Export of ramin from 2007 to 2009 (January to November)

	2006	2007	2008	2009
Export quota (m^3)	22,000	12,875	3,178	3,178
Export volume (m^3)	12,161	10,434.31	3,063.09 (5,112.12)**	2,591
Export performance (%)		81.04	96.38	81.53

** including stockpile of year 2007
Source: (CITES 2010)

The reduction in ramin production over the years was also the result of decline in areas covered by PSF. Based on the 1995/1996 satellite images, 9.2 % or 1.13 million ha of Sarawak's land area was covered by the PSF. However, in 2002, the Landsat and SPOT data showed that 98.5 % of the PSF has been opened up for various purposes leaving only 18,920.45 ha relatively untouched (Wong 2002). From the total area opened up, 78,260 ha had been converted into plantation area. The total area converted into plantation was further increased to 389,483 ha in 2004 (figure provided by Sarawak Forestry Department GIS unit and reported by Lee 2005).

Due to the reduction in the PSF within permanent forest estate (PFE) and the decline in ramin production, Malaysia particularly Sarawak has been reported by Environmental Investigation Agency (EIA) and Telapak of being involved in smuggling and "laundering" of illegal Indonesian ramin to a number of importing countries, including the US and UK (Traffic 2004, EIA/Telapak 2004). Worse still, Malaysia had been accused of failing to carry out a proper non-detriment finding for ramin export and has no effective control in place on ramin harvesting (EIA/Telapak 2006). The Malaysian government through Malaysia Timber Council (MTC 2004) responded that the country does not condone any illegal trade in timber and has implemented various measures to combat the entry of illegal logs. In Sarawak, Section 96 (1) of Forest Ordinance 1954 includes the ban on export of ramin logs that was enforced in 1980, while ban on export of ramin shorts and squares, and restriction on export of ramin timber were implemented in 1991. In addition, the CITES export permit is required when exporting timber products produce from CITES-listed species (CITES 2010).

However, there could be cases in which traders circumvented CITES controls by providing false declaration of the species involved. Inspection of timbers is currently done based on wood anatomy which identifies timber into group and is generally not identified to species level and source of timber is not determined. In the case of ramin, the wood anatomy is very similar to *Alstonia*, *Antiaris* spp., *Brosimim aliscastrum*, *Dyera costulata*, *Endospermum* spp., *Chrysophyllum beguei*, *Jacaranda copaia*, *Neolamarckia cadamba*, *Pterygota* spp., *Simarouba amara* and *Terminalia superb*a.

The application of DNA profiling in human forensic and paternity proof has long been used. The same technique has also been applied in the identification of animals (Butler, 2005). Recently in Peninsular Malaysia, a study using chloroplast DNA proved that the geographical origin of *Neobalanocarpus heimii* can be traced (Tnah *et al.* 2009), and the comprehensive DNA profiling database developed for *N. heimii* can serve for the random match probability estimation of an illegal logging with its original stumps (Tnah *et al.* 2010).

Objective

The aims of the study are; (i) to develop a DNA database as initial stage to enhance efforts of tracing and tracking of *Gonystylus bancanus* timber, (ii) to estimate the genetic diversity of ramin populations in Sarawak, and (iii) to determine extents of genetic differentiation among populations that contribute to baseline information for the tracing and tracking system using DNA markers.

Methodology

Study sites and samples collection

Samples were collected from known geographical range of PSF in Sarawak (Figure 1). Peat swamp areas in the central part of Sarawak were not surveyed for this project because the areas have been earmarked for further development. A total of nine populations were sampled (Table 3) and at least 30 individuals were collected from each population, though few areas involved intensive search due to limited stand density remaining.

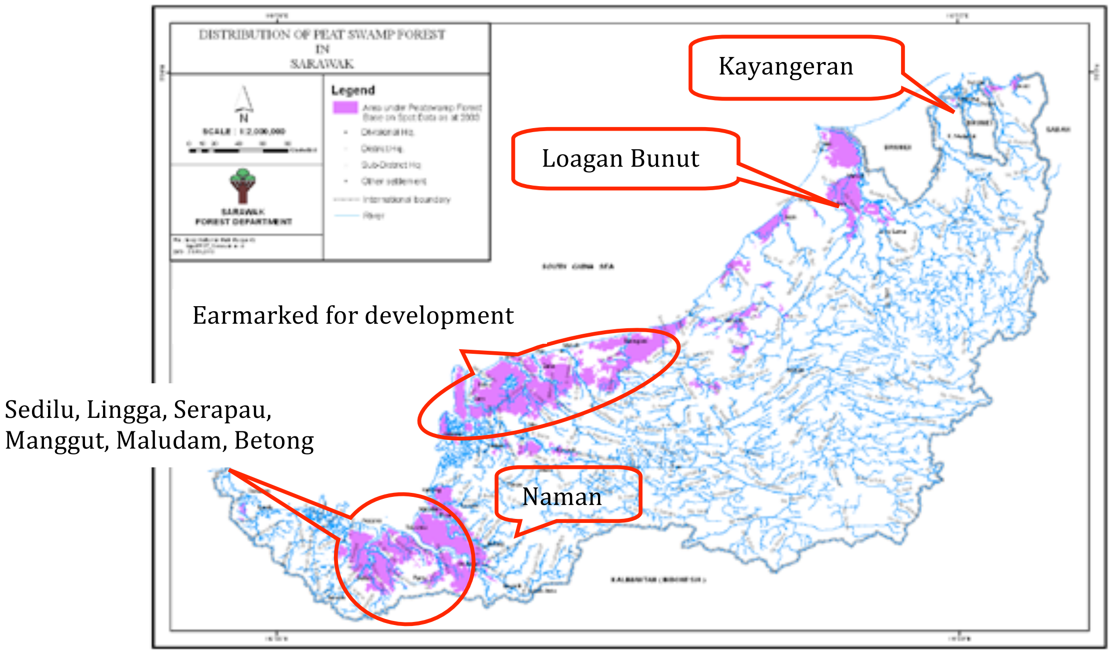

Figure 1 Distribution of PSF in Sarawak

Table 3 Surveyed populations and number of individuals sampled.

Population number	Locality	Nearest town	Latitude	Longitude	No. of individuals sampled
1	Sedilu	Simunjan	N01⁰22'	E110⁰49'	31
2	Lingga	Sri Aman	N01⁰21'	E111⁰10'	30
3	Serapau	Sri Aman	N01⁰19'	E111⁰12'	30
4	Loagan Bunut	Miri	N03⁰47'	E114⁰14'	101
5	Kayangeran	Lawas	N4°53'	E115°25'	29
6	Maludam	Sebuyau	N01°38'	E111° 03'	36
7	Manggut	Betong	N01°29'	E111° 16'	53
8	Betong	Betong	N01° 25'	E111° 23'	40
9	Naman	Sibu	N02°11'	E111° 50'E	55

DNA extraction

Genomic DNA was extracted using the prescribed method of Murray and Thompson (1980) with modification. 0.5 g of leaf or inner bark tissues were mixed with 5ml of preheated (65°C) CTAB extraction buffer (2% CTAB, 20mM EDTA, 100mM Tris-HCl, 4M NaCl, 1% PVP, 2% β-mercaptoethanol) in 15 ml tube and incubated at 50°C for 30 min. After incubation, equal amount of chloroform-isoamyl alcohol (24:1) was added and mixed gently. The mixture was centrifuged at 3500 rpm for 10 min. The aqueous layer was transferred into new 15 ml tube and the DNA was precipitated with 2/3 volumes of isopropanol. The mixture was pelleted by centrifuge at 3500 rpm for 5 minutes. Subsequently, the supernatant was removed and the DNA pellet was washed with 76% ethanol, left to dry and the DNA was redissolved in TE buffer. The DNA was further purified using High Pure PCR Template Preparation Kit (Roche Diagnostics).

PCR amplification and fragment analysis

PCR amplification was performed using Qiagen multiplex PCR in 8.0 μl reaction mixture, consisting of 2x Type-it multiplex PCR master kit. Eighteen microsatellite markers were utilised. The multiplex PCR was amplified using a GeneAmp PCR System 9700 (Applied Biosystem) at 95°C for 5 minutes initial denaturation, 35 cycles of 95°C for 30 seconds of denaturation, 50 to 57°C for 1 min 30 seconds annealing, 72°C for 30 seconds of extension, followed by final extension at 60°C for 30 minutes. The amplification product (1 μL PCR product) was combined with 9.9 μL of Hi-Di formamide (Applied Biosystems) and 0.1 μL of 400 HD Rox (Applied Biosystems) to form master mix for fragment analysis. The master mix was assigned against ABI 3130x1 Genetic Analyser System. The fragment data was edited and genotype profile created using GeneMapper ™ v3.7 software (Applied Biosystems).

Statistical analysis

Population variation within and among population was quantified by calculating the allele frequencies, mean number of alleles (MNA) per locus, observed heterozygosity (*Ho*) and expected heterozygosity (*He*) and polymorphic information content (PIC) with the Excel Microsatellite Toolkit software computer program. A number of polymorphic loci and allelic diversity have been shown to be reliable indicators of a genetic variation and can show the effect of bottlenecks and genetic drift (Nei 1978).

FSTAT, ver. 2.9.3.2 (Goudet 2002) was used to calculate the allelic richness, Ar (Petit *et al.* 1998), Wright's (1951) *F* statistics (*F*st, *F*is and *F*it) based on Weir and Cockerham's (1984) to determine the distribution of genetic variation within and among populations and *R*-statistics, Rst, (Slatkin 1995; Goodman 1997) calculation, to estimate a population differentiation. *F*it and *F*is measure heterozygosity of individual relative to the total population and its subpopulations, respectively; *F*st is a measure of genetic differentiation among populations. Cluster analysis based on genetic distances estimated from Nei's (1978) index of similarity was performed using Genetic Data Analysis (GDA) program. The population dendrograms were performed with the tree drawing software TreeView (Page 2001).

Results and Discussions

Genetic diversity

Table 4 Number of alleles per locus

Marker	Sedilu	Lingga	Serapau	Loagan Bunut	Kayangeran	Maludam	Manggut	Betong	Naman	Total
Gba082	19	20	21	16	8	20	22	23	24	32
Gba092	9	11	9	7	4	9	11	7	9	15
Gba100	11	6	9	5	4	10	10	10	12	18
Gba108	21	22	19	14	8	19	21	24	21	35
Gba129	14	15	14	11	10	12	15	16	17	25
Gba147	16	17	16	16	14	20	24	20	21	37
Gba175	2	2	3	2	2	2	2	2	3	3
Gba348	7	7	11	10	6	9	11	11	9	17
Gba430	13	13	11	11	7	11	11	12	18	20
WGb17	13	14	14	16	7	15	17	15	17	24
WGb22	12	11	11	6	2	10	14	11	11	15
WGb24	9	10	7	10	7	10	11	10	9	17
WGb29	12	15	14	9	4	14	15	19	17	27
WGb32	19	17	15	16	10	16	20	17	20	28
WGb37	6	6	6	5	6	6	7	7	7	9
WGb38	7	6	7	5	3	7	6	6	9	11
WGB39	8	8	6	4	4	6	6	7	8	11
Total	**207**	**206**	**200**	**168**	**109**	**202**	**227**	**222**	**239**	**356**

A total of 356 alleles were detected from 18 polymorphic loci (Table 4). The average number of alleles and allelic richness was relatively high for most populations except for Kayangeran (6.06 and 5.95, respectively) and Loagan Bunut (9.33 and 7.38, respectively) (Table 5). The average number of alleles over all populations was 10.99. Figure 2 shows examples of some observed alleles derived using GeneMapper ver 3.7 software. Polymorphic information content (PIC) was the lowest at Kayangeran (0.621) and the highest at Sedilu (0.76) (Table 5). Sixty seven of the 356 alleles detected occurred only in one of each of the population. Sedilu had 13 unique alleles that were not detected in other populations, Naman and Manggut had 9 unique alleles, while Lingga and Betong each had 8 unique alleles. Other populations had less than 7 unique alleles. These unique alleles are very informative used for population identification.

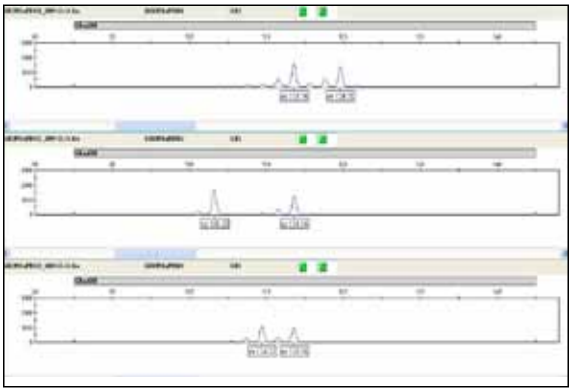

Figure 2 Example of some fragment data showing variable alleles size from three individuals of *G. bancanus*.

Observed and expected heterozygosities, *Ho* and *He* were generally high for all populations with no value less than 0.6. When all populations were compared together, Kayangeran and Loagan Bunut had the lowest value observed. On average, the expected heterozygosity was 0.766, which was within the range observed for other tropical species (refer Table 6). However, the values of *Fis* were significantly different from zero for three populations, an indication of inbreeding within population (refer Table 5). The value of measured genetic diversity at Kayangeran and Loagan Bunut are low, but this may be a function of sampling error. Because the trees at both sites grow in a clump, most of the samples were collected from trees less than 10 m apart from one another. Sedilu, Manggut and Naman had high value of genetic diversity but these populations had significant departure from Hardy Weinberg Expectation, with a deficiency of heterozygotes.

Table 5 Estimates of genetic diversities for 9 populations of ramin based on 18 microsatellite loci. *N*, number of individuals sampled from the population; PIC, polymorphic information content; MNA, mean number of alleles; Ar, Allelic richness; *Ho*, observed heterozygosity; *He*, expected heterozygosity; SD, standard deviation; *F*is, Fixation index.

Pop	N	PIC	MNA	Ar	Ho(SD)	He(SD)	*Fis*
Sedilu	31	0.762	11.50	10.96	0.688(0.019)	0.803(0.036)	0.145*
Lingga	30	0.732	11.44	10.8	0.738(0.019)	0.770(0.039)	0.042
Serapau	30	0.738	11.11	10.66	0.747(0.019)	0.775(0.036)	0.037
Loagan Bunut	101	0.677	9.33	7.38	0.706(0.011)	0.719(0.032)	0.018
Kayangeran	29	0.621	6.06	5.95	0.655(0.021)	0.682(0.036)	0.039
Maludam	36	0746	11.22	10.34	0.748(0.017)	0.785(0.030)	0.048
Manggut	53	0.746	12.61	10.33	0.731(0.014)	0.782(0.034)	0.065*
Betong	40	0.748	12.33	10.67	0.745(0.016)	0.787(0.030)	0.053
Naman	55	0.761	13.28	10.96	0.752(0.014)	0.792(0.030)	0.052*
Mean		**0.725**	**10.99**	**9.78**	**0.723(0.016)**	**0.766(0.033)**	**0.056**

*Significantly different from zero (P<0.05).

Table 6 Genetic diversity parameters (expected heterozygosities) of other tropical tree species based on microsatellite studies.

Species	No. of samples	No. of Loci	No. of populations	He	Reference
Shorea curtisii	40	8	1	0.64	Ujino *et al.*, 1998
Shorea leprosula	173	7	1	0.70	Ng *et al.*, 2004.
Shorea ovalis	156	7	1	0.64	Ng *et al.*, 2004
Neobalanocarpus heimii	30	4	1	0.78	Konuma *et al.*, 2000
Dryobalanops aromatic	90	7	5	0.71	Lim *et al.*, 2002
Shorea macrophylla	32	2	1	0.75	Konishi *et al.*, 2004

Population differentiation

Table 7 Nei's (1978) genetic identity is above the diagonal, and Nei's (1978) genetic distance coefficients are below the diagonal

	Sedilu	Lingga	Serapau	Loagan Bunut	Kayangeran	Maludam	Manggut	Betong	Naman
Sedilu	-	0.9213	0.9120	0.7612	0.716141	0.92630	0.9033	0.8890	0.8612
Lingga	0.0818	-	0.9800	0.7668	0.660457	0.98033	0.9829	0.9567	0.8849
Serapau	0.0921	0.0201	-	0.7505	0.629940	0.96877	0.9775	0.9517	0.8968
Loagan Bunut	0.2727	0.2655	0.2869	-	0.843882	0.77430	0.7575	0.8010	0.8488
Kayangeran	0.3338	0.4148	0.4621	0.1697	-	0.66920	0.6595	0.7176	0.7261
Maludam	0.0765	0.0198	0.0317	0.2557	0.401670	-	0.9768	0.9707	0.8997
Manggut	0.1016	0.0171	0.0226	0.2777	0.416145	0.02338	-	0.9685	0.8834
Betong	0.1176	0.0441	0.0494	0.2218	0.331823	0.029686	0.0319	-	0.9080
Naman	0.1494	0.1221	0.1088	0.1639	0.319942	0.1055	0.1239	0.0964	-

Genetic identity and distances differed among populations (Table 7). The genetic identity (Nei 1978) ranged from 0.629940 between Kayangeran and Serapau to 0.982971 between Manggut and Lingga. The results show that the populations are divided into at least two geographical regions. Populations from the same geographical region such as Serapau, Maludam, Lingga, Betong, Sedilu and Manggut have high values of more than 0.9. Similarly, when UPGMA cluster analysis derived based on Nei's genetic distance the populations were clustered into two, namely the west cluster consisting of Naman, Sedilu, Betong, Maludam, Serapau, Lingga and Manggut, and the east cluster consisting of Loagan Bunut and Kayangeran (Figure 3). However it seems that the west cluster was further separated and positively related to geographical location when Lingga, Serapau, Manggut, Maludam and Betong populations showed short genetic distance. The shortest genetic distance was Manggut and Lingga. The five populations were connected through Lupar Rivers. Similar results were obtained when cluster analysis was conducted using structure software ver. 2.3 computer program (Figure 4).

To determine if populations were significantly distinguishable from each other, the pairwise comparisons of populations was performed. Based on the *Fst* values, the populations were significantly differentiated ($P<0.05$) from each other except for Manggut, Serapau, Lingga and Maludam. The *Fst* values ranged from 0.0042 between Lingga and Manggut to 0.0939 between Sedilu and Kayangeran (Table 8). The low value of *Fst* observed between Lingga and Serapau, Lingga and

Maludam, and Lingga and Manggut indicated that they are similar to each other and is more likely that gene flow would occur along the watercourse.

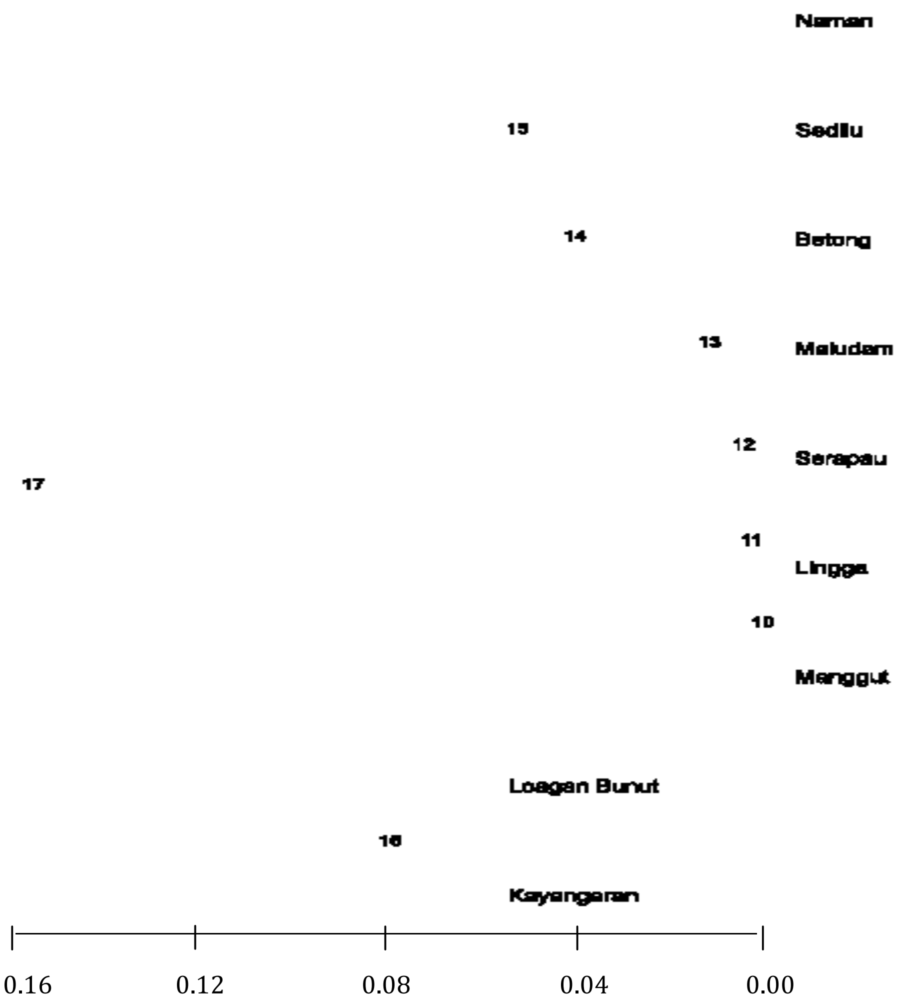

Figure 3 Dendrogram of genetic distance between populations based on UPGMA generated using GDA

Table 8 Genetic differentiation, as estimated by Fst distance among the analysed populations.

	Sedilu	Lingga	Serapau	Loagan Bunut	Kayangeran	Maludam	Manggut	Betong	Naman
Sedilu	0.0000								
Lingga	0.0200	0.0000							
Serapau	0.0220	0.0052	0.0000						
Loagan Bunut	0.0753	0.0768	0.0811	0.0000					
Kayangeran	0.0939	0.1155	0.1234	0.0619	0.0000				
Maludam	0.0176	0.0050	0.0081	0.0729	0.1096	0.0000			
Manggut	0.0240	0.0042	0.0056	0.0773	0.1113	0.0057	0.0000		
Betong	0.0268	0.0116	0.0127	0.0649	0.0951	0.0072	0.0080	0.0000	
Naman	0.0332	0.0307	0.0271	0.0502	0.0908	0.0256	0.0301	0.0234	0.0000

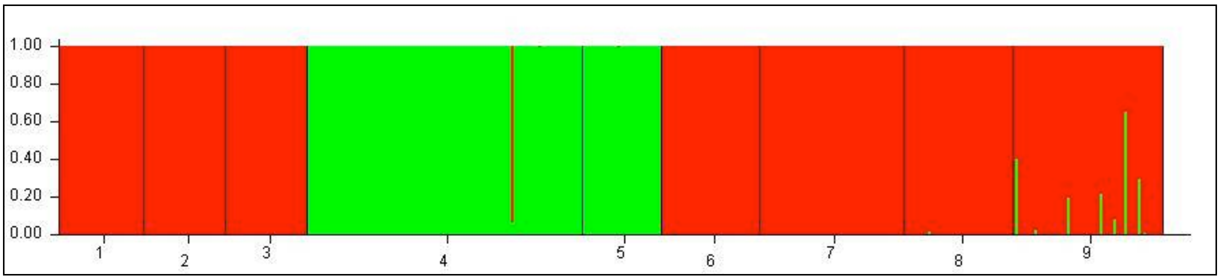

Figure 4 Cluster of population based on Structure ver. 2.3. Population divided into two clusters: Red and Blue. Population 1: Sedilu; 2: Lingga; 3: Serapau; 4: Loagan Bunut; 5: Kayangeran; 6: Maludam; 7: Manggut; 8: Betong and 9: Naman.

Conclusions

The effectiveness and efficiency of microsatellite markers to evaluate genetic diversity and population differentiation demonstrated that microsatellite markers are useful for the development of DNA database for ramin. The unique alleles detected in specific populations and signification populations differentiation revealed by cluster analysis and *Fst* value indicated that microsatellite markers could be used for population identification. Thus, microsatellite markers are suitable to generate DNA database for individual timber identification and useful for tracking of wood in chain of production (Tnah *et al.* 2010; Koopman & Diemont 2004; Smulder *et al.* 2008). However, the use of microsatellite markers for identification should not be based on a limited number of markers but on many loci (Butler 2005). Furthermore, before a marker system can be introduced into forensic casework, a population database must be established for statistical evaluation of identity match proof (Tnah *et al.* 2010).

Recommendations

The current ramin DNA database was developed using leaves and bark samples. For actual timber species identification and tracing and tracking system, samples from wood must be tested. A new proposal entitled "Use of DNA for identification of *Gonystylus* species and geographical origin" has been submitted to ITTO for funding. The unique alleles detected in specific populations in Sarawak based on the 18 markers could be detected in other population outside Sarawak. Thus, the use of more microsatellite markers and sampling across all ramin populations to other states in Malaysia and neighbouring countries is important until population specific alleles detected. To implement this, support and commitment from respective countries, local government, policy makers and various NGOs are needed. Once the database is completed, only then it would be reliable in court proceeding to curb illegal logging in order to enhance the implementation of CITES legislation/regulations in this region.

Acknowledgements

This work was made possible by a grant from ITTO under its collaborative program with CITES to build capacity for implementing timber listings. Donours to this collaborative program include the EU (primary donour), the USA, Japan, Norway, New Zealand and Switzerland. The roles played by the Ministry of Natural Resources and Environment, Malaysia (NRE) as the executing agency, as well as FRIM and the forestry departments in Malaysia as implementing agencies of the ITTO-CITES project are also greatly appreciated.

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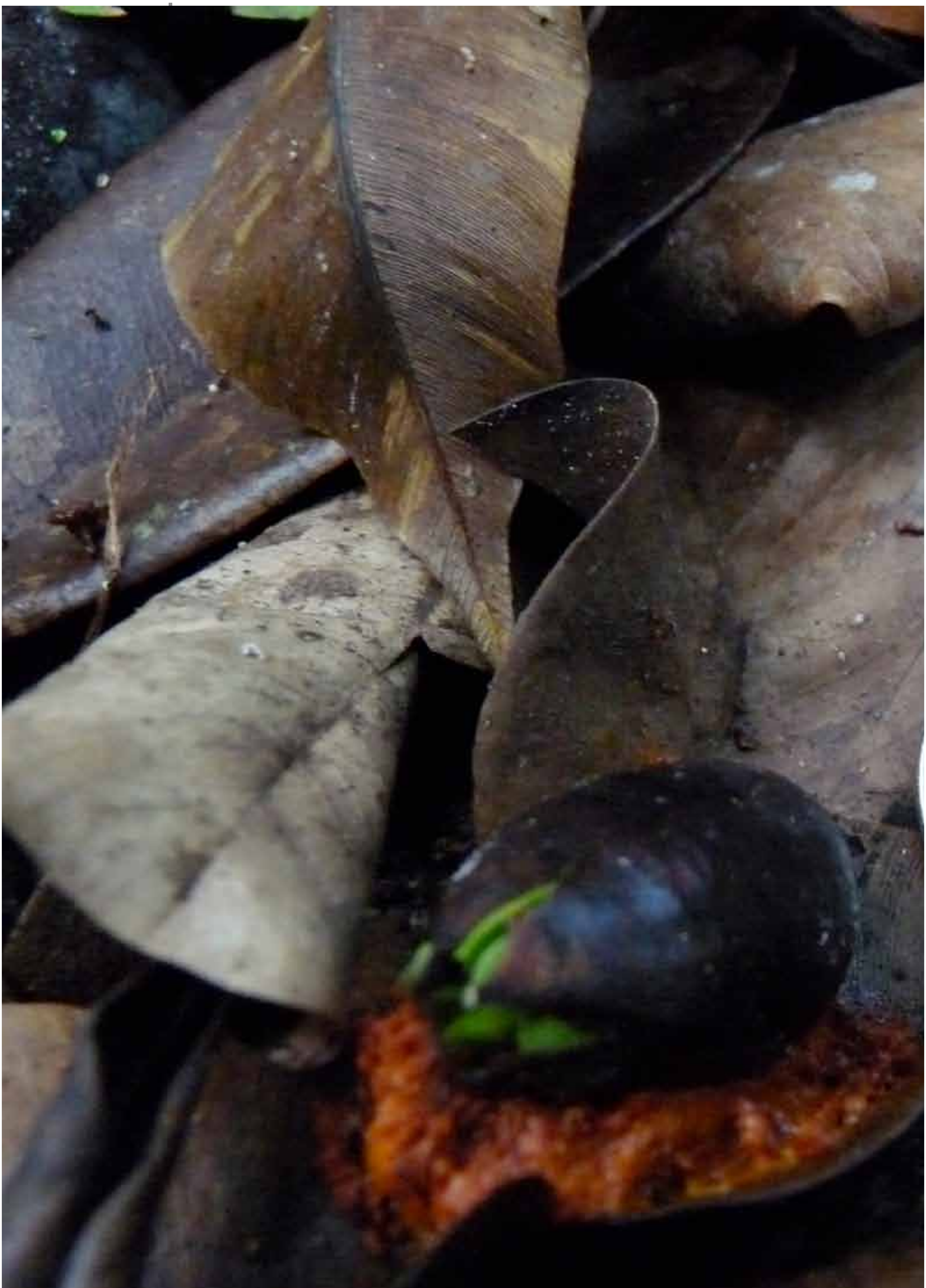

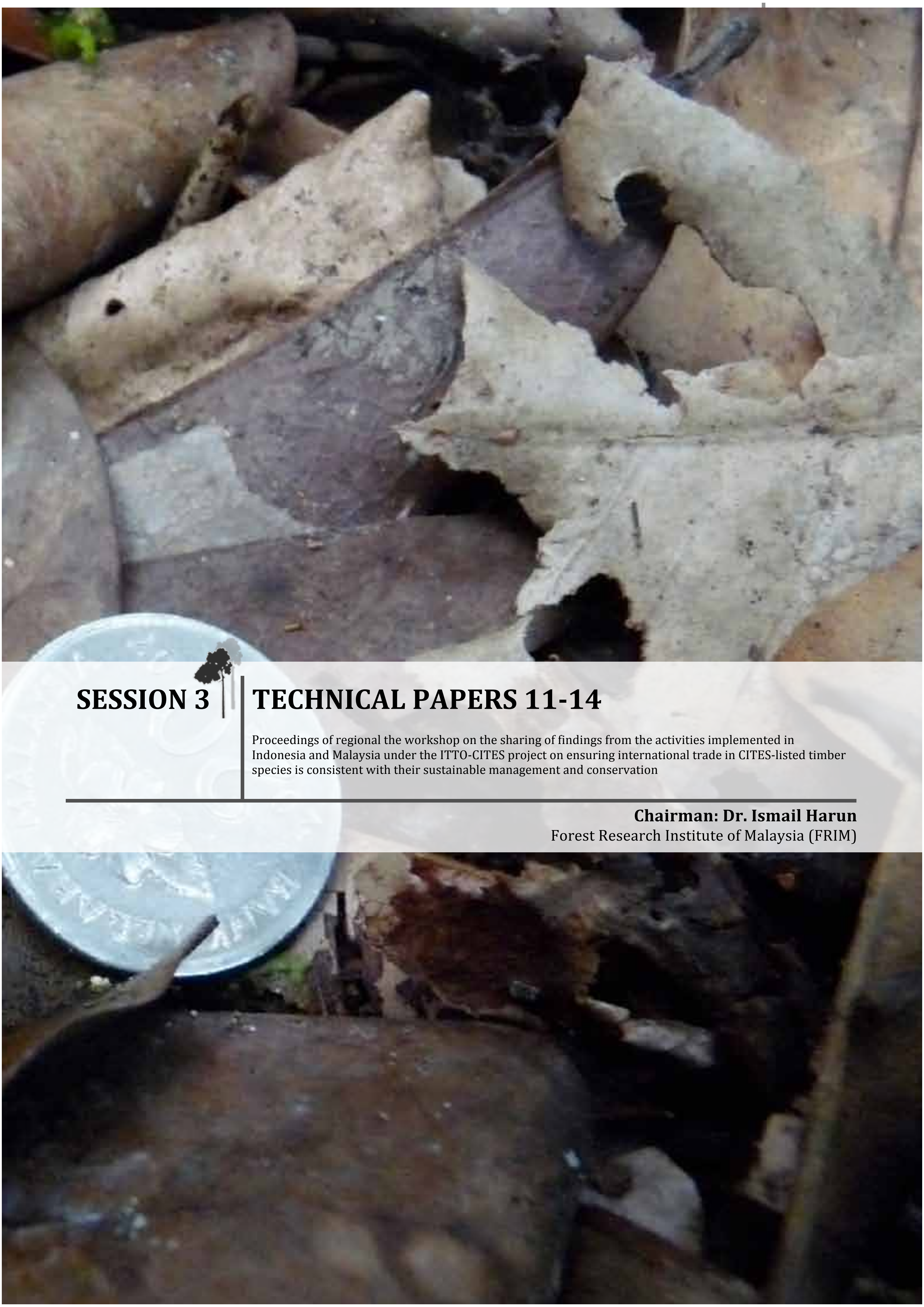

SESSION 3 | TECHNICAL PAPERS 11-14

Proceedings of regional the workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Chairman: Dr. Ismail Harun
Forest Research Institute of Malaysia (FRIM)

TECHNICAL PAPER 11 REVIEW ON RAMIN HARVEST AND TRADE CITES COMPLIANCE, TRI-NATIONAL TASK FORCE ON TRADE IN RAMIN, TRADE CONTROL AND MONITORING

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Abstract The activity is expected to contribute to improved management of ramin through the formulation of a roadmap towards sustainable forest management and conservation, improved implementation on CITES, more effective mechanism in tackling illegal trade, and improved trade control and monitoring. The overall objective of the inclusion of species into CITES Appendix is to ensure the sustainable management and conservation of the species through international trade regulation. The regulation includes the requirement that the harvest is not in contravention with national rules and regulation, and the harvest does not cause detrimental effect on the survival of species, population and habitat. Theoretically, the determination of harvest quota is aimed to minimise the detrimental effect caused by the harvest. Understanding the basis for the inclusion of species into CITES Appendix, determination of harvest quota and Non-Detriment Finding (NDF) is still limited for most field officers of the CITES management authority and other relevant stakeholders such as plant quarantine, customs officers, and the officers of Customs and Excise offices. This activity is intended to improve capacity of both institutional and human resources in order to enhance the sustainable forest management (SFM). It also intends to conserve ramin through the establishment of ramin roadmap for the management, the implementation of CITES rules and regulation, trade control and monitoring. Moreover, monitoring on harvest and trade is weak, resulting in poor statistical data presentation and accuracy. In order to improve monitoring on ramin international trade, either legally or illegally, and also to enhance data exchange to reduce illegal trade to the neighbouring countries, Indonesia, Malaysia and Singapore established a regional forum. The Tri-National Task Force on Trade in Ramin – formed in 2003 - is scheduled to have annual meeting in the member countries. Since 2006, the meeting of the Task Force has been temporarily suspended until there is a new insight to demonstrate that the Task Force will be contributing significantly to combat illegal logging and trade of ramin. Other issues may also include poor trade monitoring and tracking system not only for ramin, but also for other CITES-listed species. The poor trade monitoring has also resulted in data variation and inconsistency which will have implication to forest management, taxes and revenue. A National Workshop held on 24 July 2007 on the evaluation of CITES implementation has also questioned the pricing of ramin for both domestic and international trade. This paper recommends that a closer look on data collection mechanism, monitoring and export control of forest products, including ramin be carried out.

Introduction

The overall objective of the inclusion of species into CITES Appendix is to ensure the sustainable management and conservation of the species through international trade regulation. The regulation includes the requirement that the harvest is not in contravention with national rules and regulation and the harvest does not cause detrimental effect on the survival of species, population and habitat. Theoretically, the determination of harvest quota is aimed to minimise the detrimental effect caused by the harvest. Understanding the basis for the inclusion of species into CITES Appendix, determination of harvest quota and Non-Detriment Finding (NDF) are still limited for most field officers of the CITES management authority and other relevant stakeholders such as plant quarantine, customs officers and the officers of Customs and Excise offices. This proposed activity is intended to improve capacity of both institutional and human resources in order to enhance the SFM and conservation of ramin through the establishment of a roadmap for the management, the implementation of CITES rules and regulations, trade control and monitoring of ramin.

Moreover, monitoring on harvest and trade is weak, resulting in poor statistical data presentation and accuracy. In order to improve the monitoring on ramin international trade, either legal or illegal, and also to enhance data exchange to reduce illegal trade to the neighbouring countries, Indonesia, Malaysia and Singapore established a regional forum since 2003/2004, known as the Tri-National Task Force on Trade in Ramin. The Task Force is scheduled to have its annual meeting in the member countries. In 2006/2007, the meeting of the Task Force has been temporarily suspended until there is a new insight to demonstrate that the Task Force will be contributing significantly to combat illegal logging and trade of ramin. Other issues include poor trade monitoring and tracking system not only for ramin, but also for other CITES-listed species. The poor trade monitoring has also resulted in data variation and inconsistency which has implication to forest management, taxes and revenue. The National Workshop held on 24 July 2007 on the evaluation of CITES implementation has also questioned the pricing of ramin for both domestic and international trade. This Workshop recommended that a closer look on data collection mechanism, monitoring and export control of forest products, including ramin, be carried out. This Activity is therefore proposed to address the above issues, with specific focus on ramin.

Objective

The main objective of the activity is to contribute to the sustainable forest management and conservation of ramin through the improvement of CITES implementation, enhancing regional cooperation and improving trade data monitoring.

Overview

Indonesia has received financial assistance from ITTO-CITES project and in-kind contribution from Ministry of Forestry to execute one main Activity entitled Review on Ramin Harvest and Trade: CITES Compliance, Tri-National Task Force on Trade in Ramin, Trade Control and Monitoring, which consist of some sub activities as listed below:

a. Output 1. A roadmap for SFM and conservation, and CITES trade compliance system
   - Activity 1.1. Establish a roadmap towards the sustainable management and conservation on ramin
   - Activity 1.2. Strengthen CITES trade compliance system through dissemination of CITES rules and regulation on the listing of ramin and other plant species

b. Output 2. Review on the effectiveness of the regional forum to combat illegal trade, including ramin
   - Activity 2.1. Closer look at the Terms of Reference (TOR) of regional forum (Tri-National Task Force on Trade in Ramin) by Indonesia
   - Activity 2.2. Facilitate active communication (including informal meeting) with Malaysia and Singapore on the possibility to resume the work of the Tri-National Task Force on Trade in Ramin with improved or revised TOR.

c. Output 3. Improved trade data collection, monitoring and trade control
   - Activity 3.1. Review on trade data collection, monitoring and trade control
   - Activity 3.2. Verification workshop on trade data collection, monitoring and trade control.

The expected achievements

The expected achievements after activity completion are as follows:

1. More direct and effective efforts toward the achievement of SFM and conservation through a roadmap;
2. Improved capacity in CITES compliance systems;
3. Improved effectiveness of the Tri-National Task Force;
4. Improved trade control and monitoring; and
5. Improved, more accurate and consistent data presentation

Implementation Progress

Establish of a roadmap towards the sustainable management and conservation of ramin

A national expert from FORDA, Ir. Tajudin Edy Komar, was hired to implement this activity in August. The TOR includes preparation and submission of a draft technical report ("Roadmap toward the sustainable management and conservation of ramin). The roadmap is aimed to provide guidelines and direction towards the achievement of sustainable management and conservation of ramin by strategic intervention and action plan. The final report is expected to be completed by December 2010, after being presented and discussed in three consecutive meetings attended by Project staff and TAC as well as other related parties and NGOs in September - November.

Strengthen CITES trade compliance system through dissemination of CITES rules and regulations on the listing of ramin and other plant species

The activity includes capacity building through a training workshop on CITES trade compliance system through dissemination of CITES rules and regulations on the listing of ramin and other plant species. To support part of the workshop material, two national experts, Dr. Tukirin from Research Centre for Biology, Indonesia Institute of Science and Faustina Ida Hardjanti from CITES management authority, prepared and submitted a draft technical report ("CITES trade compliance system through dissemination of CITES rules and regulations on the listing of ramin and other plant species").

The final draft report was submitted in December. The presentation and a discussion meeting were attended by Project staff and TAC as well as other related parties and NGOs in October. The meeting had also discussed the design of the Training Workshop. The Training workshop will be conducted in Riau Province on 26-27 December. The Training workshop will involve CITES management authority officers, CITES scientific authority, the logging company, plant quarantine officers, customs officers and other related stakeholders.

Closer look at the Terms of Reference (ToR) of regional forum (Tri-National Task Force on Trade in Ramin) by Indonesia

Two national experts from CITES management authority, Trio Santoso and Nunu Anugrah reviewed, prepared and submitted a draft technical report (the Terms of Reference (ToR) Analysis of Regional Forum (Tri-National Task Force on Trade in Ramin) by Indonesia). The review aims to evaluate the TOR of Regional Forum from Indonesian point of view. The final draft report was submitted in December. It was presented and discussed in three consecutive meetings attended by Project staff and TAC as well as other related parties and NGOs in September - November.

Facilitate active communication (including informal meeting) with Malaysia and Singapore on the possibility to resume the work of the Tri-National Task Force on Trade in Ramin with improved or revised ToR.

This activity includes a workshop to discuss the findings from activity 2.1 with inputs from Malaysia and Singapore. The workshop will be conducted on 11th January 2011 in Jakarta to give Malaysia and Singapore to review the Indonesia report.

Review on trade data collection, monitoring and trade control

A national expert from CITES management authority, Puja Utama prepared and submitted a draft technical report (trade data collection, monitoring and trade control). The report aims to provide complete database related to ramin trade compiled from related authorities. The final draft report was submitted in December. It was presented and discussed preliminarily in a meeting attended by Project staff and TAC as well as other related parties and NGOs in October-November.

Verification workshop on trade data collection, monitoring and trade control

This activity includes a workshop to verify the findings from related activity. The workshop will be conducted on 23rd December 2010 at Jakarta by involving CITES management authority, BRIK (Forest Industry Revitalization Board), customs, NGO's, Directorate of Investigation and Forest Protection, Directorate General of Forest Utilisation and other related stakeholders.

Critical Analysis of project progress

MoU between ITTO and the Indonesian Government was signed in April and the project was first planned to be implemented for a period of 12 months. However, we were informed that all activities funded by the EU have to be completed by December 2010. Therefore the first two months were focused on revision of budget and a six-month work plan, preparation of ToR and contracts, etc. All activities started in August and many are one to two months behind schedule.

Conclusions

Considering the changes in work plan and tighter schedule, the project progress was initially thought to be delayed. However, all drafts were completed and related workshops scheduled, hence outputs will be fully accomplished by the end of December 2010. The exception would be the Regional Workshop on the Work of the Tri-National Task Force on Trade in Ramin that needs extension to give sufficient time for Malaysia and Singapore to look at the draft report of Indonesia.

TECHNICALPAPER 12 SAWN TIMBER AND PLYWOOD RECOVERY STUDY OF RAMIN (*GONYSTYLUS BANCANUS*) IN PENINSULAR MALAYSIA

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Abstract Malaysia is one of the largest exporter of logs and sawn timber and a major exporter of other products, such as plywood and other wood-based panels, wooden furniture, builders' carpentry and joinery (BCJ), and mouldings. The sawmilling sector is the largest and oldest wood processing industry in Malaysia. The government has expected a further reduction in output from the natural forest by 2020 and substitutes from forest plantation is planned, thus affecting the nature of the wood-based industries in Malaysia. However, ITTO (1997) has forecasted that Malaysia, principally, Peninsular Malaysia, is already an importer of hardwood logs. This trade will grow over time with most of the processing are for meeting domestic consumption or for further processing into value-added products. As resource scarcity becomes more and more severe, the sawmills, especially in Peninsular Malaysia, will have to undergo restructuring to compete with composite board plants, such as those involved in the manufacturing of medium-density fibreboard (MDF) and chipboard. There is a need for sawmills to maximise their processing recovery rates as the size of timber for the next decade will also be reduced. The objectives of the proposed activities are (i) to determine the recovery rate of ramin logs for the manufacture of sawn timber, and (ii) to develop a technique for quantifying wood waste from sawmilling production. The expected outputs from the proposed activities are (i) improved recovery rate and maximised utilisation of ramin timber; and (ii) calculation of the quantum of wood waste for estimating the recovery rate of ramin log in the production of sawn timber.

Introduction

Gonystylus bancanus (ramin) is one of three genera of plants in the *Gonystylus* sub-family of Thymelaeaceae family. At present, the genus *Gonystylus* - consisting of about 30 species of tall trees and some shrubs - is distributed throughout the Malesian area (Indonesia, Malaysia, the Philippines, Papua New Guinea, Singapore and Brunei Darussalam) with the majority of species found in Borneo, but with the exception of central and east Java, and the Lesser Sunda Islands (Soerianegara & Lemmens, 1994).

It was found that most of the seven species of ramin in Peninsular Malaysia grow in the inland dipterocarp forest, except for *G. bancanus* that can be found in the PSF. The Forestry Department Peninsular Malaysia (FDPM) found that the stocking of *Gonystylus* spp. for trees >15cm diameter at breast height (dbh) in Peninsular Malaysia, on average, has 1-3 stems ha^{-1} in all forest types, while for dry inland forest the tree stocking is <1 stem ha^{-1} (Anon 2008). Even though ramin species is widely distributed in Peninsular Malaysia, there is no guaranteed that the logs supply will increase. Furthermore, with increasing demand for timber, certain species, such as ramin has been subjected to over-harvesting and thus the long-term sustainable production of the timber is at risk. Table 1 indicates that the production of ramin had fluctuated over the years. As such, the industries need to adapt with greater efficiency in managing the timber resources, especially in the wood processing sector. Efficiency of the mills can be assessed in three ways, namely, log conversion efficiency (recovery rate), labour productivity and mill capacity utilisation.

Table 1 Ramin log production by year (m^3)

Year	Pen. Malaysia	Pahang	Terengganu	Johor
2006	15,939	9,688	817	97
2007	18,231	15,819	302	118
2008	6,892	5,484	0	12
2009	4,976	4,353	69	40

Source: Forestry Statistics Peninsular Malaysia, FDPM.

In 2009, there were 372 sawmills in operation in Peninsular Malaysia and mainly in the state of Perak (74), followed by Pahang (65) and Terengganu (15.7%). Production of sawn timber from the natural forest had shown a decrease from 4.7 million m^3 in 2006 to 3.7 million m^3 in 2009, mainly due to lower supply of logs. Pahang is the major producer for logs with a total 5.3 million m^3 for the period of 2006-2009. In contrast, forest revenue collected for the same period shows increment from RM315 million to RM321 million. The three major contributors for the collection are Pahang with RM81 million, Kelantan (RM64 million) and Terengganu (RM41 million).

There are many factors that affect the recovery of sawn wood from the log:

i. log quality
ii. log size
iii. cutting patterns
iv. species characteristics
v. machine types, and
vi. log deck

Recovery rates vary with local practices as well as species. After receiving the logs, about 12% is waste in the form of bark. Slabs, edgings and trimmings amount to about 34% while sawdust constitutes another 12% of the log input. After kiln-drying the wood, further processing may take place resulting in another 8% waste (of log input) in the form of sawdust and trim ends (2%) and planer shavings (6%). For calculation purposes, a yield factor of 50% was used (38% solid wood waste and 12% saw dust). Currently, there are about 30 sawmills which use ramin as their main raw materials for timber processing. Three (3) sawmills were selected for the study from the states of Johor, Pahang and Terengganu.

a. The volume of log is determined using the formula:

Gross volume of logs $V= 0.3927 \times (D^2 + d^2) \times L \times F$……………………..(1)

where,

V = Log volume in m^3
D = Average diameter of large end of log in cm
d = Average diameter of small end of log in cm
L = Length of log in m
F = Conversion factor 10^{-4}

b. Defects of log such as split, knots, and hollow heart is estimated using the formula:

$Vd= 0.3927 \times (Dd^2 + dd^2) \times L\ \ F$……………………………...………………(2)

where,

Vd = Volume of decay in m^3
Dd = Average diameter if decay of large end in cm
dd = Average diameter if decay of small end in cm
L = Length of hollow heart in meter
F = Conversion factor, 10^{-4}

c. During the break down process, every piece of sawn timber produced is counted, measured and recorded using the formula:

$Vg= L \times T \times W \times F$………………………………………….......……..……………..(3)

where,

Vg = Volume green in m^3
L = Length of sawn timber in m
T = Thickness of sawn timber in cm
W = Width of timber in cm
F = Conversion factor, 10^{-4}

d. Total sawn timber yield from each log is the sum of the green volume of all pieces of sawn timber from each log. The percentage of recovery will then be calculated using the formula:

Recovery rate: $\sum Vg / V \times 100$.. (4)
where,
Vg = Volume of sawn timber in m^3
V = Log volume in m^3

e. To determine the volume of saw dust removed, the following formula is used:

Total volume saw dust:
Total adjacent board kerf volume + Total kerf adjacent of edging volume.
Thus, the total coarse residue will be:
Gross volume of log – Total volume of sawn timber – Total volume of saw dust.

Objectives
The activities were carried out in three (3) states; Pahang, Terengganu and Johor. The objectives of the project are as follows:

i. To determine the recovery rate of ramin logs for the manufacture of sawn timber, and
ii. To develop a technique for quantifying wood waste from sawmilling.

Problems to be addressed
The wood-based industries require a regular and easy access to raw materials, especially logs. However, there is a rising concern on the long-term availability of this resource. To sustain the development of the industries, knowledge regarding important species, such as ramin (*Gonystylus bancanus*) need to be carried out. General observations have indicated that processing of logs resulted in a high degree of waste. The waste comprises small, short-sized residual and saw dust. It is necessary to reduce this waste by having higher recovery during log processing. Furthermore, inefficiencies in wood processing had led to large economic losses, which could be linked to the unwise use of natural forest. Improving the efficiency of sawmilling could contribute to more efficient management of the natural forest.

Target beneficiaries
At the completion of the project, the results will assist the various sawmill operators, as well as the relevant agencies, to address the issue of low supply and wastage of ramin timber incurred during sawmilling production.

Risks
The only risk in implementing the activity is the unwillingness of the selected sawmills to be involved in the study. However, this is only a perceived risk as all sawmills in Malaysia are licensed by the respective state forestry departments.

Outputs
The expected outputs of the project are improvement of the recovery rate and maximised utilisation of ramin timber, and calculation of the quantum of wood waste for estimating the recovery rate of ramin log in the production of sawn timber.

Activities
i. Output 1.1 - Improvement of the recovery rate and maximise the utilisation of ramin timber.
    a. Documentation and procedure to appoint consultant(s).
    b. Acquisition of equipment, such as vernier callipers, tapes, diameter tapes, paints, data logger and other related hardware.
    c. Inventory work in the field.

ii. Output 1.2 - Calculation of the quantum of wood waste for estimating the recovery rate of ramin log in the production of sawn timber.
    a. Documentation and reports.

Study Progress

The project is carried out over a period of 52 weeks (12 months) starting 1st October 2010 with assistance from the local university. To date, the study is still at the stage of data collection. However, initial observation shows that the recovery rate is about 80% (log to sawn timber at mill) and the major proportion of wastage is from the off cut, estimated at about 15%.

Conclusions

The study will enhance information and method of quantifying the recovery rate and wastage in the sawn timber production. The information and knowledge gain in the study will support efforts needed to improve mill efficiency. Higher recovery rate and lower wastage will also contribute to better management and conservation of ramin species.

Acknowledgements

This work was made possible by a grant from ITTO under its collaborative program with CITES to build capacity for implementing timber listings. Donours to this collaborative program include the EU (primary donour), the USA, Japan, Norway, New Zealand and Switzerland. The roles played by the Ministry of Natural Resources and Environment Malaysia (NRE) as the executing agency, as well as FRIM and the forestry departments in Malaysia as implementing agencies of the ITTO-CITES project are also greatly appreciated.

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TECHNICAL PAPER 13 CONSERVATION AND ESTABLISHMENT OF RAMIN (*GONYSTYLUS BANCANUS*) GENEPOOL

Endang Savitri[1], Tajudin Edy Komar[1] & Rusmana[2]
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[2]Researcher of Forest Research Institute of South Kalimantan, Banjarbaru, South Kalimantan

Abstract Ramin (*Gonystylus bancanus*) - one of more than 30 *Gonystylus* species - with a vulnerable status is facing a high risk of extinction in the wild. Its natural habitat is peat swamp forest areas in Sumatera (eastern coast of Riau, Jambi and South Sumatera) and Kalimantan (West and Central Kalimantan). Due to its critical status and problems in artificial regeneration, Forest Research Institute (FRI) Banjarbaru with ITTO Project carried out two studies: plantation trials since 2008 under ITTO project and the establishment of gene pool in 2010 under ITTO-CITES Project. The research sites are in Tumbang Nusa Forest Research Station, Central Kalimantan. For the plantation trials, different strip planting methods were used to study the response of ramin to light intensity (shade intensity). The result showed that the seedlings were very sensitive to light intensity (shade). With a four-meter-wide strip, the seedlings tended not to survive (high mortality) compared to those planted in a two-meter-wide strip. This indicated that too strong an intensity was not suitable for ramin planting in this site. The gene pool activity was developed to conserve ramin genetic resources and to support the provision of stem cutting for propagation of planting materials. The flowering and fruiting seasons are unreliable and difficult to predict, therefore vegetative propagation is the best solution. The materials for genepool were collected in the form of wildings in the vicinity of Teluk Umpan and Lahei, Central Kalimantan. The wildings were separated according to the source. The wildings were planted from May to July 2010 and data collection is still in progress. FRI Banjarbaru will continue with the studies and records data for analysis.

Introduction

Ramin (*Gonystyllus bancanus* (Miq.) kurz) is one of the timber species from Thymelaeaceae that grows naturally in pear swamp forest areas (Soerianegara & Lemmens, 1994) in Sumatera (east coast of Riau, Jambi and South Sumatra) and Kalimantan (West and Central Kalimantan). Various disturbances had led the population of certain species within this genus to face high risk of degradation and extinction. Species within this genus have been listed in Appendices II and III of CITES (Anon 2004; FORDA and ITTO 2009). Heavy exploitation is not the only factor that causes ramin to extinct; other significant factors are land use change, encroachment and repeated forest fire. Many ramin species are slow growing species with relatively poor flowering and fruiting. Predators like monkeys, squirrels and rats also contribute to poor production of ramin seeds and planting materials.

According to Muin (2009), ramin is also threatened by land clearing and illegal logging activities. In most cases in Sumatera and Kalimantan, land clearing by burning is also reported as activity that worsened the existence of ramin seeds and seedlings in its natural habitat. These problems make relatively difficult to apply enrichment planting in their degraded stands and artificial plantation in other areas. The only areas for collecting seeds and wildlings are in the national parks and some forest stands in Sumatra and Kalimantan (Sidiyasa *et al.* 2007), such as Sebangau National Park and Lahei (Mentangai sub district, Kapuas, Central Kalimantan).

Since the existence of ramin is important, there should be real action to improve the status of ramin. Forest Research Institute of South Kalimantan (FRI) Banjarbaru in Tumbang Nusa Forest Research Station, Central Kalimantan has carried out two field activities: the establishment of field plantation trial since 2008 (under PD 426/06 Rev. 1 (F)) and the initial establishment of gene pool in 2010 (under ITTO-CITES Project). The main purposes of these activities are to observe the effect of silvicultural treatments by planting in different light intensity and to rescue threatened genetic materials by pooling them into some relatively secure areas in Central Kalimantan. The main idea of these two studies is to conserve ramin from its extinction. Therefore, the activities chosen were plantation trial which consisted of setting up nurseries followed by planting and collecting genetic materials as much as possible for a clone bank. Although gene pool could be used as the starting point of a breeding strategy, at this stage conserving the genetic materials is the priority. Physical establishments were recently completed in September 2010, where data and information will be continuously collected.

Objectives

The main ideas of these studies are to:

1. develop plantation technology

2. promote ramin conservation, and

3. rescue ramin genetic materials through plantation trials.

These would involve setting up nurseries until the establishment of the trials using different intensity of light and collecting genetic materials as many as possible for a clone bank and/or as sources of cutting for vegetative propagation.

Material and Methods

The gene pool establishment used wildings which were collected from Lahei, Mentangai and Teluk Umpan, Kapuas District, Central Kalimantan. Two locations for the gene pool were established: Sebangau National Park and Tumbang Nusa Research Station, both are in Central Kalimantan. Figure 1 shows the location of the gene pool's source. The spacing of the gene pool was 3 x 5 m in a strip, with 2 – 3 wildings per strip. Since the gene pool could be used as the starting point of a breeding strategy, wildings from each location were marked and planted in separate areas for identification.

Figure 1 The location of the gene pool's source

Results

The gene pool establishment was developed to conserve ramin genetic resources and to provide stem cuttings for propagation of planting materials. The gene pool was planted using bare root system and the leaves were trimmed to reduce evaporation.

The condition of ramin in this trial was good and the standard measurements are still being collected. The chosen planting and spacing went along with the observation done in the plantation trial. The wildings were planted straight from the field, without transit in the nursery. Rusmana (2010) suggested that older wildings are to be planted straight in the field to reduce failure of the wildings to acclimatise in the nursery. In addition, using a 3-m spacing will result in higher survival than a 4-meter spacing due to the sensitivity of young ramin to light intensity. The total number of wildings planted since May 2010 is as follows:

– Sebangau National Park: 2050 and 1386 wildings
– Tumbang Nusa Forest Research Station: 1560 wildings
– Tumbang Nusa Forest Research Station : 5000 wildings (will be used for hedge orchard)

Recommendations
It is too early to say that this is the best way to plant ramin, since the plantation trial is still at infancy. However, the establishment of a gene pool is a must and should be continuously maintained to ensure conservation of ramin genetic resources. Future activities being recommended are:

1. Continue collecting genetic materials from other locations in Central Kalimantan and explore the natural habitat of ramin in West Kalimantan.
2. Collecting genetic materials from the PSF in Sumatera.
3. DNA testing for future breeding strategy

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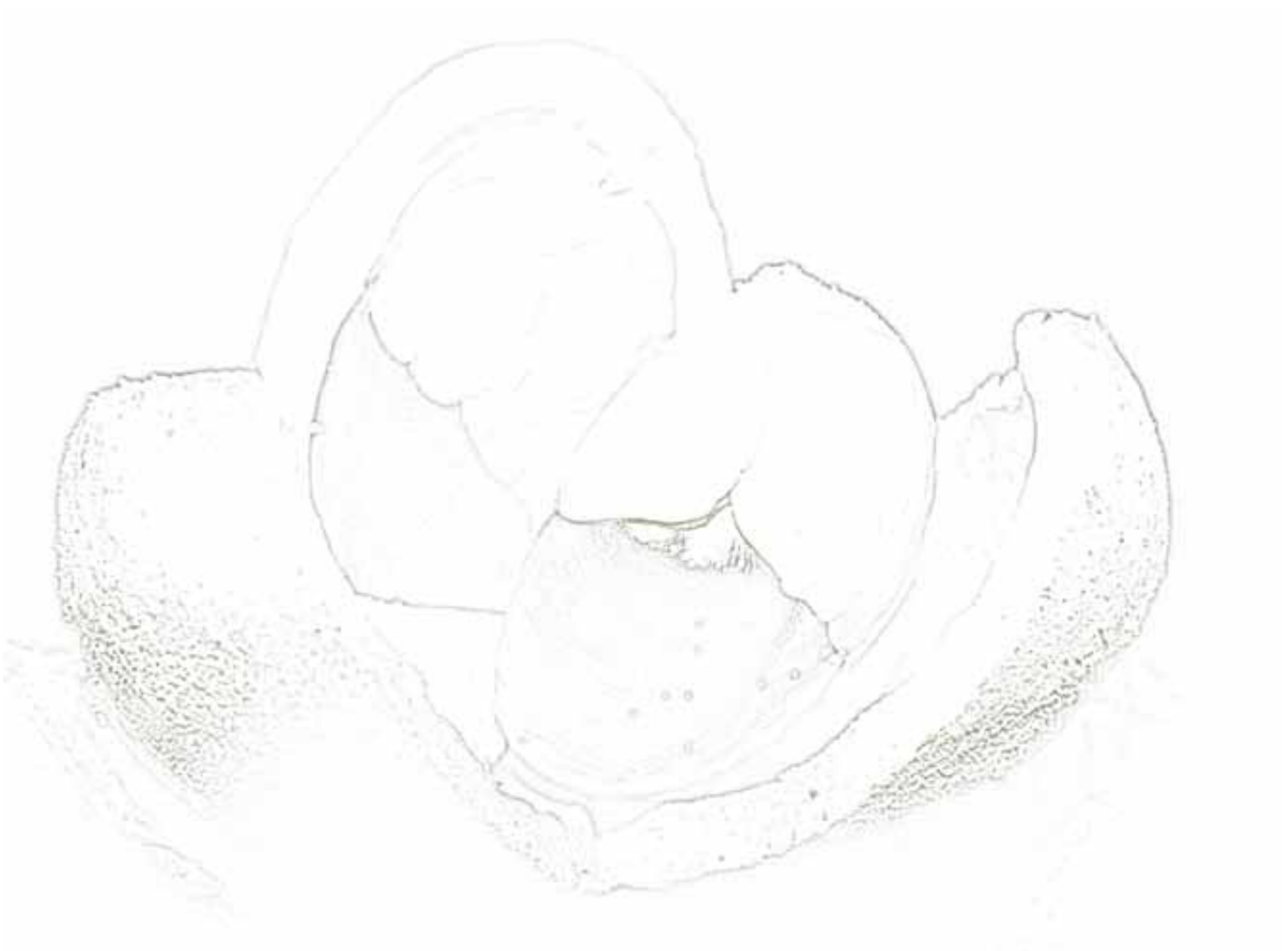

TECHNICAL PAPER 14 VEGETATIVE PROPAGATION OF RAMIN (*GONYSTYLU BANCANUS*) USING KOFFCO SYSTEM

Evalin Sumbayak & Tajudin Edy Komar
Forest and Nature Conservation Research and Development, Bogor

Abstract Ramin (*Gonystylus bancanus*) is known as commercial timber species growing naturally in peat swamp forest which now has limited natural distribution. Ramin is also a slow growing species and its seed production is irregular which causes scarcity of planting materials. The scarcity of planting materials has become critical problem in both natural and artificial regeneration. Some previous studies showed that vegetative propagation using stem cutting is one of the alternative sources of planting materials. The advantage of using vegetative is mass production of planting materials and independent of time and seeds. The production of planting materials in this study was by using Komatsu-FORDA Fogging Cooling System (KOFFCO). KOFFCO system works based on the control of light intensity (5,000 – 20,000 lux), temperature (<30 ^{0}C) and humidity (≥90 ^{0}C). The growth media used also influence the successful production of planting materials from stem cuttings. The growth media used were the mixtures of sterilised sands and local peat (2: 1). Rootone F was applied to the base of stem cutting to stimulate rooting. The percentage of rooting within 8 weeks was 88.9% and within 11 weeks, 96.8%. This method of vegetative propagation was considered successful to produce ramin planting materials through the use of stem cuttings.

SESSION 4 | WORKSHOP RESOLUTION

Sharing of Findings from the Parallel Session

Proceedings of the regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation

Chairman: Dr. Shamsudin Ibrahim
Forest Research Institute of Malaysia (FRIM)

WORKSHOP RESOLUTIONS

1. Introduction

The participants of the Workshop had deliberated and discussed various aspects concerning the management and conservation of CITES-listed timber species and their habitats, in particular *Gonystylus* spp. (ramin), including issues related to their exploitation. The Workshop agreed that the management and conservation of ramin should be accorded high priority by Indonesia and Malaysia. Concerted efforts need to be enhanced to ensure the sustainable management of ramin. The participants had highlighted some of the core issues on the management and conservation of ramin and subsequently made some recommendations to address the issues.

2. Issues and Recommendations

a. Information on the status of ramin habitat in general and the stocking and distribution of ramin, in particular are still inadequate. Accurate information on ramin is needed to enable better management and conservation of the resource. Consequently, the Workshop participants recommended the following:

   - Develop more reliable and cost-effective methods of assessing ramin. The Workshop participants recognised the efforts by Indonesia and Malaysia in developing resource assessment techniques using high resolution satellite data and hyperspectral technology as well as national forest inventories.

   - Enhance the conduct of non-detrimental findings (NDF) further and explore the possibility of having a standardised format of NDF for the region.

b. Peat Swamp forests (PSFs) as the habitat of *G. bancanus* are being exploited and converted to other land use, especially agriculture. Some harvesting activities within production PSF in the permanent reserved forests had resulted in a significant reduction of *G. bancanus* residual stands due to excessive removal. Further concerns on genetic erosion of *G. bancanus* have also been highlighted. Improvements in forest management are needed to ensure that *G. bancanus* is not harvested beyond its sustainable levels. Consequently, the Workshop participants recommended the following:

   - Improve current management prescriptions to promote the sustainable management of the production PSF particularly the sustainable harvest of *G. bancanus*, e.g. to consider spatial distribution (hyperspectral approach) as alternative to cutting limit in selection for harvesting. The studies by FRIM regarding optimum harvest of *G. bancanus* and the practice of reduced impact logging (RIL) are recognised.

   - Enhance enforcement on rules and regulations to ensure that harvesting operations are conducted accordingly. The efforts of the Forestry Department Peninsular Malaysia to introduce radio frequency identification (RFID) for better control of log extraction and transportation is recognised. The RFID also needs to be further studied and extended to sawmill gates.

   - Prevent genetic erosion of *G. bancanus* during harvesting by retaining sufficient healthy *G. bancanus* trees at various sizes within the residual stand. Studies on genetic variation by FORDA and development of DNA database by Sarawak Forestry Corporation are recognised.

c. Some logged-over PSFs are poorly stocked, are deficient in ramin and other major commercial species. Such forests are not expected to recover within the prescribed cutting cycle. Greater efforts are needed to enhance the recovery of such forests and increase their productivity. Consequently, the Workshop participants recommended the following:

- Intensify effective silvicultural treatments to enhance the productivity and recovery of PSFs.
- Prepare sufficient quality planting materials for silvicultural treatment.
- Provide greater protection for ramin during forest harvesting.

d. The project activities have generated useful information and outputs related to the management and conservation of ramin in Indonesia and Malaysia. Consequently, the Workshop participants recommended the following:

- Distribute and share the findings to other agencies e.g. universities, policy maker and forest managers.
- Enhance sharing of technology /information (clearing house mechanism).
- Explore mechanism to effectively implement the outputs of the project by relevant authorities in respective countries.
- Address outputs that require further investigation before implementation, e.g. outputs of DNA study.
- Expand cooperation between Indonesia and Malaysia on common web page in terms of R&D.
- Convene ITTO inter-regional workshop to exchange experience and lessons learnt on addressing CITES compliance for timber-listed species in Appendix II.
- Engage in publications/joint publications of the project results.
- Translate science/R&D results and outputs of the project into management/operational guidelines e.g. integrating into forest management plan, forest management systems and forest policies.

e. There were challenges and constraints in the implementation of project activities. Some of the constraints included limited and slow disbursement of funding, lacking of trained personnel and lacking of awareness at various levels. Consequently, the Workshop participants recommended the following:

- Provide sufficient timeline and funding to carry out project activities effectively.
- Raise stakeholder awareness of the need for sustainable use and appropriate national legislation and develop regional collaborative strategies.
- Adopt similar activities, method and technology to reduce cost and time to complete project activities.

f. After discussing the implementation of project activities and the achievement of the outputs, the Workshop identified gaps and suggested way forward to address them. Some of these include:

- Pursue full scale proposal to include bigger areas, including PSF in Sabah and Sarawak to be submitted to ITTO.
- Include studies on distributions, ecology, diversity and phenology of other than *G. bancanus* species.
- Embark on ramin supply and demand market studies for as input for NDF report for the industry's quota-setting purpose. .
- Conduct studies on carbon balance in PSF/ramin forest and its relationship to climate change and environmental conventions.
- Engage systematic approach to gene pool conservation as base for improving planting materials.
- Include CITES requirements under forest certification and verification schemes.
- Replicate similar projects other important forest species such as merbau, karas, cengal, belian, etc.

g. In general, the project was implemented well and achieved its objectives and desired outputs. However, the Workshop participants felt that further improvements could be made and suggested the following:

- Results of the project should be written in a way that is easily understood by wider audience (stakeholders and interested parties).
- Progress of activities to be reported quarterly instead of monthly.
- Conduct impact assessment (third party) of the project at least three months after implementation.

WORKING GROUP 1

IMPLEMENTATION PROBLEMS AND CONSTRAINTS UNDER THE CURRENT ITTO-CITES PROJECT

Moderator : Dr. Alexander K. Sayok
University Malaysia Sarawak (UNIMAS)

1. Were the project activities been implemented effectively in Indonesia and Malaysia achieved their objectives and outputs?

Activities and output were achieved albeit with some modification during implementation to suit administrative and financial mechanism of respective country.

Suggestions/Questions:

- How to make use of the output is still a big question.
- Study on ramin recovery should include the downstream industries.
- Distribute findings to other agencies, e.g. universities and policy makers.
- Further study on RFID is needed.
- Share the results with stakeholders or related agencies.
- Impact assessment should be conducted for improvement.

2. What are the challenges and constraints faced by the project in the implementation of the activities?

Indonesia
- Turnover of staff delayed project implementation.
- Physical implementation of the project, e.g. time constraint especially on field studies.

Sarawak
- Field studies, e.g. weather/climate unpredictable.
- Office, e.g. staffing.

JPSM
- Global economic situation, e.g. no body submitted tender to identify the area.

FRIM
- Data acquisition.
- Delayed disbursement of fund.

3. Suggestions for improvements?

- To further enhance internal coordination.
- To have an alternative plan for projects activities as a back-up. This plan should be drawn in consideration of climate condition of the respective country.
- Agreement to be concluded at the beginning of the year for timely implementation of the project.
- Results should be written in a way that is easily understood by wider audience (stakeholders and interested parties).
- Impact assessment of the project to be conducted by a third party
- At least three months after the project has been implemented.

WORKING GROUP 2 | STRATEGY TO IMPLEMENT OUTPUTS OF THE PROJECT

Moderator: Dr. Teguh Triono
Indonesia Institute of Science (IIS)

1. Has the project activities achieved their objectives and outputs?

- All project objectives were achieved.
- Some of the outputs were not conclusive enough to meet CITES requirement and objectives.
- Some of the project outputs required more time to get more meaningful result that meets CITES inquiry (e.g. permanent sample plots).

2. Can the outputs of the project be implemented (in short and long terms)? What are the constraints and barriers?

Short term:
- Technical outputs of the project can be implemented and incorporated in the training system for field workers. For example they be implemented and incorporated in capacity building on species identification using species identification guide and hyperspectral technology for inventory.

Long term:
- Some other outputs required further investigation before they can be implemented (e.g. DNA study).
- Amalgamate the outputs with other research/activities outputs to make them more meaningful and conclusive (e.g. national forest inventory, national biodiversity inventory).

Constraints:
- Delayed, interrupted funding.
- Lack of trained manpower (in basic science, dendrology, etc).
- Lack of awareness at all levels.
- Problem in applying results into management system.

3. How can the outputs of project activities be shared between Indonesia and Malaysia?

- Joint capacity building (e.g. on species identification).
- Sharing of technical experiences on know-how (e.g. genetic study and database, hyperspectral method, KOFCCO method).
- Exchange program (scientists & technical staff).
- Publications/ joint publications.

4. Suggestions for improvements?

- Sufficient timeline and funding.
- Developed mechanism for sharing technology/information (e.g. clearing house mechanism).
- Raising awareness.
- Adoption of similar activities, methodologies and technologies.
- Translate scientific/R&D result into management/operational level.

WORKING GROUP 3

GAP ANALYSIS AND WAY FORWARD

Moderator: Assoc. Prof. Hj. Mohd Basri Hamzah
University Putra Malaysia (UPM)

1. ITTO-CITES Programme

- Improved forest inventories for CITES
  - Pursue full scale proposal to include bigger areas, including PSFs in Sabah and Sarawak (further study to be submitted to ITTO).
  - Conduct studies on distributions, ecology, diversity and phenology for other than *G. bancanus* species.

- Improved management of species – so as to ensure that species population levels are maintained
  - Revisit current RIL for better management of ramin-dominant forests.

- Monitor species utilisation that is not detrimental to its survival
  - Revisit NDF as per applicability and effectiveness for ramin forest in the region.

- Raise stakeholder awareness of the need for sustainable use and appropriate national legislation and develop regional collaborative strategies.

- Build trust and cooperation between industries and relevant authorities

  - Case study on supply and demand for ramin: input for NDF report to set the quota for the industry (internal utilisations without export). A web-based approach to be considered.

- Strengthen trade compliance systems
  - RFID should be continued, but the tracking system within RFID need to be extended to sawmill gates.
  - Extended to DNA tracking (beyond forest), create database.

- Outreach
  - To expand on common web page on corporation between FRIM and FORDA in terms of R&D.
  - Convene ITTO inter-regional workshop to exchange experience and lessons learnt on addressing CITES compliance for timber-listed species in Appendix II.

2. The Way Forward

- Carbon balance in PSF/ramin forest and climate change.
- Systematic approach to gene-pool conservation as base for improving planting materials.
- Forest certification review with respect to CITES requirements.
- Expand NDF to other threatened species, e.g. merbau, karas, cengal, belian, etc.
- Harvesting of ramin: to consider spatial distribution (hyperspectral approach) as alternative to cutting girth limit (CGL) as basis for selection.

ITTO-CITES WORKSHOP

ACKNOWLEDGEMENTS

This work was made possible by a grant from ITTO under its collaborative program with CITES to build capacity for implementing timber listings. Donours to this collaborative program include the EU (primary donour), the USA, Japan, Norway, New Zealand and Switzerland. The roles played by the Ministry of Natural Resources and Environment, Malaysia (NRE) as the executing agency, as well as FRIM, Forestry Department Peninsular Malaysia and Sarawak Forestry Department as implementing agencies of the ITTO-CITES project are also greatly appreciated.

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ANNEX 1 WORKSHOP PROGRAM

1 December – 4 December 2010

Hyatt Regency Hotel Kuantan, Pahang, Malaysia

WEDNESDAY	**1 DECEMBER 2010**
0830 - 0900	Registration of Participants
0900 - 1000	Opening ceremony ▪ Welcome Remarks by the Director-General FRIM ▪ Speech by ITTO Representative ▪ Opening Address by the Secretary General NRE
1000 - 1030	Refreshment

SESSION 1	**ACTIVITIES OUTCOMES AND FINDINGS**
	Chair: Prof. Dr. Aminuddin Muhamad
1030 - 1055	**Malcom Demies, Mohd. Shahbudin Sabki, Lucy Chong & Ernest Chai** Non-detrimental Findings Report on *Gonystylus bancanus*: A Quantitative Assessment of *G. bancanus* in Two Selected Permanent Forests of Sarawak (Malaysia)
1055 - 1120	**Nengah Surati Jaya, Samsuri, Tien Lastini & Edwin Setia Purnama** Improving Inventory Design to Estimate Growing Stock of Ramin (*Gonystylus bancanus*) in Indonesia (Indonesia)
1120 - 1145	**Samsu Anuar Nawi, Ihsan Sabri Kamarazaman, M. Zarin Ramlan & Muhamad Azmi** The Distribution of Dry and Wet Inland *Gonystylus* spp. (Ramin), *Aquilaria* spp. (Agarwood) and *Intsia* spp. (Merbau) in Peninsular Malaysia (Malaysia)
1145 - 1210	**Khali Aziz Hamzah, Mohd Azahari Faidi, Tan Sek Aun & Hamdan Omar** Generation of Spatial Distribution Maps of *Gonystylus bancanus* (Ramin) using Hyperspectral Technology (Malaysia)
1210 – 1235	**AYPBC Widyatmoko** Genetic Diversity Study of *Gonystylus bancanus* and Genetic Relationship between *Gonystylus* spp. (Indonesia)
1235 - 1400	Lunch

SESSION 2	**ACTIVITIES OUTCOMES AND FINDINGS** (CONT.)

	Chair: Mr. Tajudin Edy Komar
1400 - 1425	**Ismail Harun, Abd Rahman Kassim, Ismail Parlan & Harfendy Osman** Population Dynamics and Optimum Harvest of *Gonystylus bancanus* in Production Forests of Peninsular Malaysia (Malaysia)
1425 - 1450	**Istomo , Cahyo Wibowo & Tajudin Edy Komar** Assessing Silvicultural System on Ramin: Review on the Current Practice and Re-vitalization of Existing Permanent Sample Plots (Indonesia)
1450 - 1515	**Harry Yong & Abdul Jalil Ahmad Tabon** The Development of *Gonystylus* spp. (Ramin) Timber Monitoring System using Radio Frequency Identification (RFID) in Peninsular Malaysia (Malaysia)
1115 - 1145	Tea Break
1545 - 1610	**Muhammad Mansur, Teguh Triono, Kade Sidiyasa, Ismail & Zaenal Arifin** Survey and Inventory of *Gonystylus* spp. in East Kalimantan. (Indonesia)
1610 - 1635	**Bibian Diway, Nurul Farhana Zakaria, Suliana Charles, Kevin Ng & Lucy Chong** Developing DNA Database for *Gonystylus* bancanus in Sarawak (Malaysia)
2000	**Welcoming Dinner**
THURSDAY	**2 DECEMBER 2010**
	FIELD TRIP TO PEKAN FOREST RESERVE, PAHANG
	Person In-charge: Dr. Ismail Parlan
0800	Depart from Hyatt Regency Hotel, Kuantan
0930	Arrive at Compartment 74, Pekan FR
1000 - 1030	Briefing by Mr. Ismail Talib (District Forest Officer, FD Pahang) on management of Pekan FR
1030 - 1100	Briefing by Dr Ismail Hj. Parlan (FRIM) on ecology of *Gonystylus bancanus* in Pekan FR
1100 - 1130	Briefing by Mr. Harry Yong (FDPM) on RFID
1130 - 1300	Demonstrations on RFID Process
1300 - 1330	Briefing and demonstrations by Mr. Mohd Azahari Faidi (FRIM) on spectroradiometer procedures
1330	Lunch
1400	Depart from Compartment 74, Pekan FR
1600	Arrive at Hyatt Regency Hotel, Kuantan
FRIDAY	**3 DECEMBER 2010**

SESSION 3	**ACTIVITIES OUTCOMES AND FINDINGS** (CONT.)
	Chair: Dr. Ismail Harun
0830 - 0855	**Sutito, Agus Badiah & Tajudin Edy Komar** Review on Ramin Harvest and Trade: CITES Compliance, Tri -National Task Force on Trade in Ramin, Trade Control and Monitoring (Indonesia)
0855 - 0920	**Harry Yong, Rosaizan Haryani Rosli & Abdul Jalil Ahmad Tabon** Sawn Timber and Plywood Recovery Study of Ramin (*Gonystylus bancanus*) in Peninsular Malaysia (Malaysia)
0920 - 0945	**Endang Savitri, Tajudin Edy Komar & Rusmana** Conservation and establishment of ramin (*Gonystylus bancanus*) gene pool (Indonesia)
0945 - 1010	**Evalin Sumbayak & Tajudin Edy Komar** Vegetative Propagation of Ramin (*Gonystylus bancanus*) using KOFFCO system (Indonesia)
1010 - 1040	Tea Break
PARALLEL SESSION	
1040 - 1300	**Group 1** : Implementation problems and constraints under the current ITTO-CITES project **Group 2** : Strategy to implement outputs of the project **Group 3** : Gap analysis and way forward
1300 - 1400	Lunch
1400 - 1700	City Tour
1800 - 1830	Refreshment
SATURDAY	**4 DECEMBER 2010**
SESSION 4	**SHARING OF FINDINGS FROM THE PARALLEL SESSION**
	Chair : Dr. Shamsudin Ibrahim
0900 - 1000	Report presentation by **Group 1** Report presentation by **Group 2** Report presentation by **Group 3**
1000 - 1030	Tea Break
1030 - 1100	Workshop resolution by Mr. Samsudin Musa (Forest Research Institute of Malaysia, FRIM)
1100 - 1200	Concluding remarks by Dr. Shamsudin Ibrahim
1200 - 1300	Lunch & Farewell

ANNEX 2 | COMMITTEE MEMBERS

1 December – 4 December 2010

Hyatt Regency Hotel Kuantan, Pahang, Malaysia

- Advisor: Dr. Shamsudin Ibrahim
- Chairman: Dr. Khali Aziz Hamzah
- Secretary: Mohd Azahari Faidi
- Treasurer: Hamdan Omar

Logistic:
- Tan Sek Aun
- Azhan Shah Idris
- Zainol Khalid
- Mohd Erwan Mohd

Technical :
- Dr. Ismail Parlan
- Dr. Abd Rahman Kassim
- Samsudin Musa
- Mohd. Ghazali Hassan

Scientific:
- Abd. Razak Othman
- Rashidah Hashim
- Harfendy Osman
- Mohd Erwan Mohd

Proceedings :
- Dr. Ismail Harun
- Dr. Ismail Parlan
- Dr. Khali Aziz Hamzah
- Abd. Razak Othman
- Mohd Azahari Faidi

NRE Representatives:
- Kartini Karim
- Siti Nawwar Zainudin

Social and Publicity :
- Rashidah Hashim
- Sofie Shaaruddin

Field Visit:
- Ismail Talib
- Grippin Akeng
- Dr. Ismail Parlan
- Harry Yong
- Norlaila Mohd. Subari

ANNEX 3 LIST OF PARTICIPANTS

1 December – 4 December 2010

Hyatt Regency Hotel Kuantan, Pahang, Malaysia

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ANNEX 4 | PHOTOS

1 December – 4 December 2010

Hyatt Regency Hotel Kuantan, Pahang, Malaysia

Figure 1 Registration

Figure 2 Opening session

Figure 3 Oral presentation

Figure 4 Participants listening to oral presentation

Figure 5 Field visit at Pekan Forest Reserve, Pekan, Pahang

Figure 6 Briefing and demonstration on spectroradiometer


ITTO
ITTO-CITES-FRIM REGIONAL WORKSHOP 2010
Hyatt Regency Kuantan, Pahang
1 - 4 December 2010

ITTO-CITES-FRIM Regional Workshop 2010

Proceedings of the regional workshop on the sharing of findings from the activities implemented in Indonesia and Malaysia under the ITTO-CITES project on ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation