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# Completion Report

## ITTO-CITES Project

ITTO Work Program for 2013 On Support to ITTO-CITES Implementation for Tree Species and Trade/Market Transparency (TMT)



## Reproductive and Genetic Studies Towards the Conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia

*Chua L.S.L., Lee S.L., Lau K.H., Nurul-Farhanah Z., Tnah L.H.,  
Lee C.T., Ng K.K.S. & Ng C.H.*

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### IMPLEMENTING AGENCY

Forest Research Institute Malaysia (FRIM)  
Kepong 52109 Selangor  
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## COMPLETION REPORT

**Title:** Reproductive and genetic studies towards the conservation and management of *Aquilaria malaccensis* in Peninsular Malaysia

**Executing Agency:** Ministry of Natural Resources and Environment Malaysia (MNRE)

**Implementing Agency:** Forest Research Institute Malaysia (FRIM)

**Host Government:** Government of Malaysia

**Starting Date:** 5 August 2013

**Actual Duration:** 28 months (with 4 months extension)

**Actual Activity Costs (US\$):**

<b>ITTO</b>	=	141,570.00
<b>GOM (in-kind)</b>	=	89,697.00
<b>TOTAL</b>	=	<b>231,267.00</b>

**Team Members**

Dr. Lillian Chua Swee Lian (Project Leader)  
Dr. Lee Soon Leong (Project Co-Leader)  
Lau Kah Hoo  
Nurul Farhanah Zakaria  
Dr. Tnah Lee Hong  
Dr. Lee Chai Ting  
Dr. Kevin Ng Kit Siong  
Dr. Ng Chin Hong

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## **EXECUTIVE SUMMARY**

### **1. Activity Context, Origin and Problem to be Addressed**

*Aquilaria* as a genus was listed in 2005 in the Appendix II of CITES. Peninsular Malaysia has five species of which only one, i.e. *A. malaccensis*, is widespread and facing severe harvesting pressures. CITES requires that the export of an Appendix II species by range states is not detrimental to the survival of that species in the wild. To achieve this, a non-detriment finding (NDF) needs to be conducted to determine the level of export. The development of an NDF is based on scientific information on population status, distribution, population trend, management and monitoring of harvest, eco-biological factors and trade information. The preparation of this Activity was based on two research studies, the first conducted between 2007 and 2008 entitled “*In vitro* Technology for Mass Propagation and Phytochemical analysis of *Aquilaria malaccensis* and *Aquilaria hirta* (Endangered Gaharu Producing Species), Project No. MINT0000089” and funded by the Government of Malaysia (Ministry of Science, Technology and Innovation, Malaysia). The second was entitled “Conservation studies and the development of DNA microsatellite markers on *Aquilaria malaccensis* in Peninsular Malaysia”, Project No. 23172000000002 which was also funded by the Government of Malaysia (Ministry of Natural Resources and Environment, Malaysia) for a period of two years (2011-2012). Both projects were implemented by the Forest Research Institute Malaysia (FRIM). In order to strengthen and ensure the continuity of these works, this Activity was proposed under Phase 2 of the ITTO-CITES Work Program.

### **2. Activity Objectives**

#### **Overall objective**

The ultimate objective of the Activity is to develop a conservation action plan that aims to reduce harvesting pressures on wild populations of agarwood in Peninsular Malaysia.

#### **Specific objectives**

The specific objectives of the Activity are to document the flowering phenology and reproductive behaviour of *A. malaccensis* in Peninsular Malaysia and to develop its DNA profiling databases, including a conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.

### **3. Most Critical Differences between Planned and Realized Activity Implementation**

#### **Activity personnel**

There were no changes in the personnel implementing this Activity.

### ***Time schedule***

A four months no-cost extension was granted to the Activity from 1 June to 30 September 2015. This was to enable further collection and analysis of flowering phenology data as there had been sporadic flowering activity during the year, and the extension would enable FRIM to observe subsequent fruiting development.

### ***Budget amendment***

The fund was adequate and has been wisely spent as scheduled. All three instalments were requested during the Activity period.

## ***4. Situation Prevailing after Activity Completion, as Compared to the Pre-Activity Situation including the Situation of the Target Beneficiaries, and the Post-Activity Sustainability***

The understanding of the flowering behaviour of the tree enable FRIM to recommend to primary beneficiaries, mainly the Forestry Department of Peninsular Malaysia (FDPM) and the various State Forestry Departments the periods when monitoring of seed trees is required. Collection, propagation and planting of materials can then be executed in a planned manner. The availability of DNA profiling databases of *A. malaccensis* will enhance the capacity of enforcement officers in the conviction of illegal harvesters under Section 15 of the National Forestry Act 1984 (amended 1993). This will significantly improve Malaysia's tracking and tracing system. In addition, such databases can also be used for rapid species authentication and to certify that an *Aquilaria* product is genuinely derived from planted or sustainably managed forests. The development of a conservation action plan (CAP) based on the findings from the Activity is a crucial step to ameliorate the decimation of wild populations.

The primary beneficiaries, i.e., the Forestry Department of Peninsular Malaysia (FDPM) and the various State Forestry Departments are expected to study, refine and implement the recommendations in the CAP with further consultations with FRIM. For this purpose, FRIM intends to submit the CAP for management and technical considerations within the Department's existing framework. Other stakeholders such as plantations and small-holders are likely to use both the reproductive ecology and genetic information. The secondary targeted beneficiaries, i.e., the Ministry of Natural Resources and Environment (MNRE) as the lead Management Authority (MA) and the Malaysian Timber Industry Board (MTIB) as the Malaysian CITES MA will mostly benefit from the result of a DNA profile database of *A. malaccensis* for timber tracking and forensic purposes. It can also be used for rapid species authentication and product certification. These agencies will be the main users of the outputs of this Activity.

## ***5. Most Relevant Outcome of the Analysis of the Activity Implementation***

In the present Activity, the combination of various genetic analyses divided the *A. malaccensis* populations in Peninsular Malaysia into two major clusters, i.e., Cluster Kedah-Perak and Cluster Kelantan-Johor. The cluster Kedah-Perak consists of populations from the states of Kedah, Pulau Pinang and Perak, whereas the cluster Kelantan-Johor consists of populations from the states of Kelantan, Terengganu, Pahang, Selangor, Negeri Sembilan, Melaka and Johor. As the cluster analysis

partitioned the populations into two genetic clusters, corresponding to two geographical regions in Peninsular Malaysia, these two regions should be considered independently for the selections of *in situ* conservation areas. *A. malaccensis* has 8.1% of the total genetic diversity residing among populations. Therefore, five strategically placed populations in each of the two regions should capture the majority of their total genetic diversity and *in situ* conservation of these populations is likely to be sufficient to prevent the species from becoming an endangered species.

The population identification database of *A. malaccensis* developed in the present Activity could be used to verify the source of origin of a suspected wood until population/regional level. By using the individual identification database, an assignment test can also be conducted based on multilocus genotypes of Short Tandem Repeat (STR) to further elucidate the source of a suspected wood until population level. Once the population of origin is ascertained, searching of potential stumps within the population can be carried out. If the suspected wood matches into its original stump, by using individual identification database, a random match probability can be estimated using subpopulation-cum inbreeding model to rule out the possibility of matching due to chance. In summary, the population and individual identification databases developed in this study are ready to be used to provide forensic evidence for the conviction of illegal harvesters of *A. malaccensis* under Section 15, National Forestry Act 1984 (amended 1993).

Information generated from this Activity provides scientific evidence for the identification of Genetic Resource Areas (GRA) and genebanks. These areas are important for conservation and serve as seed provenance areas for use in the plantation sectors.

Malaysia as a range state exporting agarwood is obliged to conduct NDF for *A. malaccensis*. The information generated from this Activity will be channelled into the relevant parts. The same information will be used to determine the annual export quota.

The CAP identifies gaps in which effort by stakeholders should be channelled into. Many of the elements have a management and cross-sectoral perspective that is necessary to make it relevant. FRIM is able to enhance evidence-based support to stakeholders arising from a better understanding of population demographic and genetic changes.

## **6. Lessons Learnt**

- 1) The Activity benefited tremendously from the continued cooperation and participation of various stakeholders, in particular the State Forestry Departments and premises owners. This had enabled FRIM to collect extensive data and samples for phenological, ecological and molecular studies. The coordination role played by the executing agency (Ministry of Natural Resources and Environment) was very important to ensure that all planned activities were conducted on time. The cooperation from all stakeholders was critical to the success of this Activity.
- 2) Number of observed trees had decreased during the Activity period due to illegal harvesting despite preventive action taken. This had slightly affected the number of samples and hence the interpretation of the data.

- 3) Samples collecting of *A. malaccensis* in natural habitat were challenging and required not only adequate funding, but also involvement of dedicated researchers. The successful implementation of this Activity generally was through awareness about the importance of protecting the country's forest genetic resources for future generations as well as close cooperation and strong support given by the State Forestry Departments.

## **7. Recommendations**

The Conservation Action Plan is forwarded as a recommendation to address the decline of wild populations in the peninsula. Many of the elements in the CAP are cross-sectoral and require the full involvement of all stakeholders for it to achieve its aim.

The tracking and tracing system capability derived from this Activity could be used by the enforcement authority as an additional tool to fight against illegal harvesting. The establishment of DNA profiling databases is useful for rapid species authentication both in the plantation and product industries.

To ensure sustainable utilisation of forest resources, besides *A. malaccensis*, genetic information and DNA database should also be generated on other species that are valuable and threatened.



## 1.0 ACTIVITY IDENTIFICATION

### 1.1 Context

#### Social, economic and environment

*Aquilaria* as a genus was listed in 2005 in the Appendix II of CITES. Peninsular Malaysia has five species of which only one, i.e. *A. malaccensis*, is widespread and facing severe harvesting pressures. CITES requires that the export of Appendix II species by range states is not detrimental to the survival of that species in the wild. To achieve this, a non-detriment finding (NDF) is required to be conducted to determine the level of export. The development of an NDF is based on scientific information on population status, distribution, population trend, management and monitoring of harvest, eco-biological factors and trade information. At present, this information is known only for several *A. malaccensis* populations in Indonesia.

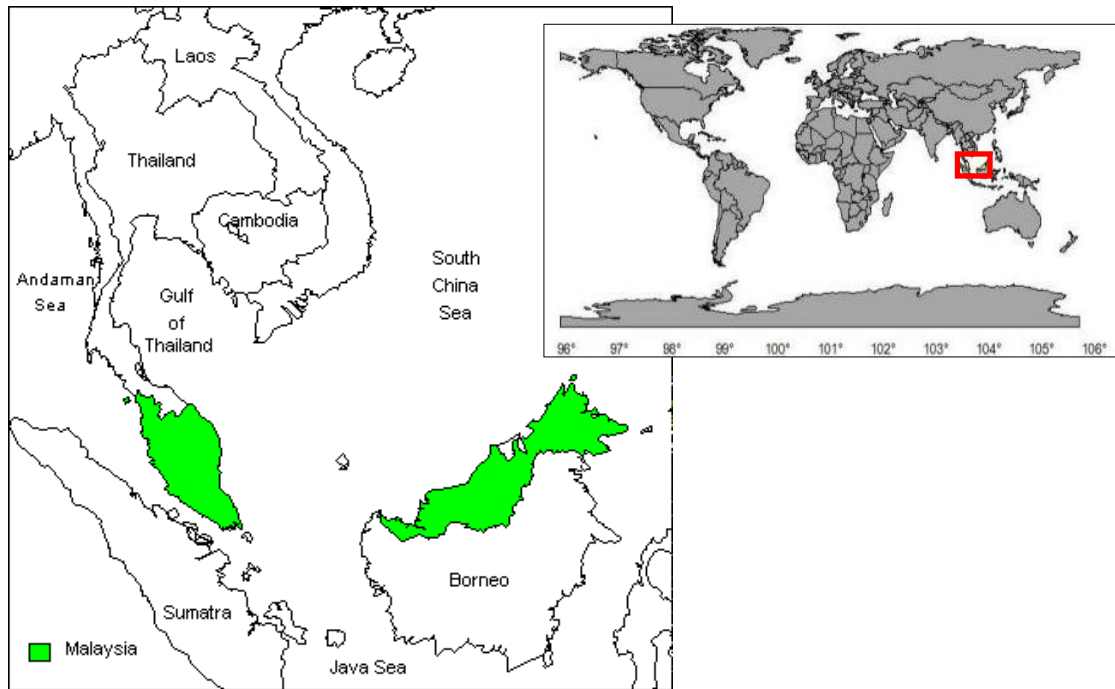
Increasing demand and aggressive harvesting of agarwood in recent decades have resulted in heavy losses of natural stands (Soehartono & Newton 2001) and concerns over the long-term survival of *A. malaccensis* in Peninsular Malaysia. To ameliorate harvesting, particularly illegal ones, timber log traceability to match a timber log to its original stump and population origin has to be applied. Such an approach has been used on *Neobalanocarpus heimii* and *Gonystylus bancanus* where DNA profiling databases were used to track timber. DNA profiling database on *N. heimii* was able to provide forensic evidence for the conviction of an illegal logger as provided for in Section 15 of the National Forestry Act 1984 (amended 1993) (Tnah *et al.* 2009, 2010a, 2010b, 2012). This approach can also be used to certify wood produced from managed forests, to satisfy phytosanitary certification procedures and chain-of-custody in timber certification (Lyke 1996; Chihambakwe *et al.* 1997).

Forest resource inventory for *A. malaccensis* was conducted by the Forestry Department of Peninsular Malaysia in 2002–2004 and 2010–2012 and this had contributed partially to the Non-Detriment Findings (NDF). The understanding of the biological characteristics of Peninsular Malaysia's *A. malaccensis* populations remain largely incomplete with critical features that impact regeneration not fully understood.

#### Activity location

The Activity was conducted in Malaysia from 2013 until 2015. Malaysia is a country in Southeast Asia, located partly as a peninsula of the Asian mainland and partly on the northern side of the Borneo Island (Figure 1). West (Peninsular) Malaysia shares a border with Thailand, is connected by a causeway to Singapore, and has coastlines on the South China Sea and the Straits of Malacca. East Malaysia (Borneo) shares borders with Brunei Darussalam and Indonesia. Malaysia has a total landmass of 329,847 km<sup>2</sup>. Geographically, these regions are situated as stated below:

- Peninsular : 6<sup>o</sup> 45' and 1<sup>o</sup> 20' N and 99<sup>o</sup> 40' and 104<sup>o</sup> 20' E;
- Sabah : 4<sup>o</sup> 00' to 7<sup>o</sup> 00' N and 115<sup>o</sup> 20' and 119<sup>o</sup> 20' E; and
- Sarawak : 0<sup>o</sup> 50' and 5<sup>o</sup> 00' N and 109<sup>o</sup> 35' and 115<sup>o</sup> 40' E.



**Figure 1.** Location of Malaysia.

Malaysia's climate is of typical humid tropics and is characterised by year-round high temperature and seasonal heavy rain. Temperature ranges from 26<sup>o</sup>–32<sup>o</sup>C and rainfall ranges from 2000–4000 mm per annum. Rainfall is considerably high due to the influence of both the north-east and south-west monsoon. Malaysia endowed with a vast amount of natural resources including lush tropical forests is one of the most diverse and complex ecosystems in the world.

All five study and 35 sampling sites were located in Peninsular Malaysia. Molecular work and analysis were conducted in FRIM.

## **Relevant national and regional policies and programmes**

The relevant international and national policies are:

1. National Policy on Biological Diversity 1998;
2. National Forestry Policy 1978 (revised 1992); and
3. Strategic Plans for Biodiversity 2011–2020 and its associated Aichi targets.

## **1.2 Origin and Problem to be Addressed**

The origin of this Activity was based on two research studies, the first conducted between 2007 and 2008 entitled “*In vitro* Technology for Mass Propagation and Phytochemical analysis of *Aquilaria malaccensis* and *Aquilaria hirta* (Endangered Gaharu Producing Species), Project No. MINT0000089” and funded by the Government of Malaysia (Ministry of Science, Technology and Innovation, Malaysia) for an estimated US\$ 243,600. The second (March 2011 to November 2012) was entitled “Conservation studies and the development of DNA microsatellite markers on *Aquilaria malaccensis* in Peninsular Malaysia”, Project No. 23172000000002 and was also being funded by the Government of Malaysia (Ministry of Natural Resources and Environment, Malaysia) for a total sum of US\$ 72,580. Both projects were implemented by the Forest Research Institute Malaysia (FRIM). This Activity

which was funded under Phase 2 of the ITTO-CITES Work Program was therefore aimed to strengthen the results from these studies.

To ensure that wild populations of *A. malaccensis* are not adversely affected by harvesting activities and that the trade of agarwood is consistent with the sustainable management and conservation of *A. malaccensis*, Malaysia needs to establish more *Aquilaria* plantations. In order to do this, sufficient number of planting materials is required which could be produced using both *in vivo* and *in vitro* methods. If the decline in natural populations persists, availability of planting materials will be extensively affected.

Results from the 2007/08 study showed that the size class distribution of each of the five *A. malaccensis* populations is distributed in a normal curve with no population showing the inverted J-pattern. The mean for each curve varied widely between locations. All populations, except one, had a predominance of juveniles (diameter at breast height (dbh) 1.6–9.9 cm); saplings with dbh  $\leq 1.5$  cm and trees with dbh  $\geq 10$  cm appeared in low numbers. The results of the 2007/08 study also suggested irregular reproductive activity, sporadic seed production and low recruitment potential. This does not support results of Soehartono & Newton (2001) who surmised that, in general, *Aquilaria* species in Indonesia have high reproductive potential. In view of the contradicting reports and observations and the preliminary nature of the 2007/08 results, Malaysia is unable to confidently report on the ecological factors in an NDF.

As landscapes become increasingly mosaics due to anthropogenic activities, larger extension of *A. malaccensis* populations become scarcer. Genetic diversity is especially important for rare species that have small and isolated populations. The levels of genetic diversity reflect the availability of genetic resources necessary for short-term ecological adaptation and for long-term evolutionary change. Population genetic theory dictates that the initial effect of small population size is the loss of rare alleles (Hedrick 1985), whereas significant reduction in heterozygosity should occur in populations that remain small for several generations (Barrett & Kohn 1991). In addition, low genetic diversity within populations can threaten their long-term existence by reducing their ability to adapt to changing environmental conditions. Decreased genetic diversity and increased homozygosity may also affect population viability and growth rates (Vrijenhoek 1994).

Spatial genetic structuring within population can arise when differentiation factors, such as genetic drift, selection favouring different genotypes and founding events (when a new population is established by a very small number of individuals coming from a larger population), are overcome by homogenizing factors, such as gene flow, selection favouring the same genotypes, extinction and recolonization. When present, spatial genetic structure at the population level will have important implications for conservation of genetic resources; if polymorphism is distributed evenly over a population, then loss of a particular segment of the population may not necessarily increase the chance of extinction. However, if the diversity is spatially structured, a loss of a particular group of individuals may result in the loss of potentially important genotypes or alleles.

Understanding the reproductive biology, patterns of genetic diversity, underlying causes of observed genetic diversity and number of individuals required to form a viable and genetically diverse population is crucial when developing action plans for the conservation of rare or threatened species. These are aspects which will determine the success and effectiveness of an *in situ* and *ex situ* conservation programme.

## 2.0 ACTIVITY OBJECTIVES AND IMPLEMENTATION STRATEGY

The main objective of the Activity is to develop a conservation action plan to reduce harvesting pressures on wild populations for the agarwood in Peninsular Malaysia.

### 2.1 Objectives

The specific objectives of the Activity are to document the flowering phenology and reproductive behaviour of *A. malaccensis* in Peninsular Malaysia and to develop its DNA profiling databases. In this regard, the expected outputs of the Activity are as follows:

- Output 1 : Reproductive ecology information on *A. malaccensis*.
- Output 2 : Ecological genetic information for the preparation of a conservation action plan for *A. malaccensis* in Peninsular Malaysia.
- Output 3 : DNA profiling databases of *A. malaccensis* in Peninsular Malaysia for timber tracking and forensic applications.
- Output 4 : A conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.

### 2.2 Implementation Strategy

As the Activity comprised two components, researchers from Conservation & Biodiversity Informatics Branch and Genetics Laboratory, FRIM were engaged to conduct various studies during the project duration. Majority of the team members are permanent staff of FRIM except one contract staff who had been hired to work on a full-time basis. Each team had been assigned with work scopes as identified in the approved Activity Document and this was carried out independently. The implementation strategies applied for each of the activity are described as below:

#### **Output 1 : Reproductive ecology information on *A. malaccensis***

- Activity 1.1.* Literature review and determination of methods to be used.
- Activity 1.2.* Identification of study sites.
- Activity 1.3.* Selection of mother trees for observation.
- Activity 1.4.* Data collection and analysis on flowering phenology, floral bud development, flower maturity, anthesis/receptivity, fruit development and maturation and germination.
- Activity 1.5.* Publications (semi-technical and technical) describing the flowering phenology and reproductive behaviour at the study sites.
- Activity 1.6.* Training on species identification and methods to identify flowering initiation.

**Output 2 : Ecological genetic information for the preparation of a conservation action plan for *A. malaccensis* in Peninsular Malaysia**

*Activity 2.1.* Population survey and sample collections.

*Activity 2.2.* Chloroplast DNA and microsatellite analyses.

*Activity 2.3.* Data analysis and interpret genetic information for the preparation of a conservation action plan.

**Output 3 : DNA profiling databases of *A. malaccensis* in Peninsular Malaysia for timber tracking and forensic applications**

*Activity 3.1.* Establishment of DNA profiling database for individual identification.

*Activity 3.2.* Establishment of DNA profiling database for species identification.

*Activity 3.3.* Establishment of DNA profiling database for population identification.

**Output 4 : A conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin**

*Activity 4.1.* Preparation of the draft conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.

*Activity 4.2.* Conduct consultation with relevant stakeholders on the draft conservation action plan.

*Activity 4.3.* Finalization of the conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.

In terms of management structure, the Activity was implemented by FRIM. The Executing Agency was the Ministry of Natural Resources and Environment (MNRE), which governed the implementation of the project. MNRE provided guidance on policy matters pertaining to the implementation of the Activity and ensured that the Activity was on schedule in achieving its objectives.

The progress of the Activity was monitored by MNRE through regular meetings and reports. The Project Leader was responsible for the preparation and submission of progress reports. Three Biannual Activity Progress Reports were required to be submitted every six month. Short monthly progress reports were prepared and submitted to MNRE and a Project Completion Report was prepared by FRIM within three months of Activity completion for submission to ITTO. At the same time, the progress of the Activity was also monitored through Project Evaluation Meeting (PEM) conducted internally in FRIM on half yearly basis.

### 2.3 Assumptions and Risks

Risks faced during the implementation of the Activity were mainly related to the study on the flowering phenology and reproductive behaviour of *A. malaccensis*. The first was that trees in the study sites did not flower or fruit as anticipated during the study period. Being a member of the Thymelaeaceae family that only flowers once in 2–3 years, there was only one major flowering event recorded in 2014. Therefore, in order to present the best knowledge on its flowering behaviour, results from a related project was incorporated. Additionally, some degree of flexibility in the methodology was also required. This two-year study provided only a small window of opportunity to document the flowering phenology and reproductive behaviour of *A. malaccensis*. In order to increase the chances of flowering, all trees above 10 cm dbh were monitored.

The second risk associated with the Activity was that the observed trees were removed illegally during the study period. The immediate corresponding effect was that this had reduced the sample size and affected data precision. Replacement of trees not previously observed had resulted in the loss of temporal data and hence presents an imprecise flowering pattern. In order to reduce risks associated with the above-mentioned assumptions which are inter-related, sites which are both safe and have a relatively large number of adult trees were selected. The selection criteria may have resulted in a biased understanding of reproductive patterns, but this cannot be avoided.

### 3.0 ACTIVITY PERFORMANCE (Activity elements planned and implemented)

#### 3.1 Performance of Each Activity

Activity	Percentage Executed	Original Planned Completion Date	Actual Completion Date
<b>Activity 1.1</b> Literature review and determination of methods to be used.	100%	August 2013	May 2014
<b>Activity 1.2</b> Identification of study sites.	100%	September 2013	September 2013
<b>Activity 1.3</b> Selection of mother trees for observation.	100%	November 2013	November 2013
<b>Activity 1.4</b> Data collection and analysis on flowering phenology, floral bud development, flower maturity, anthesis/receptivity, fruit development and maturation and germination.	100%	June 2015	December 2015
<b>Activity 1.5</b> Publications (semi-technical and technical) describing the flowering phenology and reproductive behaviour at the study sites.	100%	May – July 2015	July 2015
<b>Activity 1.6</b> Training on species identification and methods to identify flowering initiation.	100%	July 2015	July 2015
<b>Activity 2.1</b> Population surveys and sample collections.	100%	January 2014	April 2014
<b>Activity 2.2</b> Chloroplast DNA and microsatellite analyses.	100%	September 2014	December 2014

<b>Activity 2.3</b> Data analysis and interpret genetic information for the preparation of a conservation action plan.	100%	July 2015	July 2015
<b>Activity 3.1</b> Establishment of DNA profiling database for individual identification.	100%	September 2014	December 2014
<b>Activity 3.2</b> Establishment of DNA profiling database for species identification.	100%	February 2015	September 2015
<b>Activity 3.3</b> Establishment of DNA profiling database for population identification.	100%	July 2015	September 2015
<b>Activity 4.1</b> Preparation of the draft conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.	100%	June 2015	December 2015
<b>Activity 4.2</b> Conduct consultation with relevant stakeholders on the draft conservation action plan.	100%	June 2015	September 2015
<b>Activity 4.3</b> Finalization of the conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.	100%	June 2015	December 2015



### 3.2 Outputs Achievement

Outputs / Activities	Achievements
<p><b>Activity 1.1</b> Literature review and determination of methods to be used.</p>	<p>Literature related to reproductive biology, phenology and ecology was compiled for reference. Methodology used was further refined with the aid of these references.</p>
<p><b>Activity 1.2</b> Identification of study sites.</p>	<p>A total of five study sites were identified. These sites were located in Penang and Perak.</p>
<p><b>Activity 1.3</b> Selection of mother trees for observation.</p>	<p>A total of 5 mother trees were selected for germination study, 3 for flower/fruit production study and 2 for reproductive biology study.</p>
<p><b>Activity 1.4</b> Data collection and analysis on flowering phenology, floral bud development, flower maturity, anthesis/receptivity, fruit development and maturation and germination.</p>	<p>Scaffolding was erected under two trees, AM186 and AM267 in Perak and Penang respectively for detail reproductive biology study. A total of 12 quadrates were established below five trees (AM9, AM12, AM170, AM189 and AM192) each in Perak to observe seed germination. Ten seed traps were put under each mother trees in Perak (AM14 and AM186) while for Penang (AM267), 20 seed traps.</p> <p>Data collected from the study sites were analysed and interpreted.</p>
<p><b>Activity 1.5</b> Publications (semi-technical and technical) describing the flowering phenology and reproductive behaviour at the study sites.</p>	<p>A total of 10 publications were produced as below. The complete citation is as in List of Publications. Poster – 3 Working papers – 3 Semi-technical paper – 1 Reports – 3</p>
<p><b>Activity 1.6</b> Training on species identification and methods to identify flowering initiation.</p>	<p>This Activity was officially dropped as there was a similar Activity funded by ITTO-CITES for the Forestry Department of Peninsular Malaysia.</p>
<p><b>Activity 2.1</b> Population surveys and sample collections.</p>	<p>Population survey and sample collections of <i>A. malaccensis</i> had been completed throughout Peninsular Malaysia. In total, 35 populations consisting of 942 samples were used for microsatellite analysis.</p>
<p><b>Activity 2.2</b> Chloroplast DNA and microsatellite analyses.</p>	<p>The screening of 59 universal chloroplast primer pairs managed to identify seven chloroplast regions (<i>trnK-rps16</i>, <i>ycf3-3-2</i>, <i>psbB-psbH</i>, <i>rpl16-2-1</i>, <i>psbJ-petA</i>, <i>ndhJ-trnF</i> and <i>trnQ-rps16</i>) which are suitable for <i>A. malaccensis</i>. DNA sequencing on 277 samples from 35 populations were completed for all the seven regions.</p>

	<p>Microsatellite genotyping on 942 samples from 35 populations were completed for 12 loci, i.e., <i>Ama025</i>, <i>Ama040</i>, <i>Ama053</i>, <i>Ama057</i>, <i>Ama101</i>, <i>Ama114</i>, <i>Ama115</i>, <i>Ama131</i>, <i>Ama144</i>, <i>Ama177</i>, <i>Ama331</i> and <i>Ama338</i>.</p>
<p><b>Activity 2.3</b> Data analysis and interpret genetic information for the preparation of a conservation action plan.</p>	<p>Generally, the study revealed high levels of genetic diversity and moderate population differentiation of <i>A. malaccensis</i> in Peninsular Malaysia. Based on 12 Simple Sequence Repeats (SSRs), the 35 populations could be divided into 2 genetic clusters: i) cluster Kedah-Perak; and ii) cluster Kelantan-Johor. The selections of <i>in situ</i> conservation areas should be considered independently based on these two regions.</p>
<p><b>Activity 3.1</b> Establishment of DNA profiling database for individual identification.</p>	<p>The DNA profiling database for individual identification was established based on the two genetic clusters. On the whole, each of the 942 individuals possessed a unique multilocus genotype. Overall, <i>Ama053</i> was the most discriminating locus in both of the regions (PD = 0.983 and PD = 0.987). The coancestry coefficient (<math>\theta</math>) and inbreeding coefficient (<math>f</math>) calculated for each database will be used to correct the calculation of profile frequency or random match probability using subpopulation-cum inbreeding model.</p>
<p><b>Activity 3.2</b> Establishment of DNA profiling database for species identification.</p>	<p>DNA profiling databases for species identification were established for seven <i>Aquilaria</i> species, i.e., <i>A. malaccensis</i> (4 samples), <i>A. hirta</i> (6 samples), <i>A. microcarpa</i> (8 samples), <i>A. beccariana</i> (1 sample), <i>A. crassna</i> (6 samples), <i>A. subintegra</i> (5 samples) and <i>A. sinensis</i> (7 samples). DNA sequencing completed for three regions (<i>rbcL</i>, <i>matK</i> and <i>ITS2</i>) can distinguish most of the <i>Aquilaria</i> species based on these three regions.</p>
<p><b>Activity 3.3</b> Establishment of DNA profiling database for population identification.</p>	<p>Seven chloroplast regions (<i>trnK-rps16</i>, <i>ycf3-3-2</i>, <i>psbB-psbH</i>, <i>rp16-2-1</i>, <i>psbJ-petA</i>, <i>ndhJ-trnF</i> and <i>trnQ-rps16</i>) were sequenced to establish the DNA profiling database for population identification. In total, 34 intraspecific variable sites were detected within these seven non-coding regions. In particular, 29 variable sites were caused by base substitutions and the other 5 were the result of indels. Based on the 29 cpDNA haplotypes, <i>A. malaccensis</i> in Peninsular Malaysia can be distinguished according to Kedah-Perak and Kelantan-Johor regions.</p>
<p><b>Activity 4.1</b> Preparation of the draft conservation action plan to reduce harvesting pressures</p>	<p>The conservation action plan was successfully drafted based on the results from the Activity.</p>

on wild populations for the agarwood resin.	
<b>Activity 4.2</b> Conduct consultation with relevant stakeholders on the draft conservation action plan.	A stakeholders’s dialogue was successfully conducted on the 30 September 2015 at MNRE. A total of 30 participants attended the dialogue to discuss on <i>A. malaccensis</i> conservation and related issues.
<b>Activity 4.3</b> Finalization of the conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.	A Conservation Action Plan is produced based on the findings from the Activity and related prior studies.

### 3.3 Total Amount of Expenditures and Analysis

In term of expenditure, ITTO had disbursed a total of US\$ 73,210.08 in July 2013 as the first instalment, US\$ 34,774.79 in December 2014 as the second instalment and final instalment of US\$ 33,585.13 in October 2015 to undertake the Activity that had been approved under the ITTO-CITES Program. The funding was received by FRIM on behalf of the Government of Malaysia. FRIM being the implementing agency would manage the account for all the activities carried out. The overall expenditure is in line with the original work plan activities with a balance allocation of US\$ 18,579.57 (estimation) as of 31 December 2015. Details on the overall Financial Statement and Cash Flow Statement of the Activity are as in Annexes 1A and 1B respectively. The Government of Malaysia contributions for the same period are as reflected in the overall Financial Statement and Cash Flow Statement as in Annexes 2A and 2B respectively.

## **4.0 ACTIVITY OUTCOME, TARGET BENEFICIARIES INVOLVEMENT**

### **4.1 Achievement of Specific Objectives**

The objectives of the Activity which were to document the flowering phenology and reproductive behaviour of *A. malaccensis* in Peninsular Malaysia and to develop its DNA profiling databases, including a conservation action plan to reduce harvesting pressures on wild populations for the agarwood had been accomplished. The outputs from the Activity contributed towards better improvement of managing this species in the natural environment for conservation purpose.

### **4.2 Outputs**

The above objectives were achieved through four main Outputs as below:

- Output 1 : Reproductive ecology information on *A. malaccensis*.
- Output 2 : Ecological genetic information for the preparation of a conservation action plan for *A. malaccensis* in Peninsular Malaysia.
- Output 3 : DNA profiling databases of *A. malaccensis* in Peninsular Malaysia for timber tracking and forensic applications.
- Output 4 : A conservation action plan to reduce harvesting pressures on wild populations for the agarwood resin.

### **4.3 Impact/Outcome**

Improvement in the non-detriment findings (NDF) and annual export quota for *A. malaccensis* is expected to take place. Identification of Genetic Resource Areas (GRA) and genebanks could be executed using information generated from the Activity. With the availability of DNA profiling databases, the tracking and tracing system in Malaysia could be improved to curb illegal harvesting. The CAP had identified many elements and cross-sectoral aspects of which participation from the stakeholders are important. Stakeholders are expected to benefit from the evidence-based information resulted from the study.

In general, the four outputs indicated above could influence sectoral policies and programmes in the Ministry of Natural Resources and Environment Malaysia, particularly with regards to the following:

- i. Conservation and management guidelines of *A. malaccensis* in Peninsular Malaysia;
- ii. Illegal harvesting of *A. malaccensis* from natural habitat; and
- iii. Implementation of CITES regulation.

## List of publications

1. Chua, L.S.L., Lee, S.L., Lau, K.H., Nurul-Farhanah, Z., Tnah, L.H., Lee, C.T., Ng, C.H. & Ng, K.K.S. 2016. Technical Report: Conservation action plan for the threatened agarwood species *Aquilaria malaccensis* (Thymelaeaceae) in Peninsular Malaysia. ITTO Work Program for 2013 On Support to ITTO-CITES Implementation for Tree Species and Trade/Market Transparency (TMT).
2. Lee, S.L., Nurul-Farhanah, Z., Tnah, L.H., Ng, C.H., Ng, K.K.S., Lee, C.T., Lau, K.H. & Chua, L.S.L., 2016. DNA Profiling Databases of *Aquilaria malaccensis* (Thymelaeaceae) for Population and Individual Identification. ITTO Work Program for 2013 On Support to ITTO-CITES Implementation for Tree Species and Trade/Market Transparency (TMT).
3. Chua, L.S.L., Lee, S.L., Lau, K.H., Nurul-Farhanah, Z., Tnah, L.H., Lee, C.T., Ng, K.K.S. & Ng, C.H. 2015. Completion Report: Reproductive and genetic studies towards the conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia. ITTO Work Program for 2013 On Support to ITTO-CITES Implementation for Tree Species and Trade/Market Transparency (TMT).
4. Lee, S.L., Nurul-Farhanah, Z., Tnah, L.H., Lee, C.T., Ng, K.K.S., Ng, C.H., Lau, K.H., Chua, L.S.L. 2015. DNA profiling database of *Aquilaria malaccensis* for individual identification. Poster presented at the International Science & Nature Congress (ISNAC 2015), 21–23 September 2015, PWTC, Kuala Lumpur.
5. Lau, K.H. 2015. Agarwood flowering: Masting or Coincidental? Conservation Malaysia Issue No. 20.
6. Nurul-Farhanah, Z., Lee, S.L., Tnah, L.H., Lee, C.T., Ng, C.H., Ng, K.K.S., Chua, L.S.L., Lau, K.H. 2015. Population genetics of a CITES-listed species *Aquilaria malaccensis* (Thymelaeaceae). Poster presented at the 11th Malaysia Genetics Congress 2015, 12–13 August 2015, Serdang, Selangor (Awarded Best Scientific Poster under Plant Genetics Track).
7. Lee, C.T., Lau, K.H., Nurul Farhanah, Z., Tnah, L.H., Ng, C.H., Ng, K.K.S., Lee, S.L. & Chua, L.S.L. 2014. Reproductive and genetic studies towards the conservation and Management of *Aquilaria malaccensis* in Peninsular Malaysia. Paper presented at the IUFRO XXIV World Congress 2014 side event “ITTO and CITES collaboration to sustain tropical tree species”, 9 October 2014, Salt Lake City, USA.
8. Nurul Farhanah, Z., Lee, S.L., Lee, C.T., Tnah, L.H., Ng, C.H., Ng, K.K.S., Siti Salwana, H., Chua, L.S.L. & Lau, K.H. 2013. Genetic diversity of *Aquilaria malaccensis* (Thymelaeaceae) in Peninsular Malaysia. Paper presented at the 10th Malaysia Genetics Congress, “Advances in Genetics, Biotechnology and Genomics”, 3–5 December 2013, Putrajaya, Selangor.
9. Yong, W.S.Y., Lau, K.H., Chua, L.S.L., Hamidah, M. & Chan, Y.C. Conservation of threatened plants in Universiti Teknologi PETRONAS. Poster presented at the signing of Memorandum of Understanding between MFRDB-UTP, 21 November 2013, Seri Iskandar, Perak.

10. Lau, K.H., Chua, L.S.L., Tnah, L.H., Lee, C.T., Lee, S.L., Ng, K.K.S., Ng, C.H., & Nurul Farhanah, Z. *Aquilaria* in Peninsular Malaysia: Towards its conservation and management. Paper presented at the International Conference on Agarwood, 27–29 September 2013, Changhua, Taiwan.

#### **4.4 Participation of Targeted Beneficiaries**

Various stakeholders, especially the State Forestry Departments and keeper of the study sites had given full and extensive cooperation during the Activity commencement. The Ministry of Natural Resources and Environment (MNRE) as the executing agency provided administrative advices to make certain that every planned activity were conducted effectively and on time. A stakeholders' dialogue conducted in September 2015 received satisfactory attention whereby constructive and useful suggestions and opinions were gathered to conserve *A. malaccensis* in Peninsular Malaysia.

#### **4.5 Intended Situation after Activity Completion**

Establishment of plantations using predominantly seed material is a well-expounded protocol, particularly with respect to *Aquilaria* in that wild trees, in any one population, express considerable variation in agarwood production. Hence, there is the need to identify seed trees/provenances and document their flowering periods. Understanding the flowering phenology and reproductive pattern of *A. malaccensis* in Peninsular Malaysia will allow FRIM to recommend to target beneficiaries periods when monitoring of seed trees is required. Collection, propagation and planting of materials can then be executed in a planned manner. Identification of seed trees will spearhead more concerted efforts to protect trees. In the near future, wild adult trees in accessible sites will become increasingly scarce making harvest no longer viable. As the plantation production system for agarwood matures, the cooling off period will enable damaged trees to recover and grow.

The availability of DNA profiling databases of *A. malaccensis* will enhance the capacity of enforcement officers in the conviction of illegal harvesters under Section 15 of the National Forestry Act 1984 (amended 1993). This will significantly improve Malaysia's tracking and tracing system. In addition, such databases can also be used for rapid species authentication and to certify that an *Aquilaria* product is genuinely derived from planted or sustainably managed forests.

In addition, Malaysia as a range state exporting agarwood is obliged to conduct an NDF for *A. malaccensis*. The information generated from this Activity will be channelled into the relevant parts of the NDF.

In order to ameliorate the decimation of wild populations, Malaysia will also need to establish more *Aquilaria* plantations.

#### **4.6 Expectations of Activity Sustainability**

The Activity produced four outputs i) reproductive ecology information on *A. malaccensis*, ii) ecological genetic information for *A. malaccensis* in Peninsular Malaysia, iii) DNA profiling databases of *A. malaccensis* in Peninsular Malaysia for

timber tracking and forensic applications, and iv) a conservation action plan (CAP) to reduce harvesting pressures on wild populations for the agarwood resin.

The first three outputs are the essential elements for the fourth output. The primary beneficiaries, i.e., the Forestry Department of Peninsular Malaysia (FDPM) and the various State Forestry Departments are expected to study, refine and implement the recommendations in the CAP with further consultations with FRIM. Other stakeholders such as plantations and small-holders are likely to use both the reproductive ecology and genetic information. The secondary targeted beneficiaries, i.e., the Ministry of Natural Resources and Environment (MNRE) as the lead Management Authority (MA) and the Malaysian Timber Industry Board (MTIB) as the Malaysian CITES MA will mostly benefit from the result of a DNA profile database of *A. malaccensis* for timber tracking and forensic purposes. It can also be used for rapid species authentication and product certification. These agencies will be the main users of the outputs of this Activity.

## **5.0 ASSESSMENT AND ANALYSIS**

- i. All three objectives were achieved during the Activity period. The execution of the planned activities was in accordance with the milestones and expectation outlined during the preparation of the proposal. However the Activity requested a four months no-cost extension to enable further collection and analysis of flowering phenology data. There had been a sporadic flowering activity in early 2015 and the extension of the Activity would enable the Activity team to observe subsequent fruiting development.
- ii. The participation and support given by the stakeholders were very encouraging throughout the implementation of the Activity. These were proven in many field trips carried out by FRIM in the study sites and while sampling in various forest reserves in Peninsular Malaysia. In Penang and Perak where detail reproductive biology studies were carried out, the premise owners had given full cooperation to FRIM in setting up camps and scaffolding. The State Forestry Departments were involved actively in most of the molecular sampling trips that were conducted.
- iii. The exact GPS locations of individual standing trees were not revealed in this report to prevent the abuse of the coordinates by illegal loggers. With that in mind, only the names of the forest reserves were mentioned throughout the report. Throughout the period of the Activity, 28% of the observed trees had died, of which 24% were due to human factor (illegal harvesting).

## **6.0 LESSONS LEARNT**

### **6.1 Project Identification and Design Matters**

The Activity benefited tremendously from the continued cooperation and participation of various stakeholders, in particular the State Forestry Departments and premises owners. This had enabled FRIM to collect data and samples for phenological, ecological and molecular studies. The coordination role played by the executing

agency (Ministry of Natural Resources and Environment) was very important to ensure that all planned activities were conducted on time.

The design of the Activity was appropriate that all objectives were achievable in two years, although longer duration was preferred for a thorough observation on phenology (and therefore FRIM requested for a four months extension).

## **6.2 Operational Matters**

The Activity was successfully executed by MNRE and implemented by FRIM. All three instalments were received and adequate to execute all planned activities to achieve the Activity's objectives.

Number of observed trees had decreased during the Activity period due to illegal harvesting despite preventive action taken. This had slightly affected the number of samples and hence the interpretation of data.

Field trips formed parts of the Activity and posed various challenging environment to the team. Therefore, involvement of dedicated researchers was very important, besides having adequate funding.

## **7.0 CONCLUSIONS AND RECOMMENDATIONS**

- Identification  
The Activity benefited tremendously from the continued cooperation and participation of various stakeholders, in particular the State Forestry Departments and premises owners.
- Design  
The design of the Activity was appropriate that all objectives were achievable in two years.
- Implementation  
The Activity was implemented by FRIM in accordance to the milestone and proposed schedule with a four months no-cost extension.
- Organization  
Monthly progress reports, three Biannual Activity Progress Reports and a Project Completion Report were submitted to MNRE during the project implementation duration.
- Management  
The Activity was managed by MNRE as the Executing Agency which monitored the project's implementation as well as reporting aspect.

It is recommended that the Conservation Action Plan to be studied by relevant stakeholders to address the decline of wild populations in the peninsula. Many of the elements in the CAP are cross-sectoral and require the full involvement of all stakeholders for it to achieve its aim. The tracking and tracing system capability derived from this Activity could be used by the enforcement authority as an additional



tool to fight against illegal harvesting. The establishment of DNA profiling databases is useful for rapid species authentication both in the plantation and product industries.

To ensure sustainable utilisation of forest resources, besides *A. malaccensis*, genetic information and DNA database should also be generated on other species that are valuable and threatened.

## 8.0 REFERENCES

- Barrett, S. C. H. & Kohn, J. R. 1991. Genetic and evolutionary consequences of a small population size in plants: Implications for conservation. In: Falk, D. A. & Holsinger, K. E. (eds.). Genetics and Conservation of rare plants, 3–30. Oxford University Press, New York.
- Chihambakwe, M., Mupudzi, R. and Mushove, P.T. 1997. Forestry certification: a developing world viewpoint. *Commonwealth Forestry Review* 76: 191–193.
- Hedrick, P. W. 1985. Genetics of populations. Jones and Bartlett, Boston.
- Lyke, J. 1996. Forest products certification revisited: an update. *Journal of Forestry* 94: 16–20.
- Soehartono, T. & Newton, A.C. 2001. Reproductive ecology of *Aquilaria* spp. in Indonesia. *Forest Ecology & Management* 152: 59–71.
- Tnah, L.H., Lee, S.L., Ng, K.K.S., Faridah, Q.Z. & Faridah, H.I. 2010a. Highly variable STR markers of *Neobalanocarpus heimii* (Dipterocarpaceae) for forensic DNA-profiling. *Journal of Tropical Forest Science* 22: 214–226.
- Tnah, L.H., Lee, S.L., Ng, K.K.S., Faridah, Q.Z. & Faridah, H.I. 2010b. Forensic DNA Profiling of Tropical Timber Species in Peninsular Malaysia. *Forest Ecology and Management* 259: 1436–1446.
- Tnah, L.H., Lee, S.L., Ng, K.K.S., Tani, N., Subha, B. & Rofina, Y.O. 2012. DNA extraction from dry wood of *Neobalanocarpus heimii* (Dipterocarpaceae) for forensic DNA profiling and timber tracking. *Wood Science Technology* (DOI 10.1007/s00226-011-0447-6).
- Tnah, L.H., Lee, S.L., Ng, K.K.S., Tani, N., Subha, B. & Rofina, Y.O. 2009. Geographical traceability of an important tropical timber (*Neobalanocarpus heimii*) inferred from chloroplast DNA. *Forest Ecology and Management* 258: 1918–1923.
- Vrijenhoek, R. C. 1994. Genetic diversity and fitness in small populations. In: Loeschcke, V., Tomiuk, J. & Jain, S. K. (eds.). *Conservation Genetics*, Pp. 37–53. Birkhauser Verlag, Basel, Switzerland.

## ANNEX 1A Activity Financial Statement (ITTO)

ACTIVITY FINANCIAL STATEMENT (in US Dollar)							
ITTO CONTRIBUTION FUNDING							
	Component		Original	Expenditures To-date			Available
			Amount	Accrued	Expended	Total	Funds
			(A)	(B)	(C)	(D)	(E)
				b/		{ B + C }	{ A - D }
<b>I.</b>	<b><u>Funds managed by Executing Agency</u></b>						
10.	Personnel						
	11.	Coordinator					
	12.	Other Personnel					
		12.1 Assistant 1	31,650.00	0.00	32,900.12	32,900.12	(1,250.12)
		12.2 Assistant 2					
		12.3 Other labour					
	13.	National Experts					
		13.1 Expert 1					
		13.2 Expert 2					
		13.3 Expert 3					
	14.	International Consultant(s)					
		14.1 Consultant 1					
		14.2 Consultant 2					
	<b>15.</b>	<b>Personnel Total:</b>	<b>31,650.00</b>	<b>0.00</b>	<b>32,900.12</b>	<b>32,900.12</b>	<b>(1,250.12)</b>
	16.	Workshop/Seminar and Training					
		16.1 Travel/Transportation (participants)					
		16.2 Daily Subsistence Allowances (participants)					
		16.3 Venue and Logistics					
		16.4 Workshop Materials					
		16.5 Others	200.00	0.00	761.31	761.31	(561.31)
	<b>17.</b>	<b>Workshop/Seminar and Training Total:</b>	<b>200.00</b>	<b>0.00</b>	<b>761.31</b>	<b>761.31</b>	<b>(561.31)</b>
20.	Sub-contracts						
	21.	Sub-contract					
	22.	Sub-contract					
	<b>29.</b>	<b>Component Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
30.	Travel						
	31.	Daily Subsistence Allowance					

		31.1 National Expert(s)					
		31.2 International Consultant(s)					
		31.3 Others	33,300.00	0.00	32,642.26	32,642.26	657.74
	32.	International Travel					
		32.1 National Expert(s)					
		32.2 International Consultant(s)					
		32.3 Others					
	33.	Local Transport Costs					
		33.1 National Expert(s)					
		33.2 International Consultant(s)					
		33.3 Others					
	<b>39.</b>	<b>Travel Total:</b>	<b>33,300.00</b>	<b>0.00</b>	<b>32,642.26</b>	<b>32,642.26</b>	<b>657.74</b>
40.		Capital Items					
	41.	Premises					
	42.	Vehicle(s)					
	43.	Capital Equipment					
		43.1 Computer Equipment (specify)					
		43.2 Others					
	<b>49.</b>	<b>Capital Items Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
50.		Consumable Items					
	51.	Raw Materials	71,800.00	0.00	42,909.76	42,909.76	28,890.24
	52.	Spares					
	53.	Utilities					
	54.	Office Supplies	20.00	0.00	189.98	189.98	(169.98)
	<b>59.</b>	<b>Consumable Items Total:</b>	<b>71,820.00</b>	<b>0.00</b>	<b>43,099.74</b>	<b>43,099.74</b>	<b>28,720.26</b>
60.		Miscellaneous					
	61.	Sundry	1,000.00	0.00	13,587.00	13,587.00	(12,587.00)
	62.	Other miscellaneous	3,600.00	0.00	0.00	0.00	3,600.00
	<b>69.</b>	<b>Miscellaneous Total:</b>	<b>4,600.00</b>	<b>0.00</b>	<b>13,587.00</b>	<b>13,587.00</b>	<b>(8,987.00)</b>
70.		Others (specify)					
	71.	Others					
	<b>79.</b>	<b>Others Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
100.		<b>GRAND TOTAL:</b>	<b>141,570.00</b>	<b>0.00</b>	<b>122,990.43</b>	<b>122,990.43</b>	<b>18,579.57</b>

Note: Weighted average exchange rate USD to MYR 3.494.

Amount in Item 61 is not final as it includes the estimated cost for reports printing, postage and bank charges.

## ANNEX 1B Activity Cash Flow Statement (ITTO)

ACTIVITY CASHFLOW STATEMENT (in US Dollar)						
ITTO CONTRIBUTION FUNDING						
	Component		Reference	Date	Amount	
					in US\$	Local Currency In MYR
<b>A.</b>	<b>Funds received from ITTO:</b>					
	1.	First instalment		Jul-13	73,210.08	232,222.37
	2.	Second Instalment		Dec-14	34,774.79	119,398.89
	3.	Third instalment		Oct-15	33,585.13	143,004.93
	4.	Fourth instalment				
	7.	Interest on bank deposits				
		<b>Total Funds Received:</b>			<b>141,570.00</b>	<b>494,626.19</b>
<b>B.</b>	<b>Expenditures (by Executing Agency):</b>					
10.	Personnel					
	11.	Coordinator				
	12.	Other Personnel				
		12.1 Assistant 1			32,900.12	114,953.02
		12.2 Assistant 2				
		12.3 Other labour				
	13.	National Experts				
		13.1 Expert 1				
		13.2 Expert 2				
		13.3 Expert 3				
	14.	International Consultant(s)				
		14.1 Consultant 1				
		14.2 Consultant 2				
	<b>15</b>	<b>Personnel Total:</b>			<b>32,900.12</b>	<b>114,953.02</b>
16.	Workshop/Seminar and Training					
		16.1 Travel/Transportation Costs (participants)				
		16.2 Daily Subsistence Allowances (participants)				
		16.3 Venue and Logistics				
		16.4 Workshop Materials				
		16.5 Others			761.31	2,660.00
	<b>17.</b>	<b>Workshop/Seminar and Training Total:</b>			<b>761.31</b>	<b>2,660.00</b>
20.	Sub-contracts					
	21.	Sub-contract				
	22.	Sub-contract				
	<b>29.</b>	<b>Sub-contracts Total:</b>			<b>0.00</b>	<b>0.00</b>
30.	Travel					
	31.	Daily Subsistence Allowance				
		31.1 National Expert(s)				

		31.2 International Consultant(s)				
		31.3 Others			32,642.26	114,052.04
	32.	International Travel				
		32.1 National Expert(s)				
		32.2 International Consultant(s)				
		32.3 Others				
	33.	Local Transport Costs				
		33.1 National Expert(s)				
		33.2 International Consultant(s)				
		33.3 Others				
	<b>39.</b>	<b>Travel Total:</b>			<b>32,642.26</b>	<b>114,052.04</b>
40.		Capital Items				
	41.	Premises				
	42.	Vehicle(s)				
	43.	Capital Equipment				
		43.1 Computer Equipment (specify)				
		43.2 Others (specify)				
	<b>49.</b>	<b>Capital Items Total:</b>			<b>0.00</b>	<b>0.00</b>
50.		Consumable Items				
	51.	Raw materials			42,909.76	149,926.71
	52.	Spares				
	53.	Utilities				
	54.	Office Supplies			189.98	663.80
	<b>59.</b>	<b>Consumable Items Total:</b>			<b>43,099.74</b>	<b>150,590.50</b>
60.		Miscellaneous				
	61.	Sundry			13,587.00	47,472.99
	62.	Other miscellaneous				
	<b>69.</b>	<b>Miscellaneous Total:</b>			<b>13,587.00</b>	<b>47,472.99</b>
70.		Others (specify)				
	71.	Others (specify)				
	<b>79.</b>	<b>Others Total:</b>			<b>0.00</b>	<b>0.00</b>
		Total Expenditures To-date:			122,990.43	429,728.55
		<b>Remaining Balance of Funds (A-B):</b>			<b>18,579.57</b>	<b>64,897.64</b>
<p>Note: Weighted average exchange rate USD to MYR 3.494.  Amount in Item 61 is not final as it includes the estimated cost for reports printing, postage and bank charges.</p>						

**ANNEX 2A Activity Financial Statement (GOM)**

<b>ACTIVITY FINANCIAL STATEMENT (in US Dollar)</b>							
<b>GOVERNMENT OF MALAYSIA FUNDING</b>							
	<b>Component</b>	<b>Original</b>	<b>Expenditures To-date</b>			<b>Available</b>	
		<b>Amount</b>	<b>Accrued</b>	<b>Expended</b>	<b>Total</b>	<b>Funds</b>	
		<b>(A)</b>	<b>(B)</b>	<b>(C)</b>	<b>(D)</b>	<b>(E)</b>	
			<b>b/</b>		<b>{ B + C }</b>	<b>{ A - D }</b>	
<b>I.</b>	<b><u>Funds managed by Executing Agency</u></b>						
10.	Personnel						
	11.	Coordinator	61,310.00	0.00	20,471.67	20,471.67	40,838.33
	12.	Other Personnel					
		12.1 Assistant 1					
		12.2 Assistant 2					
		12.3 Other labour					
	13.	National Experts					
		13.1 Expert 1					
		13.2 Expert 2					
		13.3 Expert 3					
	14.	International Consultant(s)					
		14.1 Consultant 1					
		14.2 Consultant 2					
	<b>15.</b>	<b>Personnel Total:</b>	<b>61,310.00</b>	<b>0.00</b>	<b>20,471.67</b>	<b>20,471.67</b>	<b>40,838.33</b>
	16.	Workshop/Seminar and Training					
		16.1 Travel/Transportation (participants)					
		16.2 Daily Subsistence Allowances (participants)					
		16.3 Venue and Logistics					
		16.4 Workshop Materials					
		16.5 Others					
	<b>17.</b>	<b>Workshop/Seminar and Training Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
20.	Sub-contracts						
	21.	Sub-contract (Topic 1)					
	22.	Sub-contract (Topic 2)					
	<b>29.</b>	<b>Component Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
30.	Travel						
	31.	Daily Subsistence Allowance					
		31.1 National Expert(s)					

		31.2 International Consultant(s)					
		31.3 DSA	6,130.00	0.00	0.00	0.00	6,130.00
	32.	International Travel					
		32.1 National Expert(s)					
		32.2 International Consultant(s)					
		32.3 Others					
	33.	Local Transport Costs					
		33.1 National Expert(s)					
		33.2 International Consultant(s)					
		33.3 Others					
	<b>39.</b>	<b>Travel Total:</b>	<b>6,130.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>6,130.00</b>
40.		Capital Items					
	41.	Premises					
	42.	Vehicle(s)					
	43.	Capital Equipment					
		43.1 Computer Equipment (specify)					
		43.2 Others					
	<b>49.</b>	<b>Capital Items Total:</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>
50.		Consumable Items					
	51.	Raw Materials	6,800.00	0.00	0.00	0.00	6,800.00
	52.	Spares					
	53.	Utilities					
	54.	Office Supplies					
	<b>59.</b>	<b>Consumable Items Total:</b>	<b>6,800.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>6,800.00</b>
60.		Miscellaneous					
	61.	Sundry					
	62.	Other miscellaneous	1,300.00	0.00	0.00	0.00	1,300.00
	<b>69.</b>	<b>Miscellaneous Total:</b>	<b>1,300.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>1,300.00</b>
70.		Others (specify)					
	71.	Others (Management cost)	14,157.00	0.00	0.00	0.00	14,157.00
	<b>79.</b>	<b>Others Total</b>	<b>14,157.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>14,157.00</b>
100.		<b>GRAND TOTAL:</b>	<b>89,697.00</b>	<b>0.00</b>	<b>20,471.67</b>	<b>20,471.67</b>	<b>69,225.33</b>
Note: Weighted average exchange rate USD to MYR 3.494.							

## ANNEX 2B Activity Cash Flow Statement (GOM)

ACTIVITY CASHFLOW STATEMENT (in US Dollar)						
GOVERNMENT OF MALAYSIA FUNDING						
	Component		Reference	Date	Amount	
					in US\$	Local Currency In MYR
<b>A.</b>	<b>Funds received from ITTO:</b>					
	1.	First instalment		Jul-13	44,848.50	142,259.44
	2.	Second Instalment		Dec-14	22,032.80	75,649.40
	3.	Third instalment		Oct-15	22,815.70	97,149.25
	4.	Fourth instalment				
	5.	Interest on bank deposits				
		<b>Total Funds Received:</b>			<b>89,697.00</b>	<b>315,058.09</b>
<b>B.</b>	<b>Expenditures (by Executing Agency):</b>					
10.	Personnel					
	11.	Coordinator (Team Leader & Assistant)			20,471.67	71,528.00
	12.	Other Personnel				
		12.1 Assistant 1				
		12.2 Assistant 2				
		12.3 Other labour				
	13.	National Experts				
		13.1 Expert 1				
		13.2 Expert 2				
		13.3 Expert 3				
	14.	International Consultant(s)				
		14.1 Consultant 1				
		14.2 Consultant 2				
	<b>15.</b>	<b>Personnel Total:</b>			<b>20,471.67</b>	<b>71,528.00</b>
	16.	Workshop/Seminar and Training				
		16.1 Travel/Transportation Costs (participants)				
		16.2 Daily Subsistence Allowances (participants)				
		16.3 Venue and Logistics				
		16.4 Workshop Materials				
		16.5 Others				
	<b>17.</b>	<b>Workshop/Seminar and Training Total:</b>			<b>0.00</b>	<b>0.00</b>
20.	Sub-contracts					
	21.	Sub-contract (Topic 1)				
	22.	Sub-contract (Topic 2)				
	<b>29.</b>	<b>Sub-contracts Total:</b>			<b>0.00</b>	<b>0.00</b>
30.	Travel					



	31.	Daily Subsistence Allowance				
		31.1 National Expert(s)				
		31.2 International Consultant(s)				
		31.3 DSA				
	32.	International Travel				
		32.1 National Expert(s)				
		32.2 International Consultant(s)				
		32.3 Others				
	33.	Local Transport Costs				
		33.1 National Expert(s)				
		33.2 International Consultant(s)				
		33.3 Others				
	<b>39.</b>	<b>Travel Total:</b>			<b>0.00</b>	<b>0.00</b>
40.		Capital Items				
	41.	Premises				
	42.	Vehicle(s)				
	43.	Capital Equipment				
		43.1 Computer Equipment (specify)				
		43.2 Others (specify)				
	<b>49.</b>	<b>Capital Items Total:</b>			<b>0.00</b>	<b>0.00</b>
50.		Consumable Items				
	51.	Raw materials				
	52.	Spares				
	53.	Utilities				
	54.	Office Supplies				
	<b>59.</b>	<b>Consumable Items Total:</b>			<b>0.00</b>	<b>0.00</b>
60.		Miscellaneous				
	61.	Sundry				
	62.	Other miscellaneous				
	<b>69.</b>	<b>Miscellaneous Total:</b>			<b>0.00</b>	<b>0.00</b>
70.		Others (specify)				
	71.	Others (Management cost)				
	<b>79.</b>	<b>Others Total:</b>			<b>0.00</b>	<b>0.00</b>
		<b>Total Expenditures To-date:</b>			<b>20,471.67</b>	<b>71,528.00</b>
		<b>Remaining Balance of Funds (A-B):</b>			<b>69,225.33</b>	<b>243,530.09</b>

Note: Weighted average exchange rate USD to MYR 3.494.