Appendix

Activity Document III

PROJECT ABSTRACT

TITLE: 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

SUMMARY

Gonystylus bancanus (Ramin) is an important forest tree species that is currently being exploited in Malaysia. Due to a lack of spatial distribution and non-spatial information of this species, in addition to high market demand, population of this species is now decreasing very rapidly and threatened in some habitats. In order to conserve and sustainably manage this species, a detail and accurate information on their population, biological and ecological status should be made available to determine sustainable level of harvests and assist in designing rehabilitation and conservation programs. This project is aimed to promote sustainable utilization and conservation of Ramin in production forests of Peninsular Malaysia. The project has two objectives, (i) to generate spatial distribution maps in Peninsular Malaysia through the use of hyperspectral technology and non-spatial information of Ramin in a cost-effective manner, and (ii) to enhance conservation by determining sustainable level of harvest for Ramin in production forests of Peninsular Malaysia. The expected outputs of the project are (i) spectral library of the species, (ii) spatial distribution maps of Ramin species in Peninsular Malaysia, (iii) non-spatial data and information on Ramin species, (iv) population dynamics, and (v) sustainable harvest levels of Ramin in production forests in Peninsular Malaysia.

EXECUTING AGENCY

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DURATION

24 months

BUDGET AND PROPOSED SOURCES OF FINANCE

(a)	ITTO Contribution	US$ 131,000
(b)	Government of Malaysia (in-kind)	US$ 52,050
(c)	Other Sources Contribution (specify)	US$ -
		Total US$ 183,050

This activity is submitted to ITTO for consideration under its Work Program activity "Ensuring international trade in CITES-listed timber species is consistent with their sustainable management and conservation," with primary funding provided by the European Commission and additional support from the USA, Japan, New Zealand and Norway

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PART 1: CONTEXT

Origin/Background

ITTO Expert Meeting on the Effective Implementation of the inclusion of Ramin (*Gonystylus* spp.) to Appendix II of the Convention of International Trade on Endangered Species of wild flora and fauna (CITES), 16 - 19 May, 2006 held in Kuala Lumpur, Malaysia recommended that biological and ecological studies of Ramin (*Gonystylus* spp.) should be undertaken in order to ensure Ramin conservation. The meeting suggested Forest Research Institute Malaysia (FRIM) to take the lead in preparing a proposal for consideration of funding by ITTO.

The genus *Gonystylus* consists of about 30 species that are distributed throughout the Malesian region with the exception of Central and East Java and the Lesser Sunda Islands. Eastward, the distribution area extends towards the Solomon Islands, Nicobar and Fiji. The vast majority of species are found on Borneo (27 species), especially in Sarawak. Peninsular Malaysia and Sumatra come second with 7 species each, and the Philippines possess 2 species. Other areas are occupied by a single species.

Six species are currently known to be commercially valuable. These species include: *G. affinis, G. bancanus, G. forbesii, G. macrophyllus, G. maingayi* and *G. velutinus. G. bancanus* is the most commonly traded of the six species. However, Ramin products are used not only for the timber or wood products, but also in some cases for the agarwood used as incense like those of *Aquilaria* spp. However, this trade does not appear to be significant in comparison to the timber trade. Due to its commercial value and widespread abundance in peat swamp forest, *G. bancanus* has been selected for this study. Therefore, onwards when Ramin is mentioned in the proposal, it is referring to *G. bancanus*.

Due to concern on the unsustainable exploitation of Ramin, an assessment to identify current distribution, biological and ecological status of this threatened genus is needed. This proposal is highly important as a follow up action to the finding of previous projects, especially those related to the current status of growing stock, biological and ecological condition of Ramin.

Ramin represents the most important timber species produced by Malaysia. Most of the timber species is extracted from the permanent reserve forests designated for sustainable timber production. In recent years, forest management practices in Malaysia have undergone considerable changes to minimize degradation of natural forest ecosystems and unsustainable logging practices.

In Malaysia, the National Forestry Policy 1978 laid a firm foundation for the development of the forestry sector. It was revised in 1993 in recognition of the role of forests in providing a multiplicity of goods and services. The revised policy has had direct impacts on the management of forests through the establishment of permanent forest estates (PFE), large-scale forest plantations, importation of logs, greater incentives for downstream processing, promoting the utilization of lesser-known species and small-diameter logs, and manufacturing of value-added products. The National Forestry Policy 1978 and the National Forestry Act 1984 provide Malaysia with a strong policy framework and laws to support sustainable forest management. Both the national policy and act provide a sufficient basis for the protection against harmful activities, promote establishment of wildlife parks and reserves and reduce activities that may cause detrimental impacts on the environment.

As demand to use biological resources increases, new laws and policies are urgently needed to safeguard national treasures of biological diversity and to promote beneficial relationships with commercial ventures as well as livelihood of local communities. Since more information is needed, several priority areas in the research on the conservation of forest biological diversity have been identified for the Ninth Malaysia Plan (2006-2010) with emphasis on ecology and conservation of flora and fauna of Malaysia, conservation and management of natural forest habitats and domestication and *ex situ* conservation of forest plants. In line with this a draft Plant Conservation

Strategy is being prepared. In addition, a threat assessment project on Malaysian plant species is also on-going together with the development of a central network of database on biological diversity that will provide accurate and timely information for the development of the conservation policy.

The inclusion of Ramin into CITES Appendix III, and then Appendix II has brought some consequences in Ramin harvesting and trade regulations. Based on current knowledge, the implementation of CITES on Ramin, as well as other listed species, still face some barriers. Some of the barriers include lack of institutional and human resource capacity, especially in the implementation of harvesting and trade regulations which have contributed to the continuity of Ramin forest degradation.

PART II: THE PROJECT

1.0 Project Objectives

a. To generate spatial distribution maps of Ramin in a cost-effective manner through the use of hyperspectral technology in Peninsular Malaysia.

b. To determine sustainable level of harvest of Ramin that enhances their conservation status in production forests of Peninsular Malaysia.

2.0 Justification

2.1 Problems to be addressed

Since the early 1970's there has been wide spread public concern about the rate in which tropical forests are being degraded or destroyed. The rate accelerated with the introduction of the mechanization in timber harvesting, improved transport methods and land-use changes from forest to agriculture to support socio-economic development and increasing populations. Present concerns include increasing demand for timber from industries both local and international as well as the threats from illegal logging. Apart from these factors, deliberate fire, and land conversion leading to forest fragmentation possess new threats to the survival of the forest. In the peat swamp forest, alteration of hydrological regime of river systems may cause serious problem to the integrity of the ecosystem. Given this concern, the challenge is to manage the forest on a sustainable manner. Malaysia has high resource availability and high level of forest industry development. With increasing demand for timber, certain species such as Ramin has been subjected to over-exploitation and thus long-term sustainable production of these timbers are at risk.

Various initiatives have been undertaken to ensure the sustainability of forest resources through improved forest management strategies such as introduction of Reduced Impact Logging (RIL), establishment of permanent forest estate certification, etc. In Malaysia, a selective cutting approach based on minimum diameter limits has been adopted. Currently, the production forests of the Permanent Reserved Forests (PRFs) in Peninsular Malaysia are managed under the Selective Management System (SMS) which entails the selection of optimum management (felling) regimes based on pre-felling forest inventories (pre-f) and the retention of at least 32 sound commercial trees per hectare for diameter class of 30cm dbh up to the cutting limit. The System is designed to achieve sustainability of the forest with minimum forest development costs and to optimize the management objectives of economic and efficient harvesting under prevailing conditions. The cutting cycle under the System is approximately 30 years with an expected net economic outturn of 40-50 m^3/ha. After the first cut, the residual stand should be enriched with dipterocarp species. A flexible cutting limit approach has been adopted for three timber group namely, chengal (*Neobalanocarpus heimii*), dipterocarps and non-dipterocarps. Ramin falls into the non-dipterocarp group. The minimum cutting limits are set at 60 cm, 50 cm and 45 cm dbh for chengal, dipterocarp

and non-dipterocarps, respectively. Under SMS, the cutting limit of dipterocarps will always be higher than non-dipterocarp by at least 5 cm.

Application of cutting limits to broad species group will not be appropriate as it does not provide a means for the sustainable utilization of Ramin. As in the case of Ramin, it is unique to peat swamp forests and in some instances large trees dominate the stand. Applying broad species grouping to these forests may affect the long-term sustainability of Ramin population, as Ramin is grouped under non-dipterocarps. A revision of the species grouping that will make Ramin its own group is needed to ensure the sustainable utilization in peat swamp forests.

Besides the application of the cutting limits, several key growth parameters need to be reviewed such as the stocking density of healthy residual trees, growth, mortality and recruitment rates for Ramin. The analyzed data from permanent sample plots will be used to assess the population dynamics parameters and developing population projection models. Currently, a study is being carried out in Malaysian peat swamp forest to determine Ramin population structure to prescribe the appropriate cutting limit that will support sufficient residuals. This will also include applying a revised logging damage factor for peat swamp forest as new long haulage machine has been introduced that causes less damage to the site and residual trees.

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. In theory the remote sensing technology is cheaper 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). The ability to accurately map specific species such as Ramin in tropical ecosystems in permanent reserves as well as stateland forests will represent a significant advance that will facilitate the conservation and sustainable utilization of the resources.

The sustainability of harvest of the concerned species is critical to overall success of the sustainable tropical forest management. The knowledge of sustainable harvest is rather complex and it depends on many factors, among others are knowledge of growth rates of specified species under various stand conditions or silvicultural treatments, accuracy of the growing stock assessment, quality of the forest management practices and the silvicultural management prescription for the species. Malaysia is fortunate that many permanent sample plots have been established throughout the countries. This information will form the basis for the assessment of the population dynamics and development of projection model to ascertain the sustainable level of harvest.

2.2 Intended situation after project completion

At the end of the project, relevant government agencies in Malaysia will have a better understanding on the population structure of the species in the natural forest and contributing to better management of this species in the future. The management of the timber species received a lot of attention from the global community who claimed that the timber species is being over-exploited and could become extinct due to trade. The two components identified by the project will help to address this issue and develop a model that is applicable to the management of other tropical timber species. The outcome of this project can generate relevant information required

for the preparation of the non-detriment findings (NDF) reports, as required for species listing under CITES. The use of remote sensing, especially hyperspectral data in mixed-layer of tropical forest has been tested in a timber concession in Kelantan, Malaysia and the results obtained were very encouraging. The data can be used to classify the forest and calculate the potential stocking from each forest classification. The project intends to use the same technology available over a larger area in different geographical regions and if this proved to be successful in achieving specific objectives identified by the project, there will be a breakthrough in the sustainable management of tropical forests. The population distribution of larger-sized individuals and sustainable level of harvest of these individuals are the two most crucial information that need to be collected and analyzed in supporting good forest management practices. The approach forms a new paradigm in tropical forest management that allows forest managers to engage in a better decision making process in selecting individual trees within the population to be harvested on an optimal basis.

Besides scientists from Malaysia that will be involved directly in conducting the research, the project will hire local experts in analyzing hyperspectral data and classifying the forest into distinct forest types. This is necessary as the research being undertaken involves new dimensions that require high levels of skills. This is also advantageous to the project collaborators, as it will provide opportunities to increase capacity and experience through interaction with the experts. At the same time training will be organized to disseminate the findings of the project progressively. These opportunities for training will also be provided for individuals from other countries within the region.

2.3 Target beneficiaries

The project complements the sustainable management and utilization of forests in Malaysia. It will ensure continuous supply of Ramin for the industry thus protecting the industry in the long run. This would provide direct benefits for the industry. The sustainable harvest of both species and their contribution towards overall sustainability of the forest will also protect the forest ecosystem and contribute towards the conservation of biological diversity. This will provide benefits not only to Malaysia but also to the global community as a whole.

The forestry departments will also be direct beneficiaries as they are committed to ensuring management and utilization of the resources on a sustainable basis. The methods developed for the management of Ramin can also be applied to the management of other major species and species groups.

FRIM as the implementing agency in Malaysia will be able to enhance its knowledge and capacity in carrying out the assessment of the species and development of sustainable harvest.

Indirect beneficiaries would include research institutions, academicians, conservationists, forest communities, environmental NGO's and the public at large. Although the project focuses on Ramin, the methods and outputs developed could be applied to other species and/or species groups, while the results could also be easily adapted and applied to other tropical countries as well.

2.4 Risk

Various studies in temperate conifer and mixed deciduous forests have demonstrated accurate empirical estimates of canopy chemistry from airborne hyperspectral. However, its application is relatively new in tropical forests, thus may introduce new challenges i.e. weather conditions and varying forest composition. Consequently, additional work needs to be carried out in order to develop spectral libraries for the selected tree species, Ramin. Thus, the project will engage local remote sensing experts as the project consultants.

3.0 Outputs

Objective 1:
To generate spatial distribution maps and non-spatial information of Ramin in a cost-effective manner through the use of hyperspectral technology in Peninsular Malaysia.

Output 1.1: Spectral library for Ramin developed.

Output 1.2: Spatial distribution maps for Ramin produced and non-spatial database established in Peninsular Malaysia.

Objective 2:
To determine sustainable level of harvest of Ramin that enhances their conservation status in production forests of Peninsular Malaysia.

Output 2.1: Population dynamics of Ramin determined.

Output 2.2: Sustainable harvest levels of Ramin in natural production forests determined.

4.0 Activities

Output 1.1: Development of spectral library for Ramin.

Activity 1.1.1: Acquire high resolution of hyperspectral data.

To identify and locate the Ramin trees in a highly mixed heterogeneous rain forest is a challenging task. The most promising tool or method to overcome the problem is by applying airborne remote sensing hyperspectral technique.

Activity 1.1.2: Study of spectral signature and ground truthing.

In attempting to study the spectral signature of Ramin, it is very crucial to assess and compare its spectral reflection in laboratory and on-site measurements. The process will give better understanding of the effects of environment on the Ramin spectral reflectance patterns.

Activity 1.1.3: Data processing and analysis.

In order to accurately identify the Ramin timber, the output of both the laboratory and field work need to be integrated. Through remote sensing image processing techniques and analysis, spectral signatures from the species will be compiled, fine tuned and incorporated to produce the proposed Ramin spectral library.

Activity 1.1.4: Hands-on training for project counterparts and targeted stakeholders

As this project will be exploring the use of spectral imaging to develop spatial distribution maps for selected species of trees, it is expected that many new skills and capacity will be built. Inventory (growth and stocking) data needed to produce the growth and sustainable harvest projection model will require the input of experts thus indirectly requiring the exchange of skills and experience. It is anticipated that the output of this project will also be applicable to other countries of similar forest environments. Therefore, it is important that the project focuses on building the capacity of available expertise through hands-on training as well as formal classroom workshops as it expects to produce personnel and relevant stakeholders with sufficient skills to locally adapt and apply the project outputs in other parts of the region.

Output 1.2: Spatial distribution maps and non-spatial data for Ramin.

Activity 1.2.1: Production of Ramin spatial distribution maps.

Spatial distribution of Ramin is an important information to the forest managers in determining and preparing both management and operation plans. Spatial analysis can be carried out to determine the site references of Ramin.

Activity 1.2.2: Developing stocking density classification maps from spatial and non-spatial information

One of the main concerns in managing the tropical forest sustainably is to ensure a sufficient stocking distributed across the forest landscape. An effective way to assess the stocking will be from high resolution remotely sense data such as hyperspectral images. The information will enhance the capacity to broadly categorize the forest into several stocking classes indicating the stocking density status. However, the images only allows for detection of the canopy trees. Ground sampling is required to further examine the stocking status of lower size trees particularly below the canopy. Both the remotely sense data and ground sampling will be used to diagnose stand status and determine appropriate silvicultural operation to improve and enrich the forest.

Output 2.1: To determine population dynamics of Ramin.

Activity 2.1.1: Assessing stocking and population dynamics of Ramin.

Since Ramin has been up-listed to Appendix II (CITIES), the species is subjected to Non-detriment Finding (NDF) report before they be traded internationally. In the preparation of 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.

Output 2.2: To project the sustainable harvest levels of Ramin in natural forest stands in Peninsular Malaysia.

Activity 2.2.1: Assessment of growth projection model and existing growing stock to determine the sustainable level of harvest in Peninsular Malaysia.

In timber production forest, sustainable level of harvest can be determined by projecting future growth from the current stocking of both species in natural forest stands. It is important to incorporate current stocking with the dynamics of the species in order to estimate whether any rate of exploitation would affect the sustainability of the species. Projection can be done manually or by preparing a computer simulation model to enable us to determine the most optimum sustainable level of harvest that does not jeopardize the species sustainability in the nature.

Activity 2.2.2: Dissemination of the project materials and outputs that can be accessed by interested stakeholders.

The project will be conducted over a period of 24 months covering a number of research activities, some of which may be relatively new. In that span of time, continuous monitoring, reporting and dissemination on the project's progress and outputs need to be executed in an efficient and timely manner through the production of reports, guidelines, manuals and workshop. These project-related materials will be compiled and produced for dissemination amongst the project collaborators, relevant stakeholders, funding agency and other interested parties.

5.0 Work Plan

	Activity	Year 1												Year 2											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
	Objective 1: **To generate spatial distributon maps of Ramin cost-effectively through hyperspectral technology in Peninsular Malaysia**																								
Output 1.1	**Develop of spectral library of Ramin**																								
	Activity 1.1.1: Acquire high resolution of airborne hyperspectral data			**X**	**X**	**X**	**X**	**X**	**X**	**X**															
	Activity 1.1.2: Study of spectral signature and ground truthing									**X**	**X**	**X**	**X**	**X**	**X**										
	Activity 1.1.3: Data processing and analysis														**X**	**X**	**X**	**X**	**X**	**X**					
	Activity 1.1.4: Hands-on training for project counterparts and targeted stakeholders											**X**	**X**										**X**	**X**	
Output 1.2	**Spatial distribution maps of Ramin**																								
	Activity 1.2.1: Production of Ramin spatial distribution maps																			**X**	**X**	**X**	**X**		
	Activity 1.2.2: Developing stocking density classification maps from spatial and non-spatial information																				**X**	**X**	**X**	**X**	

	Activity	Year 1												Year 2											
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
	Objective2: **To determine sustainable level of harvest for Ramin in production forest of Peninsular Malaysia**																								
Output 2.1	**To determine population dynamics of Ramin**																								
	Activity 2.1.1: Assessing stocking and population dynamics of Ramin						**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**										
Output 2.2	**To project the sustainable harvest levels of Ramin in natural forest stands in Peninsular Malaysia.**																								
	Activity 2.2.1: Assessment of growth projection model and existing growing stock to determine the sustainable level of harvest in Peninsular Malaysia.													**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		**X**
	Activity 2.2.2: Dissemination of the project materials and outputs that can be accessed by interested stakeholders.																						**X**	**X**	**X**

6.0 Budget

6.1 Total Project Budget by Activity

Detail project budget by activity (US$)

Budget Components

		TOTAL
10.	**Project Personnel**	
	11. National Experts	50,000
	12. National Consultants	10,000
	13. Other labour	5,000
	14. Training	10,000
	19. **Component Total**	**75,000**
20.	**Sub-contracts**	
	21. Sub-contract	7,500
	29. **Component Total**	**7,500**
30.	**Duty Travel**	
	31. Daily Subsistence Allowance	5,500
	32. Transport Costs	16,500
	39. **Component Total**	**22,000**
40.	**Capital Items**	
	49. **Component Total**	**-**
50.	**Consumable Items**	
	51. Fuel and Utilities	1,000
	52. Office Supplies	4,000
	53. High resolution satellite image (IKONOS/Hyperspectral)	35,000
	59. **Component Total**	**40,000**
60.	**Miscellaneous**	
	61. Auditing	2,500
	62. Contingencies	14,000
	69. **Component Total**	**16,500**
70.	**Executing Agency Management Costs**	
	79. **Component Total**	**22,050**
100.	**GRAND TOTAL**	**183,050**

6.2 Project Budget by Source

Project budget by source (US$)

Budget Components	**Source**			
	ITTO	*Government*	*Other Source(s)*	**Total**
10. Project personnel	50,000	25,000		75,000
20. Sub-contracts	7,500	-		7,500
30. Duty travel	22,000	-		22,000
40. Capital items	-	-		-
50.Consumable items	40,000	-		40,000
60. Miscellaneous	11,500	5,000		16,500
70. Executing Agency Management Costs (15% of Total of *Overall Project Budget by Activity*)	-	22,050	-	22,050
Total	131,000	52,050		183,050

PART III: OPERATIONAL ARRANGEMENTS

1. Management Structure

The project will be implemented by the Forest Research Institute of Malaysia. A Project Steering Committee (PSC) will be established to govern the implementation of the project. The PSC will provide guidance on matters pertaining to the implementation of the project and ensure that the project is directed towards achieving its intended goals. At the same time, a Project Technical Committee (PTC) will also be established to give advice on technical matters and facilitate the data collection and analysis. The members of the committees are as follows:

Project Steering Committee (PSC)	Members of PSC
Forest Research Institute Malaysia	- Director General FRIM - Director of Forestry Division, FRIM
Forestry Department HQ Peninsular Malaysia	- 2 representatives
NRE* and KPPK+	-2 representatives
Other institutions	- 2 representatives

Project Technical Committee (PTC)	Members of PTC
Forest Research Institute Malaysia (FRIM)	- Dr. Shamsudin Ibrahim
	- Dr. Ismail Harun
	- Dr. Abd. Rahman Kasim
	- Dr. Khali Aziz Hamzah
Forestry Department of Selangor and Pahang	- Directors of State Forestry Departments of Pahang and Selangor
Other Institutions	- Universities

Note: *- Ministry of Natural Resources and Environment, Malaysia
+- Ministry of Plantation Industries and Commodities, Malaysia

2. Monitoring, Reporting and Evaluation

The progress of the project will be monitored through the PSC. Annual progress reports will be submitted to the PSC for consideration. The Senior Director of the Forestry Division as Project Coordinator will be responsible for the preparation of the reports. He will be guided by the PSC as to what detail the report should be. Short monthly progress reports and a final report will be prepared by FRIM within two months of project completion for submission to ITTO.