RAP PUBLICATION 2011/07

Protection against South American leaf blight of rubber in Asia and the Pacific region

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FOREWORD

On 26 November 1955 the Asia and Pacific Plant Protection Agreement was approved by the FAO Council under Article XIV of the FAO Constitution. The Asia and Pacific Plant Protection Commission (APPPC) was subsequently set up in 1956. According to the Agreement, the contracting governments were requested to take measures to exclude South American leaf blight (SALB) of *Hevea* from the region, specified in Appendix B to the Agreement.

In 1999 the Agreement was amended, in line with the WTO-SPS Agreement and the revised text of IPPC in 1997, and approved by the FAO Council at its 117th Session in 1999. It was decided that the amended Agreement, providing for the deletion of Appendix B, would only be distributed when the Director-General was notified by the Secretary of the APPPC that a satisfactory regional standard on SALB had been adopted by the Commission.

In early September 2009, the Regional Standard for Phytosanitary Measures (RSPM) on SALB was adopted by the 26th Session of the APPPC. In that same year the amended Agreement was submitted by the Director-General to all members of the Asia and Pacific Plant Protection Commission for their acceptance.

The APPPC has invested a great deal of effort and resources into achieving progress in safeguarding against the incursion of South American leaf blight of rubber into countries in the region. This publication contains four reference books prepared by the APPPC for protection against SALB in Asia and the Pacific:

Book 1. Pest risk analysis for South American leaf blight (SALB) of rubber (*Hevea*)

Book 2. APPPC RSPM No. 7: Guidelines for the protection against South American leaf blight of rubber

Book 3. Work plan for the importation of budded stumps or budwood of *Hevea spp*

Book 4. Contingency plan for South American leaf blight (*Microcyclus ulei*)

It is expected that this publication will provide APPPC member countries with valuable reference materials for dealing with SALB issues in the region and in preparing the way for further progress.

Hiroyuki Konuma
Assistant Director-General and
Regional Representative for Asia and the Pacific

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INTRODUCTION

Rubber is an important cash crop in a number of countries in the Asia-Pacific region. Current total global production of natural rubber is about 9 million tonnes. Over 90 percent of that amount is produced in this region, mainly in Thailand, Indonesia and Malaysia. Other major producing countries are China, India, Sri Lanka and Viet Nam. Over 410 000 households in Malaysia are dependent on the crop for their livelihoods, with more than 1.2 million hectares of planted rubber trees. The number of households involved in the industry in countries such as Thailand and Indonesia is much more.

South American leaf blight (SALB) is a fungal disease of rubber trees and poses a major threat to the region. Up to now the disease has been restricted to South and Central America, where it has inhibited natural rubber production on a commercial scale. So far, use of modern systemic fungicides and improved application techniques have failed to prevent large losses and dieback of trees. Its potential to affect other regions rises with every transcontinental airline connection that directly links tropical regions. The need to develop quarantine measures against the disease is urgent.

This publication has been prepared as a set of reference materials to improve phytosanitary measures in the Asia-Pacific region and safeguard against the incursion of South American leaf blight of rubber into countries in the region. It is a compilation of four separate documents intended as a practical reference tool for national plant protection organizations (NPPOs) especially for plant quarantine officials in rubber growing countries in the region. It is one of the many measures that the Asia and Pacific Plant Protection Commission (APPPC) is putting in place to prevent SALB disease in the region. The reference materials consist of four books.

Book I – Pest risk analysis for South American leaf blight (SALB) of rubber (*Hevea*)

The Asia and Pacific Plant Protection Commission has organized several workshops on preparation of pest risk analysis (PRA) on SALB in the past several years, in addition to sending an expert pathologist of rubber research from Malaysia to Brazil and New Zealand for joint research and filling in research information gaps. The pest risk analysis on SALB was adopted by the 25th session of the Asia and Pacific Plant Protection Commission in Beijing, China in 2007, which was the essential basis for development of a regional standard for phytosanitary measures (RSPM) on SALB.

Book II – APPPC RSPM No. 7: Guidelines for the protection against South American leaf blight of rubber

The Guidelines for Protection against South American Leaf Blight of Hevea were adopted as RSPM No.7 at the 26th session of the APPPC in September 2009 in New Delhi, India. The adoption of this RSPM represents significant progress made by the Commission in harmonizing phytosanitary measures. It allowed the process for the acceptance of the second part of the 1999 amendments to the Asia and Pacific Plant Protection Agreement to proceed. The amendment is about the deletion of Article IV and Appendix B "measures to exclude SALB of *Hevea* from the region", which remained more than 50 years in the Agreement, with a specific precondition – the amended Agreement will only be distributed when the Director-General is notified by the Secretary of the Asia and Pacific Plant Protection Commission that a satisfactory regional standard on SALB has been adopted by the Commission. The Director-General transmitted the amended Agreement to all members of APPPC in 2010 for acceptance as it was adopted by the Session of APPPC in 2009.

Book III – Work plan for the importation of budded stumps or budwood of *Hevea spp*

During the 26th session of the APPPC, it was suggested that the Commission set up a working group on SALB to develop a series of activities to support the SALB Regional Standard. The working group, led by Malaysia, would arrange for a workshop to discuss in detail the prevention of the introduction of SALB including import requirements, inspection procedures, diagnostics, disinfection of plants from SALB endemic countries and capacity building in line with the PRA and RSPM No.7 to further assist countries' efforts to safeguard against the incursion of SALB into this region. The model work plan for the importation of budded stumps or budwood of *Hevea spp* is one of the significant outputs of the workshop, which was held in Kuala Lumpur, Malaysia from 13 to 17 December 2010. It was recognised that the importation of budded stumps and budwood represented a potentially high risk pathway for the introduction of *Microcyclus ulei*, the causal agent of SALB, into the rubber producing countries of the APPPC. For this reason, the procedures outlined in the *Pest Risk Analysis for South American Leaf Blight (SALB) of Rubber (Hevea)* involve a number of pre-export activities and requirements designed to keep the risk off-shore, as well as on-arrival and post-entry procedures to ensure that rubber material released from quarantine is free from *M. ulei*. The model work plan is designed to be used by countries that wish to import budded stumps or budwood of *Hevea spp* from countries where *M. ulei* is present, and sets out the agreed responsibilities and procedures in more detail than the PRA. This work plan describes the operational requirements and the phytosanitary procedures for the importation of budded stumps or budwood of *Hevea spp* from an exporting country into an importing country in the region in order to address the risk of South American Leaf Blight and other regulated pests. The measures and requirements detailed in this document meet the management measures described in the *Pest Risk Analysis for South American Leaf Blight (SALB) of Rubber (Hevea)* and the phytosanitary import requirements for other potential pests of concern to importing countries. The model work plan is a guide. Countries that wish to use the model work plan are not bound by the existing text, but are free to vary the work plan as they see fit, in accordance with their own preferred procedures, their appropriate level of protection and the recommendations of the PRA.

Book IV – Contingency plan for South American leaf blight (*Microcyclus ulei*)

A contingency plan for the SALB is another valuable reference document for dealing with SALB in the region. The plan was drafted by the APPPC workshop on pest incursion and eradication, which was convened from 30 August to 3 September 2010 in Seoul, Republic of Korea in line with the work plan of the 26th Session of APPPC. This contingency plan is designed to prepare for an incursion of South American Leaf Blight (*Microcyclus ulei*) of rubber (*Hevea brasiliensis*). The contingency plan not only provides a summary of information on the biology of the pest and the available control measures for the disease, but also provides guidelines for steps to be undertaken and considered when developing a response plan for this pest. The response plan is operational and determines the resources that are needed. It is noted that there is a need for a specific diagnostic protocol on the causal agent of the disease. This should include information on the cultural, morphological, molecular and serological characteristics of *Microcyclus ulei* and the methodology for pathogenicity tests. A response checklist has been developed which lists the actions that need to be considered in preparing a response plan. Further pest information is provided on delimiting survey and epidemiology studies with estimations on sampling methods, and the availability of control methods including cultural, chemical, mechanical and biological methods. The second main section of the contingency plan discusses a destruction strategy and the need for destruction and decontamination protocols and disposal issues. Quarantine and movement controls for people, plant material and machinery are described. Information on the necessary zoning is provided for zones for destruction, quarantine, buffer, and for restricted and control areas. In addition, there is information on decontamination and farm clean up and surveillance and tracing. A list of appendices to be developed is provided including those for diagnostic protocols, experts, resources and facilities, a communications strategy and market access impacts.

The Pest Risk Analysis on South American Leaf Blight, The Contingency Plan for South American Leaf Blight of Rubber and the Model Work Plan for the Importation of Budded Stumps or Budwood of *Hevea* are supporting documents for the implementation of the Regional Standards for Phytosanitary Measures No. 7 – Guidelines for Protection against South American Leaf Blight of Rubber. These documents reflect the most up-to-date progress of APPPC in terms of management of SALB and are essential references for protection against SALB in Asia and Pacific region.

Further development of additional operational guidelines, references and measures for prevention of SALB in the Asia-Pacific region are ongoing. The Asia and Pacific Plant Protection Commission is at the forefront of actions taken in the region to safeguard the region from this devastating fungus. It is expected that parts of the reference materials presented in this publication will be updated in the next few years as the guidelines and measures are implemented. Updated materials will be republished and reissued to member countries as the need arises.

Book I

Pest risk analysis for South American leaf blight (SALB) of rubber (*Hevea*)

(Adopted by the 25th Session of the APPPC in 2007)

CONTENTS OF BOOK I

CONTENTS *(continued)*

PEST RISK ANALYSIS
FOR SOUTH AMERICAN LEAF BLIGHT (SALB)
OF RUBBER *(HEVEA)*

EXECUTIVE SUMMARY

Introduction

This pest risk analysis (PRA) was prepared by rubber (*Hevea brasiliensis*) growing member countries of the Asia and Pacific Plant Protection Commission (APPPC); namely Thailand, Indonesia, Malaysia, India, China, Viet Nam and Sri Lanka. The PRA is expected to provide the scientific justification for standards that will be developed by the APPPC and member countries to manage the trade-related phytosanitary risks of South American Leaf Blight (SALB). Associated standards on diagnostics, surveillance, import regulation, control and eradication would provide guidelines to further assist countries efforts to safeguard against the incursion of SALB into the PRA area.

Summary of the risk assessment

Vector	Probability of entry	Probability of establishment	Probability of spread	Likely impact	Level of risk
Host material (*Hevea* species)					
Budded stumps or budwood	High	High	High	High	High
Foliage (stem and leaf material not for planting)	Low	High	High	High	Moderate
Flowers, fruit and seeds	Low	High	High	High	Low
Plants *in-vitro*	Negligible	N/A	N/A	N/A	Negligible
Non-host material					
Inanimate goods or non-host organic material	Negligible	N/A	N/A	N/A	Negligible
Inanimate goods or non-host organic material contaminated by host plant material	Low (if <1 cm^2)	High	High	High	Low (if <1 cm^2)

Summary of recommended risk management options

Viable or non-viable SALB host material (susceptible *Hevea* species) can either be imported from areas considered free of SALB or meet the following phytosanitary requirements:

Budded stumps or budwood

a. Pre-export inspection and treatment

- Mother plants should be inspected by suitably qualified plant pathologist for signs of SALB infection and deemed to be free of SALB infection. Inspections should take place immediately before the harvesting of budded stumps or budwood and during a period considered optimal for disease expression;

- Harvesting of budded stumps and budwood should only occur when the bark has been hardened (brown in colour) and during the low-disease season (e.g. dry weather). Budded stumps and budwood should be no longer than 1 metre when exported;
- Budded stumps and budwood should be packaged for export in a manner that limits the likelihood of infestation during transport.
- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- Budded stumps should have their roots washed of any attached soil.

b. Measures on arrival (in an appropriately secure facility)

- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- All packaging material should be destroyed or appropriately sterilized, and the budded stumps and budwood repackaged after treatment.

c. Post entry quarantine

- Imported budded stumps and budwood should be grown in a suitable post entry quarantine facility for at least one year or after new foliage has been produced at least six times;
- Plants should be inspected for signs of SALB daily by suitable trained facility staff and fortnightly by suitably qualified plant pathologists;
- Should any signs of SALB be detected, plants showing signs should be destroyed and all other *Hevea* plants within the facility should be treated with suitable fungicide (treatment may require six or more applications);
- Prior to release from the facility all plants in the facility should be inspected by a suitable qualified plant pathologist for signs of SALB infection;
- Plants may be released from the post entry quarantine facility only after having all plants in the facility have been free from any signs of SALB for at least one year or after new foliage has been produced at least six times.

d. Intermediate quarantine

Intermediate quarantine offers a further option to mitigate risk. This system can have some logistical, maintenance and financial problems when used for rubber, but it may operate successfully in some specific circumstances.

Plants *in vitro*

Plants *in vitro* should be held in culture and free of any type of contamination for at least three months prior to being released into the PRA area.

Seeds, flowers and fruit

Flowers and fruits should be washed with a surface sterilant such as 200 ppm of sodium hypochlorite (Chee 2006). Only healthy seeds should be selected for export, washed with water and soaked in formalin (5%) for 15 minutes, and then air dried and dressed with thiophanate methyl, benomyl or mancozeb (Chee 1978; Santos and Pereira 1986).

Foliage

Normally, foliage of rubber plants is prohibited and hence not imported.

Non-viable host material on the cargo pathway

Cargo from SALB infested countries or areas should be screened for goods or shipments that are likely to contain or be contaminated by non-viable host material. A profile list should be established that identifies cargo most at risk of containing non-viable host material.

Cargo such as used machinery (cars, logging equipment, chainsaws, cutters etc.) that may have been used in rubber plantations should be thoroughly steam cleaned of all organic material larger than 1 cm^2, and dismantled if there are parts that can not be easily cleaned. Household effects should be inspected for gardening equipment that may be contaminated by organic material.

Any organic material that is thought to be from a susceptible *Hevea* species, is larger than 1 cm^2, and can not be removed from the goods or can not be destroyed (e.g. herbarium material), should be heat treated for a minimum of 30 continuous minutes at 56ºC or greater. Measures may include cleaning, disinfection or destruction.

Non-viable host material on the passenger pathway

Passengers and accompanied luggage arriving within 21 days from areas not known to be free of SALB should be inspected for both viable and non-viable host material. Special care should be taken with such items as camping equipment and hiking boots, farm equipment, and decorative plant material as these are more likely to contain or be contaminated by non-viable host material greater than 1 cm^2.

Residual risk after measures

While the measures above, if strictly and effectively enforced, should be expected to manage the phytosanitary risks posed by SALB to the PRA area, it should still be considered possible that slippage (undetected risk items) may result in the establishment of SALB in the region. Efforts should be made to manage this residual risk by establishing an effective monitoring system that would be expected to detect an establishment event early enough to allow for an effective eradication programme to be completed.

1.0 INTRODUCTION

This pest risk analysis (PRA) was prepared by rubber (*Hevea brasiliensis*) growing member countries of the Asia and Pacific Plant Protection Commission (APPPC); namely Thailand, Indonesia, Malaysia, India, China, Viet Nam and Sri Lanka. This PRA was prepared in response to the proposed deletion of Article IV and Appendix B (see Annex 2) on transitional measures for South American Leaf Blight (SALB) of rubber caused by *Microcyclus ulei* within the new proposed revised text of APPPC Plant Protection Agreement for the Asia and Pacific region. The revision updates the Plant Protection Agreement and brings it into compliance with the Sanitary and Phytosanitary Agreement (SPS Agreement) and the 1997 revised text of the International Plant Protection Convention (IPPC). The APPPC member countries agreed that Article IV and Appendix B of the Agreement as currently in force dealing with SALB should be retained until a PRA on SALB had been completed and an appropriate regional standard agreed to by APPPC.

Subsequently, a Technical Cooperation Programme project (TCP) was approved by FAO in July 2001 (Project Pest Risk Analysis for SALB of rubber-TCP/RAS/0168A) to develop a PRA on SALB. The PRA is expected to provide the scientific justification for standards that will be developed by the APPPC and member countries to manage the trade-related phytosanitary risks of SALB. Associated standards on diagnostics, surveillance, import regulation, control and eradication would provide guidelines to further assist countries efforts to safeguard against the incursion of SALB into the PRA area.

The purpose of this PRA is to:

i. examine and evaluate the risks of SALB being associated with the relevant commodities/pathways from the SALB endemic countries into the Asia and Pacific region;

ii. evaluate risks of introduction and spread of SALB into the region;
iii. evaluate the economic consequences that may result from the establishment of SALB in the region; and
iv. evaluate various management options to mitigate the identified phytosanitary risks.

This PRA is prepared based on the International Standard for Phytosanitary Measures Guidelines on Pest Risk Analysis (ISPM No. 2) and Pest Risk Analysis for Quarantine Pests, including analysis of environmental risks and living modified organisms (ISPM No. 11 Rev. 1).

Other resources utilized include:

a. Literature on SALB;
b. Consultation with scientists/experts on SALB;
c. Asian rubber producing country regulatory agencies and plant pathologists.

Definitions used in this PRA are consistent with ISPM 5: Glossary of Phytosanitary Terms (2005) unless otherwise stated.

1.1 Background

Natural rubber is produced by *Hevea brasiliensis*, a tree native to the Amazon region of South America. In the late eighteenth century, rubber was introduced to the Far East, which is now the main rubber-producing region of the world. Currently, the major producers of natural rubber are Thailand, Indonesia, Malaysia, India, China, Viet Nam and Sri Lanka. In 2005, the world's production of natural rubber amounted to 8 682 million tonnes whereby 7 466 million tonnes (approximately 86 percent) originated from these seven countries. In 2005, the world's consumption was over 8 742 million tonnes of natural rubber.

The natural rubber industry is a very important component of the agricultural sector and economies of the Asia and Pacific rubber producing countries. The introduction of SALB which has severely damaged the rubber industry in South America (see below), is currently considered to pose a direct threat to the natural rubber industry of these countries. Regional cooperation and phytosanitary action to protect these industries may be necessary to appropriately manage any potential consequences from SALB establishment and spread.

1.2 Compliance with international rights and obligations

The SPS Agreement applies to measures designed to protect human, animal and plant life and health from pests and diseases, or a country from pests, which may directly or indirectly affect international trade. It also recognizes the right of WTO member countries to determine the level of protection they deem appropriate and to take necessary measures to achieve that protection. Sanitary (human and animal health) and phytosanitary (plant health) measures apply to trade or movement of animal and plant based products within or between countries.

In the SPS Agreement, SPS measures are defined as any measures applied:

- to protect animal or plant health within the territory of the member from risks arising from entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms.
- to protect human or animal life or health within the territory of member from risks arising from additives, contaminants, toxins or disease-causing organism in foods, beverages or feedstuffs.
- to protect human or animal life or health within the territory of member from risks arising from diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests.
- to protect or limit other damage within the territory of the member from the entry, establishment or spread of pests.

As SALB only directly affects plant health, the SPS measures should be developed and implemented in accordance with the principles of the IPPC (ISPM 1 2006). In the context of this risk analysis these principles include:

- **Sovereignty** – Contracting parties have sovereign authority, in accordance with applicable international agreements, to prescribe and adopt phytosanitary measures to protect plant health within their territories and to determine their appropriate level of protection for plant health.
- **Necessity** – Contracting parties may apply phytosanitary measures only where such measures are necessary to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests.
- **Minimal impact** – Contracting parties should apply phytosanitary measures with minimal impact.
- **Transparency** – Contracting parties shall make relevant information available to other contracting parties as set forth in the IPPC.
- **Non-discrimination** – Contracting parties should, in accordance with the IPPC, apply phytosanitary measures without discrimination between contracting parties if contracting parties can demonstrate that they have the same phytosanitary status and apply identical or equivalent phytosanitary measures. Contracting parties should also apply phytosanitary measures without discrimination between comparable domestic and international phytosanitary situations.
- **Technical justification** – Contracting parties shall technically justify phytosanitary measures.

1.3 The PRA area

The PRA area for the purpose of this PRA is the Asia and Pacific region which encompasses the major rubber growing countries of Thailand, Indonesia, Malaysia, India, China, Viet Nam and Sri Lanka, as well as the minor rubber growing countries of Cambodia, Bangladesh, Lao PDR, Brunei, Philippines, Myanmar, and Papua New Guinea. These areas are currently considered free from SALB. The area of rubber planted, total production, export value and the number of rubber smallholders for these rubber growing countries are shown in Table 1.

Table 1. Area of rubber planted, production, export value and number of smallholders in Asia and the Pacific region 2003-2005

Country	Total area planted (million ha)			Total production (’000 metric tonnes)			Export value ($USD millions)			No. of small-holders (million)
	2003	2004	2005	2003	2004	2005	2003	2004	2005	
Thailand	2.010	2.019	2.083	2 876	2 984	2 833	2 788	3 429	3 715	6.0
Indonesia	3.290	3.262	4.363	1 792	2 066	2 270	1 493	2 180	2 582	12.10
Malaysia	1.28	1.32	1.237	985	1 168	1 126	4 800	7 880	5 787	1.6
India	0.574	0.578	0.583	712	750	803	77.08	50.1	91.55	1.0
China	0.661	0.662	0.661	565	570	460	N/A	N/A	N/A	3.0
Viet Nam	0.440	0.454	0.480	450	513	697	350	579	1 270	0.068
Sri Lanka	0.115	0.116	0.116	92	51	104	39	51	47	0.2
Other Asia and Pacific Countries	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

N/A: Information not available at time of publication.

1.4 Previous risk assessments

Ikin and Liyanage (1999) prepared a simplified PRA for SALB of rubber for the APPPC. The analysis and recommendations developed as part of that work have been considered in the development of this PRA.

2.0 INITIATION

2.1 Initiation event

Rubber is indigenous to South America. Many attempts to start a viable rubber industry in that region have met with failure because of the presence of SALB and the lack of a cost-effective management tools in that region. SALB spreads rapidly causing severe leaf fall and twig dieback. Chemical control that involves repeated fungicide applications to trees of great height has been found to be expensive and impractical. Breeding for disease resistance was continuously frustrated by the concurrent evolution of new physiological races of the pathogen that are capable of breaking down the resistance. No rubber clones can therefore escape infection over the long term. The rubber in Southeast Asia and the PRA area was introduced from South America and it was perhaps fortunate that SALB did not establish during this introduction period.

Foreseeing the potential risks of the disease, regulations, restrictions and prohibitions on imports from South America were introduced and imposed in the 1950's as required by Article IV in the Pacific Plant Protection Agreement for the Asia and Pacific region. In addition, the Association of Natural Rubber Producing Countries (ANRPC) introduced the ANRPC Agreement on SALB to complement the aforementioned agreement. The International Rubber Research and Development Board (IRRDB) also carried out research and undertook measures to exclude SALB from the region.

SALB is considered to remain a constant threat to the wellbeing of the Southeast Asia rubber industries. This is because of the expansion of international trade links with Central and South American countries wishing to penetrate Asian market. Although the importation of rubber planting material for breeding purposes is considered to pose the greatest danger of disease establishment in the region, other pathways need to be examined and their potential risks determined.

The Plant Protection Agreement for the Asia and Pacific region (APPPC) was revised between 1997 and 1999 to update and align the Agreement with the International Plant Protection Convention (IPPC 1997) and the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement 1995). The Agreement contains provisions referring specifically to SALB with a related appendix describing procedures for reducing the risk of introduction of SALB into the region.

The provisions of the APPPC Agreement placed stringent requirement on all contracting parties. These requirements are now seen not to be in compliance with the SPS Agreement or the 1997 revised text of the IPPC since phytosanitary measures imposed under the Agreement were not technically justified. This PRA on SALB is a result of the decision to amend the APPPC Agreement.

The main priority of the 1998-1999 APPPC work plan was the revision of the SALB Agreement.

- A working group meeting was held on 20-24 April 1998 to prepare the 1st draft. The working group could not reach an agreement on the deletion of Article IV and Appendix B concerning measures to exclude SALB from the region.
- A further consultation was held on 8-12 February 1999 and agreed to the restructuring and updating of the Agreement. A compromise was reached on the issue of SALB – measures in the Appendix B would be restricted to rubber producing countries and those with contiguous borders and be recognized as transitional until the Commission had developed an appropriate regional standard.
- At 21st session of APPPC (1999), it was decided that Article IV and Appendix B of the Agreement as currently in force dealing with SALB be retained until such time as a PRA had been completed and an appropriate regional standard agreed to by the Commission. It was noted that Article XIV and the Appendix B set out in the proposed revised Agreement were in contradiction with the requirements of the SPS Agreement and as such could not accept an Agreement that was not compliant with current SPS Agreement.
- October 1999, a working group on SALB was established and focused on the development of a Technical Cooperation Programme project (TCP) for a PRA for SALB of rubber.

- August 2003 – at the 23rd APPPC meeting, it was decided to rephrase some parts of the TCP to ensure that the PRA is developed by a group of experts from within the region. It is expected that follow-up work will be needed to produce supplementary standards to meet the needs of the rubber growing countries in the APPPC.

2.2 Conclusion of initiation

SALB of rubber is endemic in South America and is currently considered a high risk quarantine pest in the PRA area where 90 percent of the world's rubber is grown.

Following the decisions at the 21st session of APPPC (1999), a PRA on SALB has been initiated to develop appropriate standards to manage the phytosanitary risks of SALB to the APPPC region.

3.0 PEST RISK ANALYSIS

Given the level of uncertainty surrounding many of the epidemiological characteristics of SALB and the causal organism, the following risk analysis has been undertaken using qualitative rather than quantitative values. Table 2 describes these qualitative values in terms of the descriptors used for estimating likelihoods and consequences in the risk assessment.

Table 2. Rating for qualitative likelihood

Descriptor	Likelihood description	Consequence description
High	The event would be most likely to occur	• Impact threatens economic viability of a number of industries • A large increase in plant injury or mortality • A large decrease in production • Impacts are not reversible
Moderate	The event would be likely to occur	• Impact threatens economic viability of an industry • A moderate increase in plant injury or mortality • A moderate decrease in production • Impacts may not be reversible
Low	The event would be less likely to occur	• Impact does not threaten economic viability of an industry • Only a minor increase in plant injury or mortality • A minor decrease in production • Impact is reversible (if greater than listed)
Negligible	The event would be unlikely to occur	Impact not distinguishable

3.1 Pest categorization

At the outset, it may not be clear if an identified pest requires a PRA. The categorization process examines for the target pest whether the criteria in the definition for a quarantine pest are satisfied.

3.1.1 Pest identity, taxonomy, hosts and plant parts affected

Pathogen: *Microcyclus ulei* (P. Henn.) v. Arx

Order: Ascomycetes

Family: Dothideales

Synonyms: *Dothidella ulei* (Henn. 1904)
Melanopsammopsis ulei (Henn.) Stahel 1917
Aposphaeria ulei Henn. 1904
(conidial state: *Fusicladium macrosporum* Kuyper 1912)

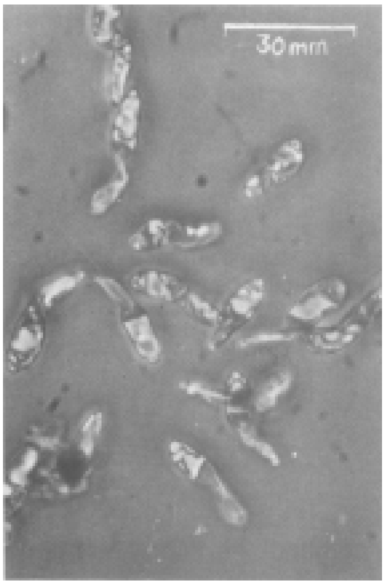
Common name:	South American Leaf Blight (SALB)
Host species:	*Hevea brasiliensis* Muell. Arg. (Commercial species) *Hevea benthamiana* Muell. Arg. *Hevea guianensis* Aubl. *Hevea spruceana* (Benth.) Muell. Arg.
Part of plants affected:	Young leaves severely affected. The young tissue of petioles, stems, inflorescences and fruit pods is less affected.

3.1.2 Biology and epidemiology

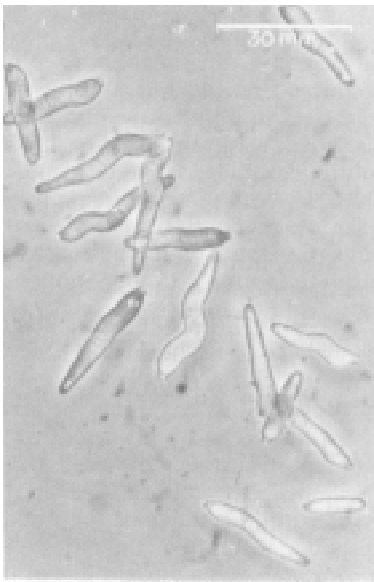
Spore production, germination and infection

The causal pathogen *Microcyclus ulei* is known to only infect species within the genus *Hevea*. It produces three types of spores; conidia on immature leaves; pycnospores on newly matured leaves; and ascospores on fully matured leaves. The main propogules are conidia and ascospores (Plate 1b, d). Pycnospores do not appear to germinate and do not therefore constitute an effective agent of disease dissemination (Plate 1c).

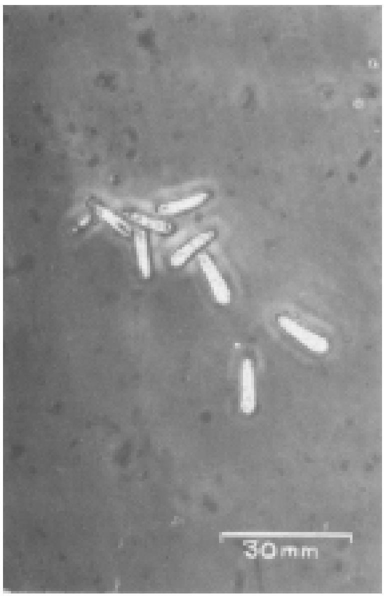
Plate 1. Conidia, pycnospores and ascospores (from Chee & Holliday 1986)



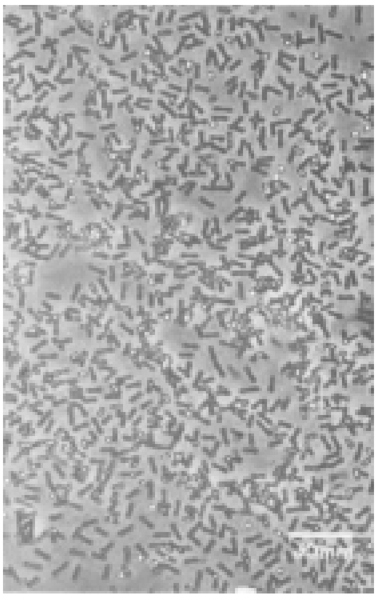
a) Dry, collapsed conidia



b) Turgid conidia



c) Pycnospores

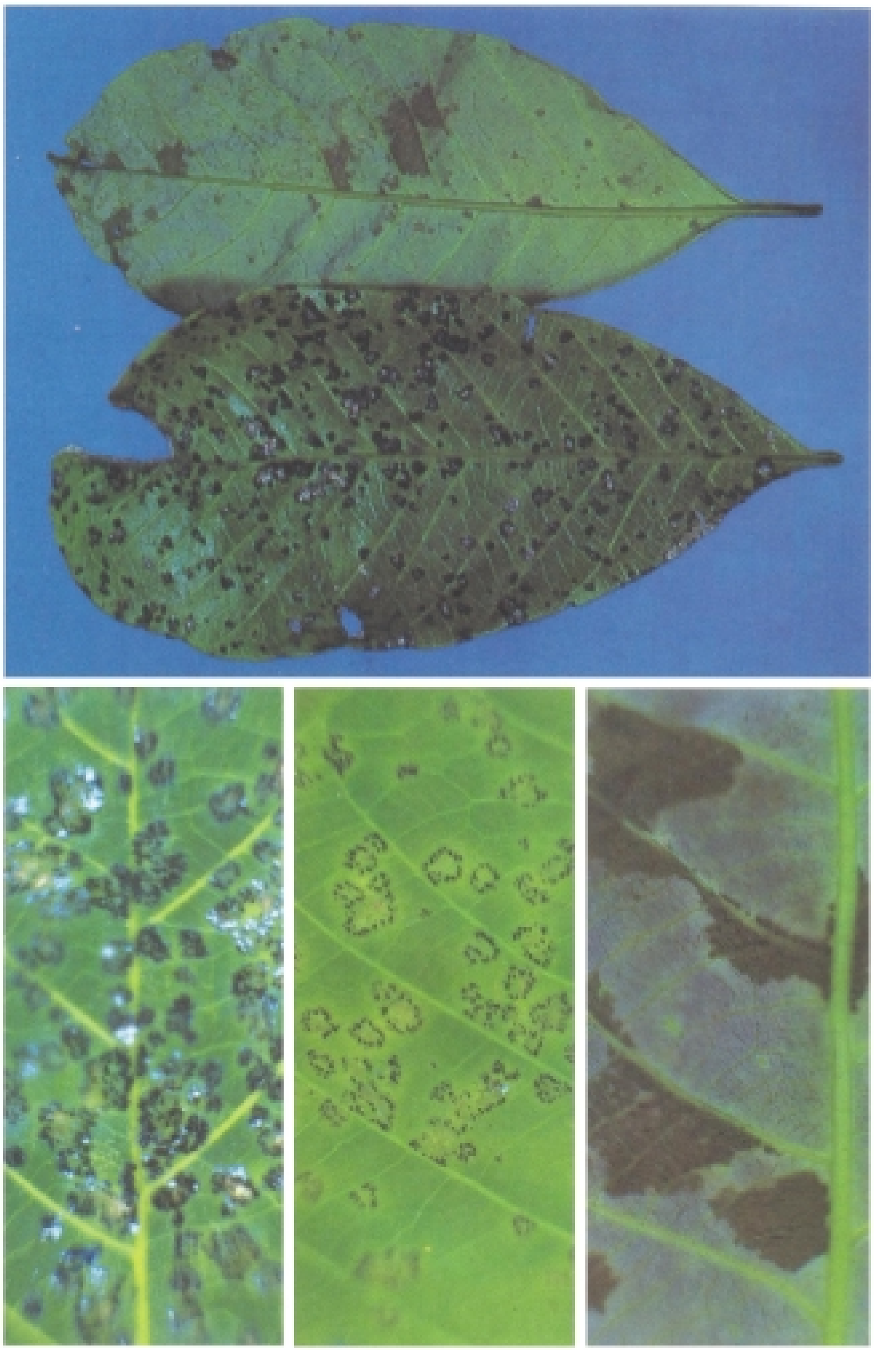


d) Ascospores

The conidia and ascospores infect the young developing leaves causing distortion followed by necrosis of the lamina (Plate 2). Affected leaves will abscise if infection is severe. Repeated defoliations and twig dieback weaken the tree and may sometimes cause its death (Plate 3) (Chee and Holliday 1986).

The primary stage of the disease on young leaves is characterized by the appearance of lesions covered by dark grey powdery masses of conidia on the abaxial leaf surface. Sporulation lasts for 2 to 3 weeks, later it becomes sparse and eventually no more conidia are produced. The conidia are disseminated by wind, vectors and water.

Plate 2. Foliar signs of SALB (from Chee & Holliday 1986)



Clockwise: a) Conidial lesions and ascostromata on leaf surfaces; b) close up of conidial lesions; c) and d) pycnidia and ascostromata on mature and old leaves respectively.

The ascospores play an important role in the survival of the fungus from one season to the next. The viability of detached conidia and ascospores is affected by moisture and temperature. The optimum temperature for growth, sporulation and infection is 24ºC. Conidia and ascospores germinate in 3-4 hours at 24ºC. The optimum temperature range for ascospore germination is 19ºC to 25ºC, but none germinate at 26-32ºC. Water, in the form of dew or rain for about 8 hours, is considered necessary for germination, the formation of an aspersorium, infection hypha and penetration. Penetration is direct and through the leaf cuticle. Conidia begin to form within a week of infection and the perfect state mature about 8-9 weeks later. In infected rubber plantations ascospores are present throughout the year with peak concentrations occurring during the wet seasons. The wet season also marks the period of maximum production and dispersal of conidia (Chee 1976a, c).

Plate 3. Plants infected with SALB

Immature rubber plant infected with SALB

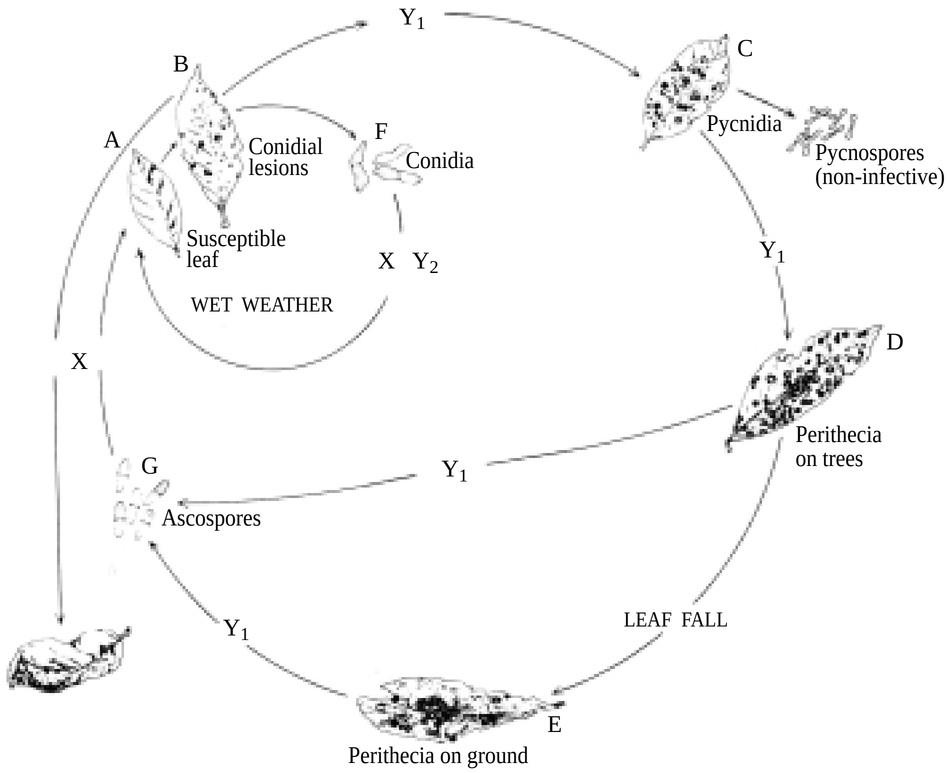
Matured rubber trees infected with SALB

The optimum temperature for germination of conidia is about 24ºC (Holliday 1970; Chee 1976a; Kajornchaiyakul *et al.* 1984; Gasparotto *et al.* 1989a). Sporulation was found by Kajornchaiyakul *et al.* (1984) to be totally inhibited at 20ºC. However, some isolates of *M. ulei* are able to infect and produce spores at 16ºC (Gasparotto and Junqueira 1994). These differences seem to reflect physiological differences between isolates from different ecological regions.

Dry conidia need to be wetted and require 6-8 hours of high relative humidity after deposition for infection. Gasparotto and Juniqueira (1994) found that one isolate of the pathogen did not need more than 3 hours of leaf wetness for infection and other isolates could infect within 4 hours. It is assumed that the different periods of leaf wetness required for infection are related to the virulence of the isolates and the susceptibility of the clones used. Optimum temperature for infection ranges from 19-25ºC, but little infection occur at 26-29ºC and none at 30-32ºC. After inoculation high disease intensity was observed on plants incubated at 19-22ºC or 23-25ºC. Lesions developed best at 23-25ºC. Conidial sporulation occurred at 19-28ºC and was increased by high humidity especially at 23-25ºC (Kajornchaiyakul *et al*. 1984). Ascospores are released in rapid succession when leaves are wetted at sub-ambient temperature (14ºC). Leaves which fall during wintering discharge ascospores readily after rain (Chee 1976a, b). During wet weather secondary infections from leaf diseases such as *Collectotrichum* and *Oidium* can occur causing secondary leaf fall (Chee 1990).

Ascospores are released from dark green leaves throughout the dry season (Chee 1976c; 1980a). Under moist conditions at 24ºC, perithecia on green leaves lose their viability after 12 days and after 9 days for perithecia on fallen brown leaves. In Brazil, epidemics of the disease occur when daily temperatures are under 22ºC for longer than 13 hours, relative humidity is over 85 percent for a period of over 10 hours, and rainfall exceeds 1 mm per day the preceding 7 days (Rocha and Vasconcelos 1978).

Plate 4. Disease cycle of SALB (from Chee & Holliday 1986)



Spore survival and adaptability

The detached conidia stored at 24°C between 65-85 percent relative humidity remained viable after 3 weeks. The conidia still attached on leaf lesions when stored under desiccation, 9 percent of the conidia still germinated after 16 weeks. Fresh conidia produced under optimum conditions can survive over a week on leaves, clothes, polyethylene, artificial leather, glass, mature *Hevea* leaves, metal, paper as well as soil (Zhang *et al*. 1986). Conidia recovered from these materials were tested for viability by their ability to germinate. These recovered single conidia were transferred to leaf discs in laboratory infection tests to determine their ability to infect host material. No infection occurred (Darmono and Chee 1985; Chee pers. com. 2007).

Plant infection requirements

Junqueira *et al*. (1986) determined that the optimum inoculum concentration was 2×10^5 conidia/ml, with higher concentrations inhibiting conidial germination and reducing the diameter of lesions. Outdoor (natural) light reduced viability more quickly than reduced-light (indoor) or no-light conditions. It is expected that for successful infection, with an inoculum concentration similar to that noted above, a spore loading equivalent to that generated from perithecia on a leaf segment at least 1 cm^2 would be required. This in effect means that for the purposes of this risk analysis it will be assumed that leaf segments of less that 1 cm^2 would not lead to successful infection under normal circumstances. This technical estimation is supported by the general experience of a number of workers (Chee, pers. com.).

Population variation

Isolates of *M. ulei* grown on agar culture exhibit morphological differences and also differ in the rate of sporulation. Numerous strains have been observed. Over the years clones resistant to SALB succumbed to infection one after another and this was found to be due to evolution of new physiological races breaking down the resistance. Eight races were found initially (Chee *et al*. 1986), and four more have been added (Rivano 1997). Additionally geographical strains have been noted in Brazil (Chee pers. com. 2007).

Propagation of commercial rubber plants (Hevea brasiliensis)[1]

Hevea brasiliensis, also known as the Para rubber tree after the Brazilian port of Para, is a quick growing, fairly sturdy, perennial tree of a height of 25 to 30 metres. It has a straight trunk and thick, somewhat soft, light brownish gray bark. The young plant shows characteristic growth pattern of alternating period of rapid elongation and consolidated development. The leaves are trifoliate with long stalks. Once older then about 6 years the tree is deciduous in habit and refoliation is quick with copious flowering following. Flowers are small but appear in large clusters. Fruits are three lobed, each holding three seeds, much like castor seeds in appearance but much larger in size. The seeds are oil bearing.

The rubber tree may live for a hundred or more years, however, its economic life period in plantations is only around 32 years – 7 years of immature phase and 25 years of productive phase.

The main form of propagation is budding, which involves the replacement of the shoot system of a plant with that of another more desirable plant. In this process, a patch of bark of the seedling plant (stock) is replaced by a patch of bark with a dormant bud (bud patch) taken from the clone to be multiplied. The bud patch gets attached to the stock permanently and becomes a part of it. The stock is then cut off above the budded portion and the grafted bud develops into a shoot (scion) exhibiting the characters of the plant from which it was taken. The new tree thus formed is a two-part tree, comprising a root system belonging to the stock plant and a shoot system contributed by the donor of the bud.

Depending on the colour and age of the buds as well as the age of the stock plants used, three types of buddings are mainly recognized. These are brown (conventional) budding, green budding and young budding. In the first method, older buds having brown colour are used while in the other two, green tender buds are utilized. Depending on the part of the stock where budding is carried out, buddings are classified into four types: base budding, crown budding, over budding and high budding. Base budding is carried out at the base of the stock plant and includes brown budding, green budding and young budding.

After harvesting, the brown budwood is cut into pieces of one metre length for the convenience of handling. The immature top portion, which may be green or partially brown, is discarded. For longer storage and transporting, the cut ends are sealed with melted wax, each piece covered with wet sacking or equivalent, and then tied into bundles of a convenient size. By this method, viability could be retained up to three days. For storing up to 14 days and carrying over very long distances each piece is first wrapped with perforated polythene and then packed in boxes with a moist substrate.

3.1.3 International distribution of SALB

SALB is present in all countries in Central and South America where rubber are present, whether cultivated or wild. In 2003 Brazil's total rubber planted area was 108 373 ha, of which Sao Paulo state had 33 477 ha, Bahia 29 314 ha and Mato Grosso 25 536 ha. The area under production was 103 586 ha; dry rubber production was 156 318 tonnes. Brazils own production for 2003 was 94 000 tonnes; and in 2004 was 100 000 tonnes. In the second largest rubber planting state Bahia, despite ravages by SALB and low rubber yield (estate: 1 000-1 200 kg/ha/yr; smallholder: 500-600 kg/ha/yr), rubber cultivation is still being attempted. Commercial rubber area in the northern states is negligible. Although indigenous wild populations exist, Amazonas' 540 ha of rubber in 1995 has dwindled to 28 ha today.

3.1.4 Presence or absence of SALB in PRA area

SALB has not been recorded from any of the Asia and Pacific rubber producing countries (the PRA area). A map showing areas where SALB is endemic and the PRA area for this analysis is provided in Plate 5.

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[1] *This section has been extracted from text on the Indian Rubber Board, Ministry of Commerce and Administration, Government of India website (http://rubberboard.org.in)*

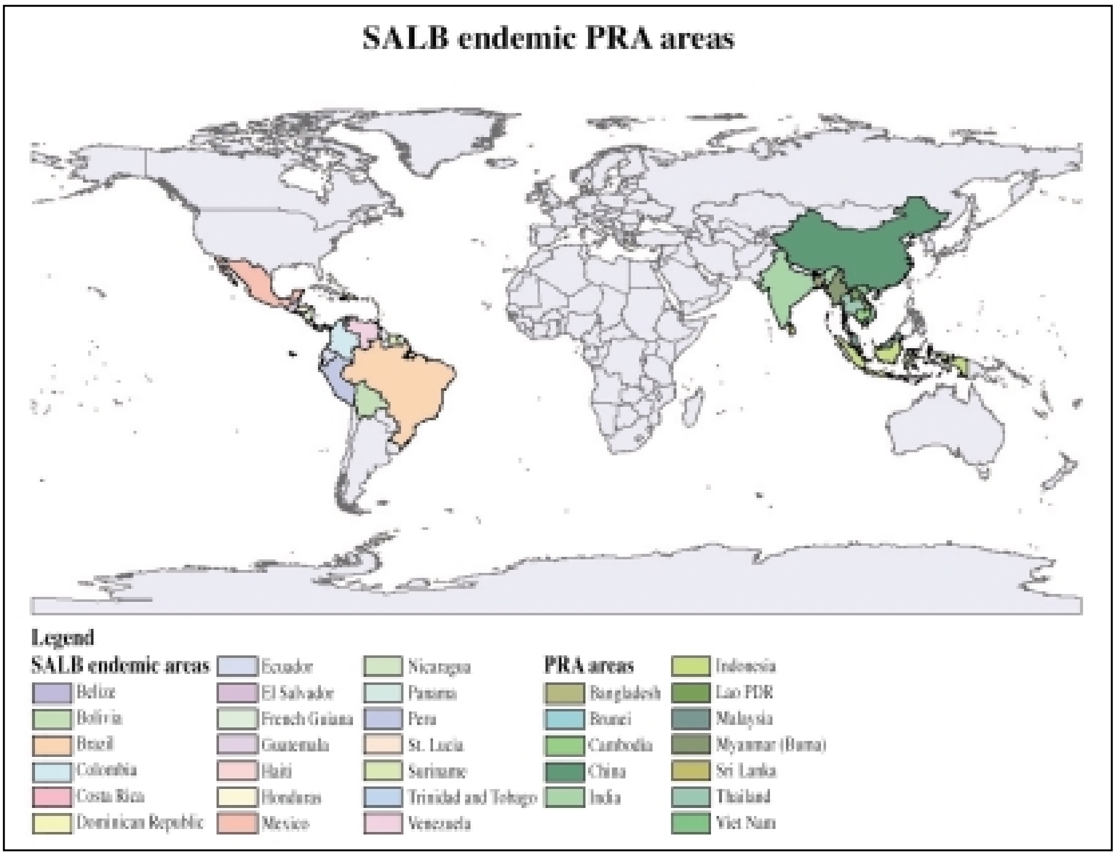
3.1.5 Current regulatory status

At present, all the Asian rubber growing countries have legislation, regulations and requirements to exclude SALB. Some countries may have more stringent measures than others due to the availability of appropriate infrastructure, facilities and resources (see Annex 4 for more details).

3.1.6 Entry potential

The pathogen *M. ulei* is specific to the plant genus Hevea and almost all aerial parts of the host plant, leaves, petioles, stems inflorescence and fruit pods, can be affected though they become infected only when the tissues are young. Fresh conidia produced under optimum conditions can survive for over a week on inorganic or inanimate objects such as clothes, polyethylene, artificial leather, glass, metal, paper and soil (Zhang *et al*. 1986). Pathways for the entry of *M. ulei* into the PRA area can therefore be separated into host and non-host material.

Plate 5. Map showing areas where SALB is endemic, and the PRA area



3.1.7 Potential for establishment and spread

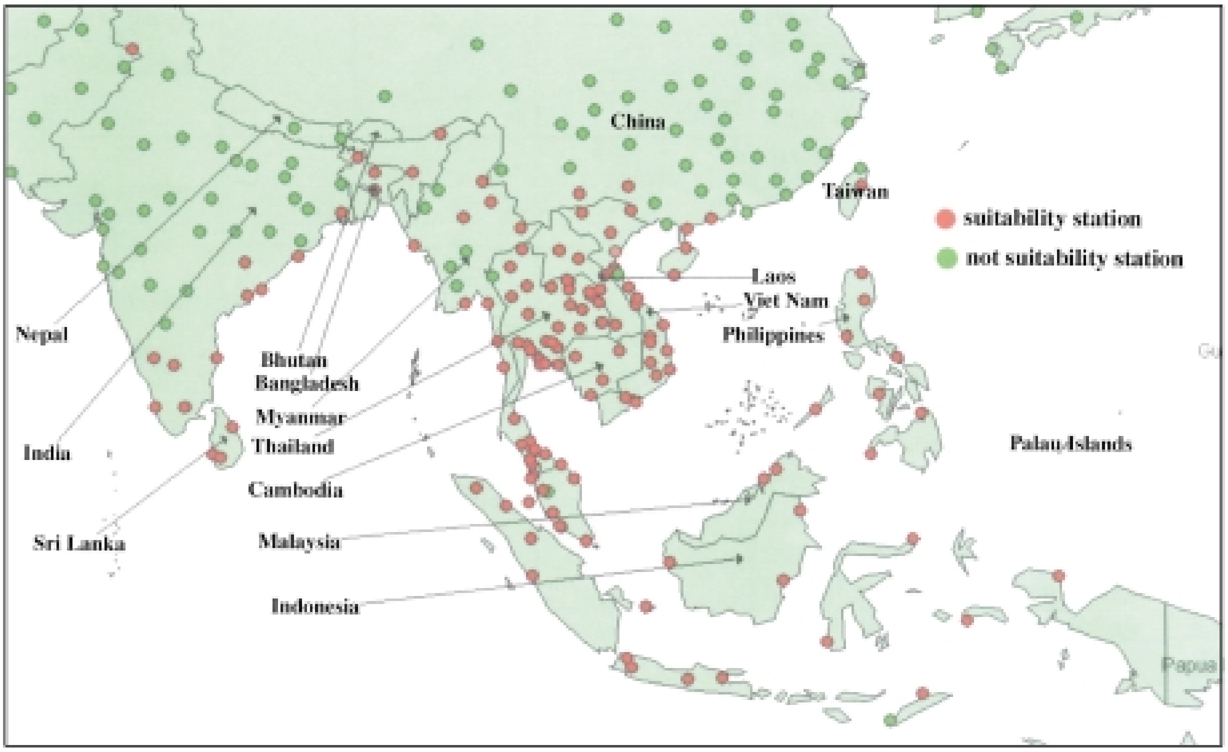
Infection and establishment of SALB requires the presence of susceptible young foliage, wet weather and suitable temperature (22ºC-28ºC). Depending on the local climatic conditions, after the annual wintering, rubber trees refoliate from February to April. There are abundant rubber plantations throughout the PRA area, and host plants (*Hevea* species) can be found in urban plantings and forest areas.

In South American countries the initial spread is believed to have originated from wild rubber trees, but spread to Trinidad and Central American and to Bahia and Sao Paulo areas of Brazil was presumably through infected material when attempts were made to grow rubber in these regions. The spread of disease to Haiti is speculated to be through the spores brought over by wind and rain from Guyana or Trinidad and Tobago. Spread of the disease from Amazon basin to the surrounding areas was possibly caused by long distance dissemination by wind and rain and deposition of spores from infected plants in the field (Holliday, 1970).

Climatic conditions especially rainfall in Asian countries are similar with SALB endemic regions of the Amazon. SALB occurs in epidemic proportions in the months which have 18 days of high relative humidity (exceeding 85 percent) for 10 hours. The climatic condition in many parts of Asian countries is similar to SALB endemic region in Brazil (Chee 1980b). Lin (2006), using Geographic Information System (GIS) analysis to compare the climatic records of 12 rubber growing countries in the PRA area, including Thailand, Indonesia and Malaysia, with SALB endemic regions, confirmed the climatic suitability of SALB to these countries. The criteria used in the analysis were:

1. Average temperature of March, April and May (refoliation in Northern Hemisphere) is higher than 18.5ºC; the average temperature of September, October and November (refoliation in Southern Hemisphere) is higher than 18.5ºC.
2. Annual rainfall is higher than 760 mm.
3. There is no more than 6 consecutive months with less than 42 mm per month of rainfall.

Plate 6. Map showing climates suitable for SALB development within the PRA area (from Lin 2006)



3.1.8 Potential for economic consequences

Natural rubber is one of the most important commercial commodities in Asia, particularly Southeast Asia. Presently, the rubber areas in Asia are free from SALB. If SALB were to establish and spread in the PRA areas the potential consequences would be expected to include:

1. Increased cost of production with lower productivity
   - additional disease and weed control costs
   - shortage of raw material for rubber and rubber wood based industries
   - poor stand and wood quality when infected trees suffer dieback
2. Adverse financial effects
   - reduction in country’s revenue from rubber and rubber wood exports including effects on growers and rubber manufacturing sectors
   - loss of income due to unemployment of rubber smallholders
   - escalating rubber wood prices because of low supply

3.1.9 Conclusion of pest categorization

There are abundant rubber plantations throughout the PRA area. Currently SALB is absent from the PRA area. If SALB were to be introduced into the PRA area, it has the potential to establish, spread and cause unwanted consequences as the PRA area has similar climatic conditions as in the SALB affected area (Lin, 2006). SALB therefore fulfils the criteria for a quarantine pest as defined by IPPC: "*A pest of potential economic importance to the area endangered thereby and not yet present there …",* (ISPM 5 2006).

3.2 Assessment of the probability of introduction and spread

Pest introduction includes both the entry and establishment. As mentioned in section 3.1.6, commodities that can carry *M. ulei* into the PRA area can be separated into host and non-host material. For ease of analysis host material, which includes plant parts from species in the *Hevea* genus, has been classified into the following groups:

1. *Budded stumps or budwood*
2. *Foliage (including stem and leaf material but not for planting)*
3. *Flowers, fruit and seeds*
4. *Plants* in-vitro
5. *Rubber wood*

Non-host material can be classified into two main groups:

1. *Inanimate goods or non-host organic material*
2. *Inanimate goods or non-host organic material contaminated by host plant material*

3.2.1 Probability of entry

The probability of entry describes, in qualitative terms, the likelihood of an organism successfully moving from the place of origin to the PRA area. In this PRA the organism in question is *M. ulei*, the place of origin is the areas in which SALB is endemic, and the PRA area includes the rubber growing member countries of APPPC (see section 1.3).

3.2.1.1 Probability of being associated with host pathways

Budded stumps or budwood: On infected young leaves, conidia are found on the surface of necrotic lesions. On old leaves ascospores are borne within the stromata and are released following wetting and cooling. Conidia are therefore more readily dispersed from this material when infected leaves are present. SALB and therefore *M. ulei* is present in all areas of South America where host material is likely to be sourced. Infection is mainly through young leaves however once plants have SALB all aerial parts can contain the disease. There is no evidence that stems (e.g., budwood) are affected by the pathogen when they are mature brown wood, but these may carry infections which have occurred when the stems were green. The likelihood that this material would be infected before transport to the PRA area is therefore considered **high**.

Foliage (including stem and leaf material but not for planting): At the height of an epidemic *M. ulei* affects actively growing stems and petioles causing them to curl and twist and occasionally spirally roll. The lesions become suberised and sometimes split (Holliday, 1970). SALB and therefore *M. ulei* is present in all areas of South America where host material is likely to be sourced. Therefore the likelihood that this material would be infected before transport to the PRA area is considered **high**.

Flowers, fruit and seeds: The inflorescences and flowers are infected by the pathogen. The small flowers turn black and drop. Young fruit pods up to 1 cm diameter can be destroyed by the pathogen. Larger fruit pods form swellings, 0.5-2 cm in diameter, on which the fungus fructifies (Holliday, 1970). In Bahia, Brazil, SALB coincides with *Phytophthora*, both occur during the wet season. Fruit pods are highly susceptible to *Phytophthora* thus denying SALB infection. There is no evidence that the pathogen is directly seedborne and seed transmitted (Holliday, 1970), however, it is likely that conidia could contaminate seed lots in the same manner that inanimate objects could become contaminated. SALB and therefore *M. ulei* is present in all areas of South America where host material is likely to be sourced. Therefore the likelihood that this material would be infected before transport to the PRA area is considered **moderate**.

Plants in-vitro: Plant parts or callus that has been held in sterile culture for more than 3 continuous months should be considered axenic and pose a **negligible** risk of being associated of *M. ulei*. This material will therefore not be considered further in the risk assessment sections of this analysis.

Wood: Manufactured wood and logs with bark are considered unlikely to transmit the pathogen and thus constitutes a **negligible** risk.

3.2.1.2 Probability of being associated with non-host pathways

Inanimate goods or non-host organic material: Conidia from infected host plants may become associated with this type of material if it is sourced from or passes through SALB infested areas. It is unlikely that the conidia in these circumstances will remain viable given the extended period that may occur between contamination and shipment, and contamination levels are likely to be low. Therefore the likelihood that this material would be contaminated before transport to the PRA area is considered **low** (Zhang *et al.* 1986).

Inanimate goods or non-host organic material contaminated by host plant material: Goods that contain or become contaminated by host plant material, such as plant cutters, chainsaws, compost, footwear, or plant decorations, could be contaminated with conidia if the host plant material in question is leaf material and of a significant quantity. SALB and therefore *M. ulei* is present in all areas of South America where host material is likely to be sourced. Therefore the likelihood that these goods would be contaminated before transport to the PRA area is considered **moderate**.

3.2.1.3 Probability of surviving during transportation

For the purposes of this PRA methods of transport were categorized into three main groups:

1. *Sea cargo, passengers, and ocean going vessels*
2. *Air freight and aircraft*
3. *Air passengers and accompanied luggage*

Sea cargo, passengers, and ocean going vessels: The most significant aspects of these methods of transport are the duration of travel and the environmental conditions during travel. Transport by sea generally takes three weeks from South America and environmental conditions such as temperature and moisture would not be optimal for spore survival during this period. It is therefore considered that *M. ulei* would not survive the journey via this pathway unless it was infecting host material (Zhang *et al*. 1986). The likelihood that *M. ulei* would survive transport via this pathway is therefore considered **negligible** unless associated with the appropriate host material. Under these exceptions the likelihood that *M. ulei* would survive transport via this pathway would be considered **high** for appropriately packaged budwood or foliage and **low** for other host material.

Air freight and aircraft: Transport by air takes three days from South America to the PRA area in Southeast Asia. In optimal environmental conditions it is likely that spores of *M. ulei* would survive the journey via this pathway. However the aircraft surfaces and freight held within aircraft holds is exposed to low temperatures at high altitudes that would significantly reduce spore viability. The survival of spores in the aircraft would be **negligible**.

Spores on the outside of an aircraft would be subject to extreme conditions. It is noted that while the spores of *M. ulei* are reported to survive at -28ºC and -78ºC (LebaiJuri *et al*. 1997) (a method used in preservation of the viability of many micro-organisms), conidia are killed on exposure to ultraviolet irradiation for periods 4-60 minutes or solar radiation for 3 (ascospores) to 6 hours (conidia) (Chee 1985; 2006). Survival of spores on the outside of an aircraft would be **negligible**.

Air passengers and accompanied luggage: Air passengers and accompanied luggage should be considered equivalent to air freight above. Unless spores of *M. ulei* were infecting live or fresh host material, the likelihood that they would survive transport via this pathway is **negligible**. When infected live host material is introduce to this pathway, the likelihood of survival should be considered **high** for budwood or foliage and **moderate** for other host material.

3.2.1.4 Probability of surviving existing pest management procedures

Visual inspection: Unless there are obvious signs of infection in the host material, detecting the presence of *M. ulei* would not be possible by visual examination alone. To confirm the identity of the pathogen by laboratory isolation, a special technique of isolating *M. ulei* must be used (Holliday 1970; Junqueira *et al*. 1984). Inspections for host material above 1 cm^2 should be considered a relatively effective measure if the material is not otherwise concealed.

No other pest management procedures were considered relevant to this analysis.

3.2.1.5 Probability of transfer to a suitable host

Rubber is widely planted in smallholdings scattered over the PRA area, and can be found in urban areas within parks and peoples dwellings.

Infected host material: Any propagable host material that is infected with *M. ulei* would be expected to act as both a vector of the disease into a region and as a host once the material has been planted into the environment. The likelihood that *M. ulei* would transfer to a suitable host would only be limited by the nature of the imported host material itself. This material has therefore been separated into the following sub-groups for analysis:

1. *Budded stumps or budwood*: This type of imported material would be expected to act as both a vector and host. The likelihood that *M. ulei* would transfer to a suitable host on budded stumps or budwood is considered **high**.
2. *Seeds*: While seeds could also act as a vector, the likelihood that the infecting agent, in this case surface spores, could survive until the seed has germinated and young leaves have developed, and subsequently infect these young leaves is considered highly unlikely. In the absence of conclusive research data demonstrating the potential or not for vector transfer in this manner, the likelihood should be considered **low** (rather than negligible).

Infected fresh non-viable host material: While this type of material could act as a vector for *M. ulei* into a region, this material will not or can not be propagated. Therefore any contaminating infection agent such as spores must find their way onto a suitable host in the PRA area. As a suitable host in this instance is the young leaf material of a susceptible *Hevea* species, and the spore load for achieving infection must be relatively high, the conceivable mechanism for successful transfer to a suitable host would be via the development of conidia (on immature leaves) or ascospores (on fully matured leaves) and the dissemination of subsequent spores. The host material must therefore be suitable for conidia or ascospore production and of a size sufficient to produce the required volume of airborne or water washed spores.

The likelihood, therefore, that small sizes (<1 cm^2) of infected fresh non-viable host material could result in the transfer of *M. ulei* to a suitable host in a new region should be considered **negligible**. The likelihood that larger sizes (>1 cm^2) of infected fresh non-viable host material could result in the transfer of *M. ulei* to a suitable host in a new region should be considered **low**.

3.2.1.6 Conclusions of the assessment of the probability of entry

Table 3 provides a summary of the different aspects of the entry pathway discussed in the previous sub-sections (3.2.1.1-3.2.1.5) and provides a final probability of entry for each category of potential vector.

Table 3. Summary of the assessment of entry

Vector	Probability of association	Probability of transit by Sea/Air	Probability of transfer to a suitable host	Conclusion of probability of entry
Host material (*Hevea* species)				
Budded stumps or budwood	High	High / High	High	High
Foliage (stem and leaf material not for planting)	High	High / High	Low (<1 cm^2)	Low (<1 cm^2)
Flowers, fruit and seeds	Moderate	Low / Moderate	Low	Low
Plants *in-vitro*	Negligible	N/A / N/A	N/A	Negligible
Wood	Negligible	Negligible / Negligible	Negligible	Negligible
Non-host material				
Inanimate goods or non-host organic material	Low	Negligible / Negligible	N/A	Negligible
Inanimate goods or non-host organic material contaminated by host plant material	Moderate	Low / Moderate	Low (<1 cm^2)	Low (<1 cm^2)

3.2.2 Probability of establishment

The definition of establishment provided in ISPM 5: Glossary of Phytosanitary Terms (2005) is:

> The perpetuation, for the foreseeable future, of a pest within an area after entry
> [ISPM 5 2006]

ISPM 11 considers the following factors should be taken into consideration when determining the probability of an organism establishing in a PRA area.

3.2.2.1 Availability, quantity and distribution of host in the PRA areas

There are 8.7 million ha of rubber in the PRA area and all the clones planted are susceptible to SALB. Initial signs of SALB are similar to other rubber leaf diseases already occurring in PRA area. Therefore, early detection of the occurrence of SALB is difficult.

3.2.2.2 Environmental suitability in the PRA areas

The climatic conditions in SALB endemic area are characterized by high rainfall and temperatures from 26°C to 28°C. Similar environmental conditions exist in the PRA area. Temperatures in the west of Malaysia may be slightly above the optimum for development of the disease, but the rainfall regime appears to be extremely favourable (Holliday 1969). However the north-west region of Malaysia may be sufficiently dry when the rubber trees undergo withering and therefore could escape serious disease development (Wycherley 1967).

3.2.2.3. Potential adaptation of the pathogen

Morphological, ecological and physiological strains of *M. ulei* have evolved suggesting that the pathogen is adaptable to the new environment in the PRA area.

3.2.2.4 Reproductive strategy of the pathogen

The pathogen produces abundant conidia during refoliation. If the infected leaves escape severe infection and do not fall ascospores are produced on the dark green harden leaves. Sporulation therefore follows from one spore stage to another. When conidia production is tailing off ascospores begin to produce. Ascospores are therefore present through the year but low in concentration during wintering when old leaves are shed. Infection can be due to conidia or ascospores or both depending the time of the year.

3.2.2.5 Method of survival of the pathogen

In plantations, the pathogen survives on old leaves by producing the secondary stage of stromata. The stromata are alive on the leaves that are on the trees or have fallen to the ground, and will continue to eject ascospores from the perithecia contained in the stromata.

3.2.2.6 Effectiveness of existing control programmes

Cultural practice has little value in control measures. Fungicide spraying is effective to certain extent, but the cost of chemical control is high and method of application is difficult because of uneven terrain and tree height.

3.2.2.7 Conclusion of the assessment of the probability of establishment

The probability of establishment within the rubber growing areas of the PRA area should be considered **high** if SALB is introduced into a suitable environment on appropriate host material.

3.2.3 Probability of spread after establishment

The definition of spread provided in ISPM 5: Glossary of Phytosanitary Terms (2005) is:

> Expansion of the geographical distribution of a pest within an area [ISPM 5 2006]

ISPM 11 considers the following factors should be taken into consideration when determining the probability of an organism spreading in a PRA area.

3.2.3.1 Suitability of the natural environment

The natural environment is suitable for natural spread of the disease. Given the temperatures between 16ºC-32ºC the pathogen will establish on the susceptible host and spread unabated. Little information is known on the relative humidity over the region in relation to SALB.

3.2.3.2 Presence of natural barriers

Spores of SALB are spread by wind and splashing rain. Natural barriers such as desert, arid area, mountains, ranges and seas may limit the spread to some areas over the short term, but SALB would be expected to spread to all areas over time.

3.2.3.3 Potential of dispersal with commodities or conveyances

There is currently free movement of commodities, planting materials, conveyances and people within and between countries in the PRA area. As many of these areas have relatively uncontrolled land borders, effective limitations on dispersal with commodities or conveyances are not considered possible.

3.2.3.4 Intended use of commodity

Rubber is a processed product and should not be considered a pathway for SALB. Rubber wood may act as a pathway for a short period immediately after harvesting, but natural drying and use in manufacturing would remove any viable infection.

3.2.3.5 Potential of natural enemies

There is no known natural enemy or other biological control agent for SALB. Work with *Dicyma pulvinata* does not appear to have produced successful results (Chee pers. com.).

3.2.3.6 Conclusion of the assessment of the probability of spread

The probability of spread within the rubber growing areas of the PRA area should be considered **high** if SALB is introduced into a suitable environment and an area where sufficient host material is available.

3.3 Assessment of economic consequences

SALB is known to cause severe economic losses in the agriculture system and until today it remains as the main obstacle for the viable natural rubber industry in South America. Severely affected plantations had been abandoned (Holliday 1970). Rubber cultivation in Brazil has moved from its traditional state of Bahia to Sao Paulo and Mato Grosso where refoliation occurs during the dry season escaping *M. ulei* infection. Rubber growers in Bahia are therefore denied of an income while land in Sao Paulo is escalating in price. According to Michelin Plantation in Itubera, in Bahia SALB causes, conservatively, rubber yield reduction of about 30 percent.

3.3.1 Direct effects of SALB

SALB would directly affect the yield of latex and rubber wood, shortage of raw material for downstream rubber industry, loss in employment and effect on environment. The direct effects of the disease on the host were evaluated with these considerations using factors listed in table 4.

Table 4. Direct consequences of SALB

Event	Rationale	Consequence
1. Rubber plant mortality	The pathogen causes defoliation and dieback, weakens the plants and kills the tree. All clones are susceptible. Within a few years, all standing stock within the PRA area is expected to be infected.	**High** Almost all rubber plants affected; 8.7 million ha.
2. Reduction in latex yield	Infected trees are bare of leaves or having poor canopy and twig dieback. It causes a reduction of rubber yield and indirectly affecting the down stream rubber industry. Estimate 30-50 percent yield reduction in rubber production (Chee K.H., pers. com.)	**High** Estimated loss 4.4 million tonnes.
3. Reduction of rubber wood production	Affected trees experience retarded growth. Estimated 40 percent reduction in rubber wood availability. Affect manufacturing and industrial sector.	**Moderate** Estimated loss of 1.1 million m^3.
4. Investment in eradication	Should SALB be detected within an isolated area early in the infection cycle, eradication may be possible. For the period of the eradication programme tree mortality due to eradication measures would exceed expected disease mortality.	**Moderate** Eradication exercises to be carried out of a minimum area of 1 000 ha within a radius of 3 km of infected trees.
5. Increases in production costs	Costs of production would increase due to increased need for disease control, weed control and stock replanting or replacement.	**Moderate**
6. Loss of income and employment within affected regions	Rubber industry supports millions of families, mainly smallholders.	**High** Loss of income for the country due to closing down-stream rubber industries/ factories. Loss of income for employment in rubber industry.

Table 4. *(continued)*

Event	Rationale	Consequence
7. Environmental impact	Chemical control of rubber leaf diseases is not normally practiced. In the event of SALB eradication and prophylactic treatment, large scale fungicide application will be implemented. Loss of rubber stands equivalent to deforestation with subsequent habitat degradation.	**High** Environmental pollution and health hazards to human and animals, soil erosion.
8. Loss in aesthetic value	Rubber trees contribute to the agro ecosystem beauty and tourism from its unique form and attraction.	**Low**
9. Loss in foreign exchange	Loss of revenue due to reduction in export of rubber and rubber products. Increase production costs are thus not competitive in global export market. Loss of foreign exchange in importation of pesticides.	**High**

3.3.2 Indirect effects of SALB

The indirect consequences of SALB would be a shift in consumer demand and domestic social dislocation. The indirect SALB effect is evaluated using factors listed in Table 5.

Table 5. Indirect consequences of SALB

Event	Rationale	Consequence
1. Loss of market opportunity (International trade)	Depressed supply of rubber and rubber wood would be expected to lead to loss of market share	**High**
2. Intensified research and development	Increase research and development costs for disease management	**Moderate**
3. Social dislocation	Urbanization and migration of rubber labour force	**High**
4. Decline in the standard of living of people involved in rubber industries, especially small holders	Smallholders and workers in the rubber downstream industry will be denied of decent income affecting food and education expenditure	**High**

3.3.3 Conclusion of the assessment of economic consequences

Both the direct and indirect SALB effects are high. Control measures for a relatively widely spread infestation would involve great costs and would not be economical sustainable. Without treatment, vast areas of rubber would eventually be lost, directly affecting the livelihood of rubber smallholders and indirectly the rubber wood furniture industry and rubber goods manufacturing sector, in particular rubber gloves and tyres. The combined economic consequences are a loss of revenue in the region of USD 10 billion a year. This would have a significant impact on the gross domestic product of the highest volume rubber-producing countries.

The economic consequences of SALB are **high** as rubber is a significant economic crop in ANRPC countries. It provides employment to many people and brings in foreign exchange earnings as a result of export of the raw material or processed products.

3.4 Endangered areas

The endangered area is where rubber is grown in the Asia and Pacific countries i.e. Thailand, Indonesia, Viet Nam, Sri Lanka, Malaysia, southern part of India, tropical part of China, part of Lao PDR, Myanmar, Bangladesh, Brunei, Cambodia, the Philippines and Papua New Guinea.

The major rubber producing countries Thailand, Indonesia and Malaysia will be the most vulnerable since rubber is found throughout the country. Other countries although rubber is scattered, but all the countries in the region are in fact in close proximity to each other geographically and there is active inter-countries movement of trade and people in the region.

3.5 Conclusions of the risk assessment

Table 6 provides a summary of the conclusions reached in the assessments of introduction, spread and consequences completed in the previous two sections (3.2 and 3.3).

Table 6. Summary of the assessments of introduction, spread and consequences

Vector	Probability of entry	Probability of establishment	Probability of spread	Likely impact	Level of risk
Host material (*Hevea* species)					
Budded stumps or budwood	High	High	High	High	High
Foliage (stem and leaf material not for planting)	Low	High	High	High	Moderate
Flowers, fruit and seeds	Low	High	High	High	Low
Plants *in-vitro*	Negligible	N/A	N/A	N/A	Negligible
Non-host material					
Inanimate goods or non-host organic material	Negligible	N/A	N/A	N/A	Negligible
Inanimate goods or non-host organic material contaminated by host plant material	Low (if <1 cm^2)	High	High	High	Low (if <1 cm^2)

It should be noted that foliage is normally prohibited and entry would not generally occur. The strict control and treatment of other host material such as budded stumps, budwood or flowers, fruit and seed is discussed in section 4.

4.0 RISK MANAGEMENT

The guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. Pest risk management (in the analytical sense) is the process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options (ISPM 11 2005). The effectiveness of any risk management measures depends on our perception and understanding of the disease and the risk pathways. Phytosanitary measures drawn up on the basis of science and practicality are essentially easy to implement, have minimal economic impact and are discriminating.

Based on the assessment of risks completed in the previous chapters of this risk analysis, risk commodities have been divided into the following groups.

A. *Viable host material*:
   1. *Plants for planting*: Whole plants and cuttings, and plants *in-vitro*;
   2. *Seeds, flowers and fruit.*

B. *Non-viable (inanimate) host material:*

3. *Cargo pathway* (including sea freight, airfreight and mail);
4. *Passenger pathway* (including accompanied luggage).

For goods or passengers originating from an area not known to be free of SALB, the following risk management measures may be applied.

4.1 Management options for viable host material

Viable host material includes any plant parts that are being imported into the region for the purposes of propagation or could be propagated by conventional means.

4.1.1 Plants for planting

The IPPC definition of plants for planting includes whole plants and cuttings, and plants *in-vitro* (ISPM 5 2006). For the purposes of this risk analysis only budded stumps and budwood have been considered for measures as they are the most likely form to be transported between countries for planting.

4.1.1.1 Budded stumps and budwood

Management of the phytosanitary risks associated with the import of budded stumps and budwood for propagation should start in the country of origin. Efforts should be made to ensure that, as far as is reasonable and possible, budded stumps and budwood exported to the PRA area should be free of SALB. The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ): *Postentry Quarantine Manual for State Inspectors* (2006) states that to achieve an appropriate level of assurance from plant inspections, plants should be inspected over two growing seasons. It is therefore considered appropriate that mother plants of budded stumps and budwood should undergo periods pre-export and post entry inspection for signs of SALB before being distributed in the PRA area.

In the case of SALB and the susceptible *Hevea* species, the period of greatest disease expression is at the time of new foliage growth. Therefore budded stumps and budwood should only be harvested from mother plants that have been recently inspected during a period of optimal disease expression and no signs of SALB were detected. To further lessen the likelihood of contamination, harvesting of budded stumps and budwood should only occur when the bark has been hardened (brown in colour) and during the low-disease season (e.g. dry weather). Budded stumps and budwood should be no longer than 1 metre when exported, and the material dipped into a suitable surface sterilant followed by a suitable systemic fungicide. All packaging material should be destroyed on arrival in the PRA area.

During the post-entry quarantine inspection period plants should be maintained in an environment that both stimulates SALB expression and limits the ability of SALB to escape the facility and infect surrounding host plants. No fungicides effective against SALB should therefore be applied to plants during the inspection period (new leaf growth) as fungicides may mask disease expression. SALB containment can be achieved either through the use of high security quarantine facilities or by ensuring no host plants are within 3 km of the boundaries of the facility. To ensure any infected plants are removed from the post-entry quarantine facility as possible, plants should be inspected daily by staff trained to detect signs of SALB infection. Suitably qualified plant pathologists should also inspect the plants every two weeks to verify the daily inspections by facility staff.

If SALB is positively identified in the quarantine facility, all host plants in the facility should be treated with an appropriate fungicide, and another inspection period instigated.

Based on the aforementioned recommendations, the following measures should be applied to budded stumps and budwood before export from the SALB affected country or region, during transport to the PRA area, and on arrival in the PRA area.

Pre-export inspection and treatment

- Mother plants should be inspected by suitably qualified plant pathologist for signs of SALB infection and deemed to be free of SALB infection. Inspections should take place immediately before the harvesting of budded stumps or budwood and during a period considered optimal for disease expression;
- Harvesting of budded stumps and budwood should only occur when the bark has been hardened (brown in colour) and during the low-disease season (e.g. dry weather). Budded stumps and budwood should be no longer than 1 metre when exported;
- Budded stumps and budwood should be packaged for export in a manner that limits the likelihood of infestation during transport.
- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- Budded stumps should be free from soil.

Measures on arrival (in an appropriately secure facility)

- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- All packaging material should be destroyed or appropriately sterilized, and the budded stumps and budwood repackaged after treatment.

Post entry quarantine

- Imported budded stumps and budwood should be grown in a suitable post entry quarantine facility for at least one year or after new foliage has been produced at least six times;
- Plants should be inspected for signs of SALB daily by suitable trained facility staff and fortnightly by suitably qualified plant pathologists;
- Should any signs of SALB be detected, plants showing signs should be destroyed and all other *Hevea* plants within the facility should be treated with suitable fungicide (treatment may require six or more applications);
- Prior to release from the facility all plants in the facility should be inspected by a suitable qualified plant pathologist for signs of SALB infection;
- Plants may be released from the post entry quarantine facility only after having all plants in the facility have been free from any signs of SALB for at least one year or after new foliage has been produced at least six times.

Intermediate quarantine

Intermediate quarantine offers a further option to mitigate risk. This system can have some logistical, maintenance and financial problems when used for rubber, but it may operate successfully in some specific circumstances.

4.1.1.2 Plants **in-vitro**

Plants *in-vitro* should not be considered a risk pathway for the entry of *M. ulei* if the cultures are axenic. However, at the moment the practice is not commercially used.

4.1.2 Seeds and fruit

As the risk from seeds and fruit material relates to surface contamination only, all such products exported from SALB regions should be surface sterilized immediately prior to export.

Flowers and fruits should be washed with a surface sterilant such as 200 ppm of sodium hypochlorite (Chee 2006). Only healthy seeds should be selected for export, washed with water and soaked in formalin (5%) for 15 minutes, and then air dried and dressed with thiophanate methyl, benomyl or mancozeb (Chee 1978; Santos and Pereira 1986).

4.2 Management options for non-viable host material

Non-viable host material is essentially leaves or other parts of a host plant (susceptible *Hevea* species) that are imported either deliberately or as contaminants into the PRA area from countries or areas not known to be free of SALB. These types of host material are not able to be propagated by normal means.

4.2.1 Cargo pathway

Cargo from SALB infested countries or areas should be screened for goods or shipments that are likely to contain or be contaminated by non-viable host material. A profile list should be established that identifies cargo most at risk of containing non-viable host material.

Cargo such as used machinery (cars, logging equipment, chainsaws, cutters etc.) that may have been used in rubber plantations should be thoroughly steam cleaned of all organic material larger than 1 cm^2, and dismantled if there are parts that can not be easily cleaned. Household effects should be inspected for gardening equipment that may be contaminated by organic material.

Any organic material that is thought to be from a susceptible *Hevea* species, is larger than 1 cm^2, and can not be removed from the goods or can not be destroyed (e.g. herbarium material), should be heat treated for a minimum of 30 continuous minutes at 56^oC or greater.

4.2.2 Passenger pathway

Passengers and accompanied luggage arriving within 21 days from areas not known to be free of SALB should be inspected for both viable and non-viable host material. Special care should be taken with such items as camping equipment and hiking boots, farm equipment, and decorative plant material as these are more likely to contain or be contaminated by non-viable host material greater than 1 cm^2. Measures may include cleaning, disinfection or destruction.

4.3 Residual risk after management

While the measures above, if strictly and effectively enforced, should be expected to manage the phytosanitary risks posed by SALB to the PRA area, it should still be considered possible that slippage (undetected risk items) may result in the establishment of SALB in the region. Efforts should be made to manage this residual risk by establishing an effective monitoring system that would be expected to detect an establishment event early enough to allow for an effective eradication programme to be completed.

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Annex 1

ARTICLE IV OF THE APPPC

Functions of the Commission

1. The function of the Commission shall include:

   a. the determination of procedures and arrangements necessary for the implementation of the Agreement and the making of recommendations to the Contracting Governments accordingly;

   b. the review of the state of plant protection in the region and the need for action to prevent the introduction and spread of pests;

   c. the promotion of appropriate measures to prevent the introduction and spread of pests of plants and plant products, and to control pests, including the use of integrated pest management, as appropriate, eradication and the establishment of Pest free areas and areas of low pest prevalence and the application of phytosanitary measures in relation to genetically modified organisms;

   d. the development and adoption of Regional Standards, including the development of pest risk analyses, and the identification of pests for common action and recognition of pest free areas and areas of low pest prevalence;

   e. assistance in the development of International Standards to be adopted within the framework of the International Plant Protection Convention;

   f. the review of the status of integrated pest management and the promotion of its implementation within the region;

   g. the harmonization of pesticide regulation;

   h. the collection, collation and dissemination of information on plant protection in the region as decided by the Commission;

   i. the coordination and, as appropriate, the arrangement for training of human resources;

   j. the promotion and development of multilateral and, as appropriate, bilateral arrangements to further the objectives of this Agreement;

   k. coordination of the work of the sub-commissions and consideration of matters of regional concern arising from that work; and

   l. the resolution of technical issues.

APPENDIX B

MEASURES TO EXCLUDE SOUTH AMERICAN LEAF BLIGHT OF *HEVEA* FROM THE REGION

1. In this Appendix

   a. "the American tropics" means those parts of the continent of America, including adjacent islands, which are bounded by the Tropic of Capricorn (latitude 23 1/2ºS) and the Tropic of Cancer (latitude 23 1/2ºN) and the meridians of longitude 30ºW and 120ºW, and includes the part of Mexico north of the Tropic of Cancer;

   b. "Competent Authority" means the officer or Government Department or other agency, which each Contracting Government recognizes as its authority for the purpose of this Appendix.

2. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus Hevea from outside the region, unless

   a. the importation is made for scientific purpose; and

   b. written permission has been granted for each consignment of plant or plants by the Competent Authority of the importing territory or territories and the importation is in accordance with such special conditions as may be imposed by the Competent Authority in granting such permission; and

   c. the plant or plants have been disinfected and freed of any original soil in the country of origin in a manner acceptable to the Competent Authority of the importing territory and are free from pests and diseases, and each consignment of plant or plants is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled, and signed by an appropriate authority in the country of origin; and

   d. each consignment is addressed to and is received by the Competent Authority of the importing territory.

3. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus Hevea capable of further growth or propagation (excluding seed) from the American tropics or from any other country in which South American Leaf Blight (*Dothidella ulei*) is present, unless, in addition to the requirements of paragraph 2 of this Appendix, at a place approved by the Competent Authority of the importing territory and situated outside the Region and outside the American tropics and any other country in which South American Leaf Blight (*Dothidella ulei*) is present, such plant or plants have been grown for an adequate period at a plant quarantine station for Hevea and each consignment of such plant or plants is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled, and signed by the officer-in-charge of such quarantine station.

4. Each Contracting Government shall prohibit by law the importation into its territory or territories of any seed of any plant of the genus Hevea from the American tropics or from any other country in which South American Leaf Blight (*Dothidella ulei*) is present, unless, in addition to the requirements of paragraph 2 of this Appendix, such seed, having been examined and again disinfected at a place approved by the Competent Authority of the importing territory and situated outside the region and outside the American tropics and any other country in which South American Leaf Blight (*Dothidella ulei*) is present, has been repacked with new packing materials in new containers, and unless each consignment of such seed is accompanied or covered by a certificate to the effect that the above requirements have been fulfilled, and signed by the officer-in-charge of these operations.

5. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants of the genus Hevea not capable of further growth or propagation (such as fresh or dried

herbarium specimens); unless, in addition to the requirements of sub-paragraphs (a), (b) and (d) of paragraph 2 of this Appendix, the Competent Authority of the importing country is satisfied that such plant or plants are required for a legitimate special purpose and that such plant or plants have been sterilized in the country of origin by a method satisfactory to the said Competent Authority.

6. Each Contracting Government shall prohibit by law the importation into its territory or territories of any plant or plants other than the genus Hevea, capable of further growth or propagation and originating in the American tropics or in any other country in which South American Leaf Blight (*Dothidella ulei*) is present, unless written permission has been granted for each consignment of such plant or plants by the Competent Authority of the importing territory or territories and the importation is in accordance with such special conditions as may be imposed by the Competent Authority in granting such permission.

7. The Competent Authority of any territory or territories into which any plant or plants of the genus Hevea are imported for further growth or propagation shall ensure that such plant or plants are grown under control for such period as will ensure that such plant or plants are free from all pests and diseases before they are released.

Annex 3

INFORMATION GAP AND ADDITIONAL AREAS FOR RESEARCH FOR PRA ON SALB

Information Gap (Detection)	Status
Determine whether *M. ulei* is seedborne.	Available evidence and expert opinion considers that *M. ulei* is not seedborne. Research to confirm this assumption should be completed when possible.
Develop quick detection methods/procedures.	At present, there is no available method for rapid diagnosis or detection of SALB. Molecular-based techniques may be able to provide an appropriate method. This technology would require capacity building in this aspect.
Determine latent infection period of various races on various ages of leaves (susceptible and moderately susceptible leaf stages), clones and young stems.	Still requires research.
Determine the level of contamination on various related pathways.	Research partially completed.

Information Gap (Survival)	Status
In carriers and containers.	Not done
In real situation studies.	Research partially completed

Information Gap (Spread)	Status
Distance of spore travel.	Distance was determined to be 3 km based on available information. Further information is necessary to provide more confidence in this assumption. This information can be obtained through the use of spore-traps.
Dispersal agents – animals.	Bees, flies and birds should be included as potential dispersal agents in future research.

Annex 4

CURRENT REGULATORY STATUS FOR SALB IN SEVEN RUBBER PRODUCING COUNTRIES WITHIN PRA AREA

Thailand

The Plant Quarantine Act (PQ Act) has been established in Thailand in 1964. With the authority of the PQ Act, the Department of Agriculture (DOA) carries on regulatory measures against the introduction of the exotic pests including SALB into Thailand. Recently, the PQ Act has been revised to widen the scope of the Act and to strengthen the phytosanitary measures and the 2nd Edition of the PQ Act came into force in 1999. There are some changes in quarantine regulations and implementation with regard to prevention of introduction of SALB into Thailand as follows.

Plant Quarantine Regulations on Importation of Plant Materials

Hevea plant materials

- Hevea species from every sources as prohibited materials
- Importation authorized by Director General of DOA under specified conditions
- Limitations of amount and for scientific purposes only
- Maximum quantity:
  - seed – 100
  - budwood – 5 metres
  - budded stump – 50 plants
  - tissue culture – 100 plants/clone
- Plants treated with effective fungicides on SALB organism
- Import consignment accompanied by Phytosanitary certificate
- Subject to intermediate quarantine station
- Import via Plant Quarantine Stations in Bangkok
- Subject to Post-Entry Quarantine Station upon arrival

Non-Hevea planting material

- Subject to Post-Entry Quarantine Station upon arrival
- Require Import Permit/Phytosanitary Certificate
- Planting materials treated with fungicides

Non-Hevea plant products

- Phytosanitary certificate
- Inspection at port of entry
- Passenger from SALB areas (direct flight)
- To fill in Quarantine Declaration Form

Baggage (direct flight)

- Double tagging and separate compartment
- UV irradiation
- Spray with soap solution

Indonesia

- Law No. 12 of 1992 on Crop Cultivation System (Article 19 up to 21)
- Law No. 16 of 1992 on Animal, Fisheries, Plant Quarantine
- Government Decree No. 14 of 2002 on Plant Quarantine
- Ministry of Agricultural Decree No. 38 of 2006 on List of Quarantine Pest
- Ministry of Agricultural Decree No. 559 of 1985 on Plant Quarantine Requirements for the importation of plant propagating materials of rubber, cocoa, coffee, tea, sugarcane, coconut, oil palm, and tobacco
- Ministry of Agricultural Decree No. 861 of 1989 on Prevention of the Introduction into Indonesian territory of SALB of Hevea

    a. Basically, import of propagation material and products of hevea and non-Hevea from SALB endemic countries into Indonesia territory is probihited.

    b. The exception is made to import of above materials under the following terms and conditions
    - For research purposes which is conducted by government research institution
    - Having import permit from Minister of Agriculture and comply with other terms and condition according to prevailing law and regulation
    - Addressed to the related government research institution
    - Have been treated in its origin country
    - Have been washed or cleaned of any attached soil from its origin country
    - Accompanied by Phytosanitary Certificate explaining that all requirement stated in point d and e above have been fulfilled

    c. In addition to the compliance to the above stipulation, import of hevea propagation material other than seeds has to comply with the following condition as well:
    - Has been grown in the intermediate quarantine installation of a non-SALB endemic country outside Asia-Pacific region and has been treated
    - Accompanied by recommendation letter from Phytopathologist from the intermediate quarantine installation stating that the above requirement has been fulfilled and the propagation material is free from SALB
    - Subject to post-entry quarantine on arrival in entry point

    d. In addition to the compliance to above stipulation, import of hevea in the form of seeds has to comply with the following conditions:
    - Subject to treatment in the intermediate quarantine installation in a non-SALB endemic country outside Asia-Pacific region
    - All packaging material, including the containers, from origin country has to be replaced with a new one in the intermediate quarantine installation
    - Accompanied by recommendation letter from Phytopathologist from the intermediate quarantine installation stating that requirement in point a and b above have been fulfilled and the hevea seeds is free from SALB
    - Have been given treatment on arrival in entry point
    - Subject to import quarantine

    e. In addition to the compliance to the above terms and conditions, import of products of hevea should be treated in its exporter/origin country

    f. In addition to the compliance to the above terms and conditions, import of non hevea propagation material is subjected to post entry quarantine on arrival in entry point

    g. Import non-Hevea products from SALB endemic country subject to treatment in entry point

    h. Non-plants material which is carrier medium of SALB disease, such as luggages, clothes, camera, shoes and parcels from SALB endemic countries should not be released before being treated

Malaysia

Restriction on the importation Hevea planting materials

- Only for research
- Consigned to the Director of DOA
- Refer to Director General of Rubber Research Board before importation
- Subject to PEQ upon arrival

Hevea from area where SALB is present

- PEQ outside SEA Pacific Region for a period of time
- Free from pests
- Accompanied by phytosanitary certificate

Seed of any Hevea species from SALB area is prohibited unless inspected and treated outside the area where SALB is not found:

- Outside Pacific and Southeast Asia
- Repacked with new packing/containers
- Accompanied by phytosanitary certificate

Vessels

- If more than 40 days, allow entry (spores will not survive),
- If less than 40 days, refuse entry

Importation of plants and plant products

- For research only, Consigned to the Director General of DOA
- Subjected to quarantine or treatment

Lumber (non-Hevea)

- Import permit and PC

Direct flight

- Interception of passengers and baggage
- Plant Quarantine Declaration Card
- Announcement in the flight
- Double tagging
- Passengers and Cargo Manifest
- Separate compartment/conveyer for baggage

Treatment for passengers

- Floor mat with Dettol
- Air tunnel
- X-ray machine

Treatment baggage including equipment

- Treated with soap/Dettol
- UV – light chamber

India

Plant Quarantine Order (Regulation of Import into India) Order 2003 effective with effect from 1 January 2004

Hevea planting material

- Prohibited from American continent and West Indies. For remaining countries require Import Permit, Phytosanitary Certificate, Intermediary Quarantine Station and Post-Entry Quarantine.
- Special permission from export and import committee of Department of Agriculture and Cooperation.
- Can only be imported through/by Director of Rubber Institute, Kottayam (Kerela).

Hevea plant product

- Require Import Permit, Phytosanitary Certificate and inspection upon entry

Non-Hevea planting material

- Require Import Permit, Phytosanitary Certificate, inspection upon entry and post-entry quarantined.

Non-Hevea plant products

- Require Import Permit, Phytosanitary Certificate and inspection upon entry

Passengers from SALB area/Container

- No regulation

China

SALB is listed on the Quarantine Pest List (A1)

Hevea planting materials

- Restriction on importation from countries where SALB is known present.

Non-Hevea planting materials

- Restriction on importation from the countries where SALB is known present.

Seeds or other Hevea planting materials

- Special import permit required in advance.
- Quarantine treatment required at intermediate quarantine station.

Soil

- Restriction on importation from the countries where SALB is known present.

Passengers

- Should be transited one day at the place of North American or Europe
- Plant Quarantine Declaration Cards

Cargo or posting materials

- Quarantine treatment such as ultraviolet and so on, required.

Viet Nam

SALB is listed on the Quarantine Pest List (Group I)

Hevea planting materials

- *Import permit required in advance from Plant Protection Department (PPD)*
- *Phytosanitary certificate (PC) is required*
- *Inspection at point entry*
- *Subject to Post-Entry Quarantine*

Hevea plant product

- *PC is required*
- *Inspection at point of entry*

Non-Hevea planting materials

- *Import Permit required in advance from PPD*
- *PC is required*
- *Inspection at point of entry*
- *Subject to Post-Entry Quarantine*

Soil

- *Prohibited*

Passengers from SALB area/Container

- *No regulation*

Sri Lanka

Regulatory Position on Importation of Rubber.

- Import of rubber planting material is allowed only for scientific purposes.
- Import permit from Director-General of Agriculture (DGA) is necessary.
- Permission from Rubber Controller is necessary.
- DGA will issue the permit only for the Director of the Rubber Research Institute Sri Lanka (RRISL).
- Import conditions specified.
- Soil, packing material of plant origin and planting media are not allowed.
- Phytosanitary certificate required.
- Inspection at port of entry.
- Mandatory PEQ for a considerable period.

Import from SALB Endemic Area.

- All conditions given in previous case will apply.
- Collection of the material preferably by a senior researcher of RRISL.
- Intermediate Plant Quarantine mandatory.
- Phytosanitary certificate for re-export is required.
- Inspection at port of entry.
- Packing material and packaging material should be destroyed.

Other (non-Hevea) planting material from SALB endemic area for scientific studies.

- Import permit of DGA is required.
- No soil and plating media.
- Intermediate Plant Quarantine Station.
- Phytosanitary certificate (PC) and PC for re-export are required.
- Inspection at port of entry.
- Mandatory PEQ for a period less than 2 years.
- RRISL should have a contingency plan to combat the disease, in case of accidental entry.

Book II

APPPC RSPM No. 7

Guidelines for the protection against South American leaf blight of rubber

(Adopted by the 26th Session of the APPPC in 2007)

CONTENTS OF BOOK II

GUIDELINES FOR PROTECTION AGAINST SOUTH AMERICAN LEAF BLIGHT OF RUBBER

INTRODUCTION

Scope

This standard provides guidelines for members of the APPPC, particularly rubber growing countries, to assist them to improve or develop their phytosanitary measures, including prevention, eradication and control, against South American leaf blight of rubber (SALB). It covers all the areas of plant health dealing with the protection of member countries rubber industries from SALB.

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Definitions and abbreviations

Except where noted, the definitions are from ISPM No. 5, *Glossary of phytosanitary terms*.

Control (of a pest)	Suppression, containment or eradication of a pest population [FAO, 1995]
devitalization	A procedure rendering plants or plant products incapable of germination, growth or further reproduction [ICPM, 2001]
eradication	Application of phytosanitary measures to eliminate a pest from an area [FAO, 1990; revised FAO, 1995; formerly eradicate]

inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations [FAO, 1990; revised FAO, 1995; formerly inspect]
intermediate quarantine	Quarantine in a country other than the country of origin or destination [CEPM, 1996]
pathway	Any means that allows the entry or spread of a pest [FAO, 1990; revised FAO, 1995]
Pest Free Area	An area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained [FAO, 1995]
Pest Risk Analysis	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it [FAO, 1995; revised IPPC, 1997; ISPM No. 2, 2007]
phytosanitary import requirements	Specific phytosanitary measures established by an importing country concerning consignments moving into that country [ICPM, 2005]
phytosanitary procedure	Any official method for implementing phytosanitary measures including the performance of inspections, tests, surveillance or treatments in connection with regulated pests [FAO, 1990; revised FAO, 1995; CEPM, 1999; ICPM, 2001; ICPM, 2005]
point of entry	Airport, seaport or land border point officially designated for the importation of consignments, and/or entrance of passengers [FAO, 1995]
surveillance	An official process which collects and records data on pest occurrence or absence by survey, monitoring or other procedures [CEPM, 1996]
treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalization [FAO, 1990, revised FAO, 1995; ISPM No. 15, 2002; ISPM No. 18, 2003; ICPM, 2005]

Outline of requirements

Guidelines for the protection of APPPC rubber growing countries against SALB, based on the 2007 *Pest risk analysis for South American leaf blight (SALB) of rubber (Hevea)*, are proposed by considering five major areas:

- the prevention of the introduction of SALB into Asia and Pacific region using import requirements, and systems for points of entry inspections, laboratory diagnostics, and surveillance;
- the establishment of eradication or control programmes in case of entry of SALB;
- the development of training programmes on inspection and diagnostic methods, surveillance, eradication and control programmes;
- the minimum resources, in terms of for personnel and facilities, for protection against SALB;
- the establishment of coordination and cooperation activities for SALB programmes.

Systems for preventing the introduction of SALB include the establishment of import requirements for host material (including budded stumps and budwood, seeds, *in vitro* plants and foliage) and non-host material (inanimate goods or non-host organic material, travellers from SALB endemic countries and other items). Risk management can include measures such as inspection for freedom from infection; surface sterilization and post-entry quarantine for plants for planting; seed treatment for seeds; and removal, destruction or heat treatment for contamination of non-viable host material. The operational structures supporting the prevention of the introduction of SALB include points of entry inspection systems, a laboratory diagnostic system and SALB surveillance systems.

Rubber growing countries should also, within their SALB protection programme, develop and establish contingency plans for eradication or control programmes in case the disease is found in a country. Training programmes for inspection, diagnostic and disinfection procedures, surveillance, eradication and control measures, and staff management need to be developed. A minimum resource level of personnel and facilities should be established for SALB protection programmes.

In managing a national SALB protection programme, NPPOs should ensure that a centralized committee is set up to coordinate activities and that appropriate links are made with other related bodies to exchange information. For a regional coordination programme, the commission may consider establishing an SALB cooperation committee, the activities of which could be supported by all member countries.

Background

The South American leaf blight (SALB) is caused by the fungus *Microcyclus ulei* (P. Henn) v. Arx and is the most destructive disease of rubber. It has been a major constraint in the production of rubber in South America. The disease could also cause great economic damage to the rubber growing countries of Asia and the Pacific region if it were to be introduced into the area. This was recognized by countries of the region when establishing the Plant Protection Agreement for the Asia and Pacific region (the Agreement) in 1956, with the promulgation of Article IV and Appendix B to the Agreement which dealt specifically with SALB. This obliged members to prohibit the import of: plants or seed of the genus *Hevea* from outside the region; plant material of genus *Hevea* not capable of further growth or propagation (such as fresh or dried herbarium specimens); and any plants of other than genus *Hevea* from SALB endemic areas into their countries unless certain stringent phytosanitary import requirements were met.

When revising the Agreement in 1999 to bring it in line with the WTO Agreement on the Application of Sanitary and Phytosanitary Measures, the 1956 provisions relating to SALB were found to be inconsistent. APPPC decided that a pest risk analysis (PRA) on SALB should be developed by APPPC member countries.

The PRA for SALB was completed and accepted by the 25th session of the APPPC in August 2007 (subsequently referred to as the SALB PRA). The PRA is the guideline used to develop this standard on SALB.

Purpose

This standard provides guidelines for APPPC member countries that grow rubber to prevent the entry, spread and establishment of SALB, taking into account the SALB PRA.

The guidelines cover five major areas:

- the prevention of the introduction of SALB into Asia and Pacific region using import requirements, and systems for points of entry inspections, laboratory diagnostics, and surveillance;
- the establishment of eradication or control programmes in case of entry of SALB;
- the development of training programmes on inspection and diagnostic methods, surveillance, eradication and control programmes;
- the minimum resources, in terms of for personnel and facilities, for protection against SALB;
- the establishment of coordination and cooperation activities for SALB programmes.

REQUIREMENTS

1. The prevention of the introduction of SALB

The prevention of the introduction of SALB into rubber growing countries can be achieved by an integrated programme including:

- strict phytosanitary import requirements (enabled through legislation) that reduce any potential risk from imports to a level acceptable to the importing country
- an inspection system at points of entry that ensures compliance with import requirements
- a laboratory diagnostic system for the identification of the pathogen
- an efficient surveillance system that ensures early detection of the pest.

1.1 Import requirements

Import requirements should be determined based on the SALB PRA which describes the pathways of entry and the relative risks of those pathways taking into account consequences and the appropriate level of protection of the individual country.

The SALB PRA noted the pathways for the entry of the pathogen as:

- Budded stumps and budwood
- foliage (stem and leaf material not for planting)
- flowers, fruit and seeds
- plants *in vitro*
- rubber wood
- travellers
- inanimate goods or non-host organic material (contaminated by spores)
- inanimate goods or non-host organic material contaminated by host plant material

Appendix 1 is a summary of the assessments of introduction, spread and consequences from the SALB PRA.

The NPPO of each rubber growing member country should consider import requirements as follows:

*1.1.1 Host material (*Hevea *spp)*

As identified in the SALB PRA, planting material of *Hevea* from SALB endemic countries (see Appendix 2) is categorised as high risk. Importing countries should apply measures as necessary. Rubber growing countries should consider limiting the entry of high risk material to designated entry points. Measures are described in the SALB PRA and include the following.

For budded stumps and budwood*:

- prohibition of imports if an importing country does not have the capacity to apply effective measures to mitigate risk to an appropriate level of protection
- restriction of quantity based on the capacity of the pose-entry quarantine (PEQ) station
- restricting the length of each budwood stick to less than 1 metre
- pre-export inspection and treatment
- measures applied on arrival (in an appropriately secure facility)
- restriction of imports to Government Research Institutes only and using PEQ stations
- other PEQ facilities or intermediate quarantine for at least one year and certified free from SALB by an SALB expert.

For seeds:

- restrictions on the quantities of seed imported
- only healthy seeds should be imported
- washing with a surface sterilant and dressing with a fungicide immediately prior to export.

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* budded stumps includes seedling stumps

For *in vitro* plants:

- growing the plants aseptically on agar for more than three months followed by appropriate inspection or testing.

For foliage:

- the prohibition of foliage of *Hevea* from SALB countries unless treated to remove the risk.

1.1.2 Non-host material (SALB endemic countries)

Non-host material includes travellers, inanimate goods and non-host organic material.

Travellers from SALB endemic countries

Where a rubber growing country has determined a level of risk associated with travellers from SALB endemic countries, the travellers should be required to make a declaration to the NPPO point of entry inspector if they have visited a SALB endemic country in the last 21 days and have visited a rubber plantation. Special care should be taken with such items such as camping equipment and hiking boots, farm equipment and decorative plant material as these are more likely to contain non-viable host material greater than 1 cm^2 that may be contaminated with SALB. Measures to remove possible contamination may include cleaning, disinfection or destruction.

Inanimate goods

Cargo such as machinery that has been used in rubber plantations as well as household effects (gardening tools/equipment) in SALB endemic countries may be contaminated with non-viable host material carrying the pathogen. Measures include steam cleaning to remove all organic material which should be destroyed. Machinery should be dismantled if necessary. Where suspect material cannot be removed or the material cannot be destroyed (e.g. herbarium material) the material should be heat treated for a minimum of 30 minutes at 56ºC or a level that achieves the importing countries appropriate level of protection.

Non-host organic material

Other items, such as planting material and foliage, of non-SALB hosts may need to be assessed for possible SALB contamination and phytosanitary procedures and appropriate treatment applied.

1.1.3 Risk management methods

A number of risk management methods from section 4 of the SALB PRA are given in Appendix 3.

1.2 Points of entry inspection systems

When determined necessary, consignments from SALB endemic countries, including traveller's hand-carried items, should be subjected to inspection by NPPO inspectors at points of entry.

Points of entry inspection systems should be such to ensure that consignments and travellers comply with import/entry requirements.

NPPOs should follow the general guidelines provided in ISPM No. 23: *Guidelines for inspection.*

Specific points relating to inspection for risk items concerning SALB include:

- examination of documents associated with consignments to ensure that all permitted planting material has the correct certification
- examination of manifests to identify inanimate goods or non-host organic material that might be contaminated with the spores of the pathogen or host material that need to be inspected
- trained personnel to be stationed at entry points to recognize live and dead plant material of *Hevea*

- inspection of consignments, including used machinery, that have been in the rubber plantations of SALB infected countries
- equipment and chemicals for disinfection and disposing of any suspect material or non compliance consignment should be available to inspectors
- to ensure appropriate security, systems for packing and transporting suspect material to diagnostic laboratories should be available
- phytosanitary action, as noted in ISPM No. 20 *Guidelines for an import a phytosanitary import regulatory* system, section 5.1.6.1), should be taken where non-compliance occurs or SALB is detected.

1.3 Laboratory diagnostic system

Countries should have, or have access to, appropriate laboratory diagnostic tools. This may include the following:

- diagnostic facilities for the identification of suspect fungal isolates. These laboratories should be established at or near the designated entry points where possible.
- the laboratories should follow standard procedures for the diagnosis of the pathogen(s) on specimens.

1.4 SALB surveillance systems

NPPOs in rubber growing countries should establish and maintain national systems for surveillance for SALB – see ISPM No. 6. It is essential that any incursion of the pathogen is detected before it establishes and becomes widespread.

Additional surveillance programmes may be implemented in countries if the disease occurs in neighbouring country or is intercepted at an entry point. Such surveillance systems would be ongoing. Specific surveillance systems are described in Appendix 4.

2. Eradication or control programmes

To be prepared in the event that the disease is found in a country, the NPPOs of APPPC rubber growing countries should develop and establish contingency plans for eradication or control programmes according to ISPM No. 9 *Guidelines for pest eradication programmes*. The plans should include a system for preventing the movement of potentially infected or contaminated materials within and out of infected areas. Such plans could include the following components:

Operational procedures

- undertaking of a delimiting survey of the affected area
- undertaking other surveys as necessary
- documenting records of occurrences
- international notification
- carrying out an eradication feasibility study
- establishing and undertaking the eradication programme or control measures including surveillance, containment, treatment
- disinfection and destruction procedures
- systems for the prevention of the movement of possibly infected or contaminated material within and out of infected areas
- verification of eradication.

Required resources

- a means of identifying the disease in the field plus a diagnostic laboratory support for confirmation of identifications
- identification of appropriate eradication methodologies
- administrative systems including a management structure and documentation procedures
- trained operational staff
- regulations providing authority for procedure implementation (movement prohibitions, setting up check-points, etc.)
- information management system
- communications programme, including media, public awareness
- financial support.

3. Training programmes

NPPOs of rubber growing countries should establish training programmes for the staff on inspection, diagnostic and disinfection procedures; surveillance; eradication and control measures; and management of programmes for SALB. The components of such programmes are listed below:

3.1 Inspection, diagnostic and disinfection procedures

- procedures of inspection
- procedures of clearance
- inspection of document and import requirements
- recognizing the symptoms of SALB and its pathogen
- recognizing host plants and host plant parts
- laboratory diagnostic protocols and procedures for identification of the pathogen
- disinfection or destruction of infected or non-compliant materials
- disinfection procedures for personnel handling diseased material.

3.2 Surveillance programmes

- early detection systems
- identification of symptoms and the pathogen
- surveillance procedures and sampling techniques
- documentation and reporting.

3.3 Eradication and control measures

- knowledge on eradication and control procedures
- safe handling of chemicals and equipment
- use of a geographical information system to map affected areas
- application of fungicides
- eradication programmes (including simulated outbreak exercises).

3.4 Management of programmes

- eradication programme management
- programme documentation and recording
- communication with growers, industry representatives government departments, NGOs and public
- communications/media.

4. Minimum requirements for personnel and facilities

The NPPO of each rubber growing country should have as a minimum resource for protection against SALB:

- designated expert(s) on SALB
- trained inspectors for consignment inspection and for surveillance programmes
- diagnostic capabilities to detect and identify the pathogen
- PEQ facilities
- access to aerial spraying organizations or companies
- disinfection facilities including:
  - dipping tank with sodium hypochlorite
  - hot water jet system for disinfection
  - incinerator
  - UV Chamber
  - access to chemicals and any necessary registration for use

5. National and regional coordination and cooperation

5.1 National

The NPPO of each rubber growing country should coordinate the activities of the SALB programme or, where appropriate, establish a centralized body or committee (if one does not already exist) to do this. The activities of such a body or committee could cover the following areas:

- resource management
- programme documentation, evaluation and improvement procedures
- centralized communication with growers, industry representatives, government departments and NGOs
- establishment and maintenance of a national focal point
- surveillance planning
- public awareness initiatives and programmes.

5.2 Regional

The NPPO or the committee would also establish links with related bodies or committees in other rubber growing countries to exchange information and establish regional programmes where necessary to:

- seek technical assistance
- seek financial assistance
- ensure availability of technical expertise through regular regional and international workshops, training and seminars on SALB
- provide training on SALB
- cooperate with other regional and international organizations that deal with rubber and with the NPPOs of non-rubber growing countries (that could, for example, supply opportunities for intermediate quarantine, undertaking research)
- cooperate with SALB endemic countries in training, research, the safe transfer of rubber plant germplasm including the verification of phytosanitary systems and information exchange.

The Commission may consider the establishment of an SALB Cooperation Committee to oversee and coordinate various regional activities for the prevention of the introduction of SALB into the region. The NPPOs of all member countries should support regional activities for the prevention of the entry of the disease into the area where this is appropriate.

APPENDICES

Appendix 1

Table 1. Summary of the assessments of introduction, spread and consequences to rubber growing countries (source SALB PRA, 2007 Table 6)

Vector	Probability of entry	Probability of establishment	Probability of spread	Likely impact	Level of risk
Host material (*Hevea* species)					
Budded stumps or budwood	High	High	High	High	High
Foliage (stem and leaf material not for planting)	Low	High	High	High	Moderate
Flowers, fruit and seeds	Low	High	High	High	Low
Plants *in-vitro*	Negligible	N/A	N/A	N/A	Negligible
Non-host material					
Inanimate goods or non-host organic material	Negligible	N/A	N/A	N/A	Negligible
Inanimate goods or non-host organic material contaminated by host plant material	Low (if <1 cm^2)	High	High	High	Low (if <1 cm^2)

Appendix 2

SALB endemic countries

(Source SALB PRA, 2007 Plate 5)

1. Belize
2. Bolivia
3. Brazil
4. Colombia
5. Costa Rica
6. Dominican Republic
7. Ecuador
8. El Salvador
9. French Guiana
10. Guatemala
11. Guyana
12. Haiti
13. Honduras
14. Mexico
15. Nicaragua
16. Panama
17. Paraguay
18. Peru
19. Surinam
20. Trinidad and Tobago
21. Venezuela

Appendix 3

Risk management methods for SALB
(Source SALB PRA, 2007 Section 4)

This is a direct copy of the relevant section of the SALB PRA (with the reference to ISPM No. 5 being updated). The section numbers are changed to fit this appendix. References are to be found in the SALB PRA.

RISK MANAGEMENT

The guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. Pest risk management (in the analytical sense) is the process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options (ISPM No. 11 2004). The effectiveness of any risk management measures depends on our perception and understanding of the disease and the risk pathways. Phytosanitary measures drawn up on the basis of science and practicality are essentially easy to implement, have minimal economic impact and are discriminating.

Based on the assessment of risks completed in the previous chapters of this risk analysis, risk commodities have been divided into the following groups.

1. Viable host material:
   - 1.1 Plants for planting: Whole plants and cuttings, and plants in-vitro;
   - 1.2 Seeds, flowers and fruit.
2. Non-viable (inanimate) host material:
   - 2.1 Cargo pathway (including sea freight, airfreight and mail);
   - 2.2 Passenger pathway (including accompanied luggage).

For goods or passengers originating from an area not known to be free of SALB, the following risk management measures may be applied.

1. Management options for viable host material

Viable host material includes any plant parts that are being imported into the region for the purposes of propagation or could be propagated by conventional means.

1.1 Plants for planting

The IPPC definition of plants for planting includes whole plants and cuttings, and plants *in-vitro* (ISPM No. 5 2009). For the purposes of this risk analysis only budded stumps and budwood have been considered for measures as they are the most likely form to be transported between countries for planting.

1.1.1 Budded stumps and budwood

Management of the phytosanitary risks associated with the import of budded stumps and budwood for propagation should start in the country of origin. Efforts should be made to ensure that, as far as is reasonable and possible, budded stumps and budwood exported to the PRA area should be free of SALB. The United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ): *Postentry Quarantine Manual for State Inspectors* (2006) states that to achieve an appropriate level of assurance from plant inspections, plants should be inspected over two growing seasons. It is therefore considered appropriate that mother plants of budded stumps and budwood should undergo periods pre-export and post entry inspection for signs of SALB before being distributed in the PRA area.

In the case of SALB and the susceptible *Hevea* species, the period of greatest disease expression is at the time of new foliage growth. Therefore budded stumps and budwood should only be harvested from mother plants that have been recently inspected during a period of optimal disease expression and no signs of SALB were detected. To further lessen the likelihood of contamination, harvesting of budded stumps and budwood should only occur when the bark has been hardened (brown in colour) and during the low-disease season (e.g. dry weather). Budded stumps and budwood should be no longer than 1 metre when exported, and the material dipped into a suitable surface sterilant followed by a suitable systemic fungicide. All packaging material should be destroyed on arrival in the PRA area.

During the post-entry quarantine inspection period plants should be maintained in an environment that both stimulates SALB expression and limits the ability of SALB to escape the facility and infect surrounding host plants. No fungicides effective against SALB should therefore be applied to plants during the inspection period (new leaf growth) as fungicides may mask disease expression. SALB containment can be achieved either through the use of high security quarantine facilities or by ensuring no host plants are within 3 km of the boundaries of the facility. To ensure any infected plants are removed from the post-entry quarantine facility as possible, plants should be inspected daily by staff trained to detect signs of SALB infection. Suitably qualified plant pathologists should also inspect the plants every two weeks to verify the daily inspections by facility staff.

If SALB is positively identified in the quarantine facility, all host plants in the facility should be treated with an appropriate fungicide, and another inspection period instigated.

Based on the aforementioned recommendations, the following measures should be applied to budded stumps and budwood before export from the SALB affected country or region, during transport to the PRA area, and on arrival in the PRA area.

Pre-export inspection and treatment

- Mother plants should be inspected by suitably qualified plant pathologist for signs of SALB infection and deemed to be free of SALB infection. Inspections should take place immediately before the harvesting of budded stumps or budwood and during a period considered optimal for disease expression;
- Harvesting of budded stumps and budwood should only occur when the bark has been hardened (brown in colour) and during the low-disease season (e.g. dry weather). Budded stumps and budwood should be no longer than 1 metre when exported;
- Budded stumps and budwood should be packaged for export in a manner that limits the likelihood of infestation during transport;
- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- Budded stumps should be free from soil.

Measures on arrival (in an appropriately secure facility)

- Budded stumps and budwood should be dipped in an appropriate surface sterilant and a systemic fungicide effective against *M. ulei*;
- All packaging material should be destroyed or appropriately sterilized, and the budded stumps and budwood repackaged after treatment.

Post-entry quarantine

- Imported budded stumps and budwood should be grown in a suitable post-entry quarantine facility for at least one year or after new foliage has been produced at least six times;
- Plants should be inspected for signs of SALB daily by suitable trained facility staff and fortnightly by suitably qualified plant pathologists;

- Should any signs of SALB be detected, plants showing signs should be destroyed and all other *Hevea* plants within the facility should be treated with suitable fungicide (treatment may require six or more applications);
- Prior to release from the facility all plants in the facility should be inspected by a suitable qualified plant pathologist for signs of SALB infection;
- Plants may be released from the post-entry quarantine facility only after having all plants in the facility have been free from any signs of SALB for at least one year or after new foliage has been produced at least six times.

Intermediate quarantine

Intermediate quarantine offers a further option to mitigate risk. This system can have some logistical, maintenance and financial problems when used for rubber, but it may operate successfully in some specific circumstances.

1.1.2 Plants in vitro

Plants *in vitro* should not be considered a risk pathway for the entry of *M. ulei* if the cultures are axenic. However, at the moment the practice is not commercially used.

1.2 Seeds and fruit

As the risk from seeds and fruit material relates to surface contamination only, all such products exported from SALB regions should be surface sterilized immediately prior to export.

Flowers and fruits should be washed with a surface sterilant such as 200 ppm of sodium hypochlorite (Chee 2006). Only healthy seeds should be selected for export, washed with water and soaked in formalin (5 percent) for 15 minutes, and then air dried and dressed with thiophanate methyl, benomyl or mancozeb (Chee 1978; Santos and Pereira 1986).

2. Management options for non-viable host material

Non-viable host material is essentially leaves or other parts of a host plant (susceptible *Hevea* species) that are imported either deliberately or as contaminants into the PRA area from countries or areas not known to be free of SALB. These types of host material are not able to be propagated by normal means.

2.1 Cargo pathway

Cargo from SALB infested countries or areas should be screened for goods or shipments that are likely to contain or be contaminated by non-viable host material. A profile list should be established that identifies cargo most at risk of containing non-viable host material.

Cargo such as used machinery (cars, logging equipment, chainsaws, cutters etc.) that may have been used in rubber plantations should be thoroughly steam cleaned of all organic material larger than 1 cm^2, and dismantled if there are parts that can not be easily cleaned. Household effects should be inspected for gardening equipment that may be contaminated by organic material.

Any organic material that is thought to be from a susceptible *Hevea* species, is larger than 1 cm^2, and can not be removed from the goods or can not be destroyed (e.g. herbarium material), should be heat treated for a minimum of 30 continuous minutes at 56ºC or greater.

2.2 Passenger pathway

Passengers and accompanied luggage arriving within 21 days from areas not known to be free of SALB should be inspected for both viable and non-viable host material. Special care should be taken with such items as camping equipment and hiking boots, farm equipment, and decorative plant material as these are more likely to contain or be contaminated by non-viable host material greater than 1 cm^2. Measures may include cleaning, disinfection or destruction.

3. Residual risk after measures

While the measures above, if strictly and effectively enforced, should be expected to manage the phytosanitary risks posed by SALB to the PRA area, it should still be considered possible that slippage (undetected risk items) may result in the establishment of SALB in the region. Efforts should be made to manage this residual risk by establishing an effective monitoring system that would be expected to detect an establishment event early enough to allow for an effective eradication programme to be completed.

Appendix 4

SALB surveillance system

1. Responsibilities of the Survey and Monitoring Officer

- Plan surveys and monitoring programmes
- Produce format and guidelines on survey procedures
- Identify agencies and persons to implement surveys
- Monitor, coordinate and direct all survey
- Report immediately the event of detection of SALB or any other disease and pests not hitherto found
- Assist in the identification of SALB

2. Types of surveillance

There are several types of survey each conducted for different purposes as outlined in ISPM No. 6 *Guidelines for surveillance*. These may include: initial detection surveys, delimiting surveys, monitoring or evaluation surveys and nationwide surveys.

2.1 Detection Survey

The initial detection surveys will be conducted to determine if the disease is present for the first time. A detection survey should include the following components:

2.1.1.1 Areas

Areas that should be inspected include rubber estates, smallholdings and nurseries which are likely to be exposed to:

- travellers and air carriers
- planting materials from SALB endemic areas.

2.1.1.2 Coverage

- points of entry, parcel/post office, tourist routes,
  Any rubber trees found within 2 km from the site
- Rubber estate, small holding and rubber research institute
  All rubber tree growing areas within a plantation/institute.

2.1.1.3 Sampling procedure

All trees in the nurseries should be inspected. For mature plantings, the numbers of sampling point is one(1) every 5 hectares.

2.1.1.4 Survey frequency

The survey in the nurseries should be carried out monthly during the wet season and fortnightly on mature stands during refoliation irrespective of weather.

2.2 Farmer-based detection survey

For rubber growing areas (small holders or plantation-owned), a detection survey must be farmer-based. The owners of these estates or smallholdings shall be provided with leaflets biennially informing them to be vigilant for SALB and to report immediately to the Survey and Monitoring Officer in the event of any suspected presence of SALB in their respective holdings. This instructional and informative leaflet should be prepared and distributed by the Survey and Monitoring Coordinator for dissemination to all estates and smallholders.

2.3 Delimiting surveys

When an infection of SALB is suspected or detected in an area, a delimiting survey should be conducted immediately to determine the extent of the infection. This involves inspection (as outlined under the Sampling Procedure, Section 2.1.1.3) of all the surrounding fields starting from the centre of the infected area and extending to a radius of 5 km (beyond the affected areas).

2.4 Monitoring/Evaluation surveys

The purpose of the monitoring and evaluation surveys is to monitor the effectiveness of the eradication measures that have been carried out and to establish whether the disease has been contained, eradicated or has spread to other areas surrounding the infested zone. Hence monitoring and evaluation surveys will have to be conducted once the eradication procedures have been initiated. They need to continue until eradication is declared or until it is determined that eradication is not possible. If the incursion is contained, ongoing monitoring surveys will be necessary.

2.5 Nationwide survey

In the case of a detection of SALB, a nationwide survey should be conducted to determine if the disease has spread or an incursion has occurredin other part of the country. The results may initiate emergency measures to be implemented by other countries.

3. Reporting of surveys

After completion of each survey round, the report from each survey should be submitted immediately to the coordinator. Any suspected detection of SALB should be notified to the NPPO immediately.

Book III

(Importing country NPPO name)

Work plan for the importation of budded stumps or budwood of *Hevea spp* from (*exporting country)* into (*importing country)*

(prepared by the Workshop on development of harmonized
plant import requirements for rubber planting materials and other pathways
associated with South American leaf blight
in December 2010)

CONTENTS OF BOOK III

WORK PLAN FOR THE IMPORTATION OF BUDDED STUMPS OR BUDWOOD OF *HEVEA SPP*

1. Scope

This Work Plan describes the mandatory operational requirements and the phytosanitary procedures, for the importation of budded stumps or budwood of *Hevea spp* from (exporting country) into (importing country) in order to address the risk of South American Leaf Blight and other regulated pests.

The measures and requirements detailed in this document meet the management measures described in the '*Pest Risk Analysis for South American Leaf Blight (SALB) of Rubber (Hevea)*, and the phytosanitary import requirements for other potential pests of concern to (*importing country*).

2. Definitions

Treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalization [FAO, 1990, revised FAO, 1995; ISPM No. 15, 2002; ISPM No. 18, 2003; ICPM, 2005]
Intermediate Quarantine	Quarantine in a country other than the country of origin or destination [CEPM, 1996]
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations [FAO, 1990; revised FAO, 1995; formerly inspect]
Packaging	Material used in supporting, protecting or carrying a commodity [ISPM No. 20, 2004]
Phytosanitary Certificate	Certificate patterned after the model certificates of the IPPC [FAO, 1990]
post-entry quarantine	Quarantine applied to a consignment after entry [FAO, 1995]
IP	Import Permit
NPPO	National Plant Protection Organization
IPPC	International Plant Protection Convention
PC	Phytosanitary Certificate
Verification	The process of reconciling export certification and product description with respective consignments and labelling requirements
Mother plants	Plants from which exported budded stumps or budwood is obtained

3. Product being exported

3.1 *Hevea* spp budded stumps or budwood produced in compliance with this work plan may enter (*importing country*), subject to on-arrival inspection and treatment and disease screening in a post-entry quarantine facility.

3.2 Post-entry quarantine may occur in (*importing country*) or in another country which is free of SALB.

3.3 Imported budded stumps or budwood must not be longer than 1 m, and must be free of soil and other regulated articles, such as trash and quarantine pests.

3.4 Consignments must be packaged using clean, new materials and be accompanied by a PC issued by the NPPO of the exporting country, confirming that the consignment meets the management measures described in this work plan.

4. Responsibilities

4.1. Responsibilities of the NPPO of the exporting country

4.1.1 The NPPO shall follow all requirements of the work plan, the import permit issued by the importing country and any applicable regulations.

4.1.2 The NPPO will advise the grower/exporter of the export conditions.

4.1.3 The NPPO will ensure that a plant pathologist accredited by the importing country conducts inspections of mother plants for symptoms of SALB and any other diseases of concern to the exporting country in accordance with this work plan. Any mother plants showing signs of disease of SALB or other diseases of concern to the importing country shall not be used to propagate planting material for export to (*importing country*).

4.1.4 Propagating material must only be taken from mother trees which show no evidence or very low incidence of the symptoms of SALB.

4.1.5 Any propagating material showing signs of disease of SALB or other diseases of concern to the importing country shall not be exported to (*importing country*).

4.1.6 The NPPO will ensure through direct supervision that budded stumps or budwood for export are harvested at the brown bark stage of development and during the low-disease season, and are no longer than 1 m.

4.1.7 Where nurseries are used to establish budded stumps, the NPPO will register these nurseries and ensure that budded stumps for export are segregated from other product.

4.1.8 The NPPO will ensure that budded stumps or budwood for export have been dipped in the specified surface sterilant and systemic fungicide and shall supervise the application of the treatments.

4.1.9 The NPPO will inspect the consignment and issue a PC certifying that the requirements of the work plan have been met and that the consignment conforms to the import requirements of the importing country.

4.2. Grower/exporter responsibilities

4.2.1 The grower/exporter will contact the exporting country's NPPO when it receives an import permit for budded stumps or budwood and request that the NPPO provide inspection and certification services in accordance with the IP and this work plan.

4.2.2 The grower/exporter will provide the location or mother plants, exporting nurseries and packing houses to the NPPO and any other relevant information required by the NPPO to conduct inspection and the certification in accordance with this work plan.

4.2.3 The grower/exporter will abide by all requirements of this work plan and applicable regulations.

4.2.4 The grower/exporter will maintain accurate records of all activities, identify the growing sites, assign lot numbers to each of the plantings and identify the plant material for export.

4.2.4.1 The identification of product for export must allow product to be traced back to mother plant blocks, nurseries and packing houses.

4.2.5 Where the grower/exporter has a quality management system in place, the requirements of this work plan will be referenced in the quality manual.

4.2.6 The grower/exporter will abide by the recommendations of the accredited plant pathologist.

4.3 Importing Country Responsibilities

4.3.1 The NPPO of the importing country will issue an import permit for the importation of budded stumps or budwood specifying the import conditions and referencing this work plan.

4.3.2 The NPPO of the importing country may conduct audits and verification checks to ensure compliance with this work plan.

4.3.3 The NPPO of the importing country may elect to send a plant pathologist to the exporting country to conduct inspections of plant material for export and to supervise any other elements of this work plan.

4.3.4 The NPPO of the importing country will conduct an on-arrival inspection of the imported consignments to verify freedom from pests and other regulated items.

4.3.5 The NPPO of the importing country will dip budded stumps or budwood in an appropriate surface sterilant and systemic fungicide on arrival.

4.3.6 The NPPO of the importing country will ensure that all original packing material is destroyed or sterilized.

4.3.7 The NPPO of the importing country will transfer the imported consignment to a suitable post entry quarantine facility for growth and disease screening.

4.3.8 Alternatively, the NPPO of the importing country will arrange for intermediate post entry quarantine in another country.

5. Quarantine pests

M. ulei is the principle pest of concern for the importation of *Hevea spp*, however the consignment must comply with the general import conditions of the importing country for plant propagating material. These requirements are set out in K.H. Chee, W.I. Wan Normah, A.K.J. Atikah, K.C. Gupta, K.H. Ong, Budiman, Y. Surapol, T.D. Phan, C.M. Barron, 2010, "*Import Requirements of Plants, Plant Materials and Agriculture Products from the SALB Endermic Countries", *Workshop on the Prevention of Introduction of South American Leaf Blight (SALB) of Rubber, Kuala Lumpur, Malaysia p. 5-8.

6. Mother stock and growth requirements

6.1 Plants must be developed from mother stock that was inspected by an accredited plant pathologist and found free from evidence of diseases and pests of concern to the importing country, in particular SALB.

6.1.1 The NPPO of the exporting country will recommend a suitably qualified plant pathologist to the importing country's NPPO to conduct inspections of mother plants for symptoms of SALB and any other diseases of concern to the exporting country. The experience and qualifications of the plant pathologist will be sent to the importing country NPPO for consideration.

6.1.2 In consultation with appropriate research institutes, the NPPO of the importing country will consider the recommended plant pathologist and accredit that plant pathologist if it is satisfied with the qualifications and experience.

6.1.3 Alternatively, the importing country NPPO may send its own plant pathologist to perform inspections.

6.1.4 The NPPO shall verify that the inspections occur immediately before the harvesting of budded stumps or budwood for export, and during a period considered optimal for SALB disease expression.

6.1.5 Any plants showing signs of SALB or other diseases of concern to the importing country shall not be used to propagate budded stumps or budwood for export to the importing country.

6.2 Where nurseries are used to establish budded stumps, they shall be accredited by the NPPO of the exporting country and the importing country NPPO informed.

6.2.1 An accredited plant pathologist shall inspect the budded stumps prior to export for signs of disease.

7. Harvesting of budded stumps or budwood

7.1 The NPPO of the exporting country will verify by supervision that budded stumps or budwood for export are harvested at the brown bark stage of development and during the low-disease season, and are no longer than 1 m.

7.2 The NPPO of the exporting country will ensure that harvested budded stumps or budwood is identified to allow trace back to specific mother tree blocks.

8. Pre-export treatments

8.1 The NPPO will ensure that budded stumps or budwood for export have been dipped in a 200 ppm solution of sodium hypochlorite and a solution of thiophanate methyl or alternative chemicals approved by the importing country NPPO.

8.1.1 The NPPO will supervise the application of the above treatments.

8.2 The treatments will be applied in an enclosed secure facility, and the budded stumps or budwood will be packed immediately following treatment to guard against re-infestation.

9. Pre-export packaging and inspection

9.1 The NPPO will ensure that budded stumps or budwood for export are segregated from budded stumps or budwood which are not for export and that the packing premises are enclosed, clean and not subject to contamination from *M. ulei*.

9.2 The budded stumps or budwood will be inspected immediately prior to export by the NPPO and found free from evidence of plant pests and diseases.

9.2.1 The NPPO will issue a PC certifying that the requirements of the work plan have been met and that the consignment conforms to the import requirements of the importing country.

9.3 The NPPO will ensure that budded stumps or budwood for export are packed in clean, new packaging materials and secured to ensure that they are not exposed to contamination by spores of *M. ulei* after treatment.

9.4 The NPPO will supervise the packing of the budded stumps or budwood for export, and ensure that the consignment can be traced back to specific mother tree blocks.

9.5 The NPPO will ensure that the consignment is exported within 24 hours of packaging.

10. Intermediate quarantine

10.1 Where budded stumps or budwood are exported to a third country for intermediate quarantine, the importing country will ensure that appropriate records are retained for trace back purposes and that a PC is issued by the third country for export of the released plants to the importing country.

10.2 The on-arrival import conditions above will apply for imported budded stumps or budwood received after intermediate quarantine.

10.3 The post-entry quarantine period may be reduced for this material.

11. Programme review and evaluation

11.1 The work plan may be reviewed or amended when necessary by the importing country NPPO and the exporting country NPPO.

11.2 The NPPO of the importing country may audit the system for compliance with this work plan or arrange for a third party to audit the system on its behalf.

Annex 1

DIAGNOSTIC SYSTEM – EQUIPMENT AND APPARATUS

A. General pathology equipment

1. Major equipment

- Autoclave
- Incubators
- Oven
- Water Distiller
- Bio-safety cabinet/Laminar Flow
- Refrigerators
- weighing balances
- microscopes
- cameras
- pH Meter
- Water bath
- Shaker
- Microwave Oven
- Thermometer
- Isolation needles

2. PCR and related accessories

- Thermocycler
- Electrophorosis
- Gel documentation
- PCR Workstation
- Pippete
- Grinder
- Fumehood

3. ELISA

- ELISAR Reader
- Grinder

B. Disease treatment and disposing equipments

- Sprayers
- Moist Heat Chambers
- Dipping Tanks
- Incinerators
- Hot Water Jets Apparatus
- Waterbath

C. Chemicals and consumables item

- Media (PSA, PDA, MEA etc.)
- Chemicals for making media (agar, sucrose, glucose, malt etc.)
- Chemicals for sterilization – formalin, mercuric chloride, sodium hypochlorite, alcohols etc.
- Glasswares – Petri plates, test tubes, flasks, beaker, Glass slide/cover etc.
- PCR – Primer
- ELISA – Antiserum

D. For sampling and transportation of samples, examples

- Cooler Box
- Containment Box

E. Information and storage facilities

- Computer
- Software for data management
- Reference Books
- Networking for diagnostic
- Diagnostic manual

Annex 2

TECHNIQUES OF ISOLATION, CULTURING AND INDUCTION OF SPORULATION OF MICROCYCLUS ULEI

Microcyclus ulei, the causal agent of South American leaf blight (SALB) is classified as an obligate parasite. Various attempts were made to culture the fungus on artificial medium either liquid or solid media. Special techniques had also been used to isolate *M. ulei*. This paper documents some of the most successful methods.

ISOLATION METHODS

The fungus infects young rubber leaves forming lesions which produced conidiophores and consequently on more mature leaves ascospores. The pure culture of the fungus had been isolated from fresh lesions on young leaves:

Culturing young fresh disease lesion

Small sections of fresh young leaves are cut and surface sterilized and transferred onto isolation medium. Holliday (0) found it was better to use sections cut across the lesion than sections cut around disease lesions. Sodium hypochlorite or aqueous mercuric chlorides are used for surface sterilization.

Culturing the spores

Fresh lesions which are actively producing conidia are selected. Contamination is higher if older lesions are used or from leaves harvested on a rainy day. Various methods can be used to transfer the conidia onto the isolation medium:

- Using a moisten tip and sterile isolation needle, gently touch the upper surface of the lesion and place the spores onto the surface of the isolation medium.
- Cut a small piece of isolation medium and mount it at the tip of an isolation needle. Gently touch the piece of agar to the surface of the lesion and then transfer the agar to the surface of isolation medium.
- Tap the conidia from the fresh lesion onto the surface of agar (water agar). Using a stereo-microscope, pick the conidia and transfer to an isolation medium.

Isolation medium

Various media used to isolate M. ulei include water agar and potato dextrose agar. If water agar is used, the fungal colony must be transferred to richer medium. Antibiotics (chloroamphenicol) had been used to reduce bacterial contamination.

Growth medium

The first success of culturing M. ulei on artificial medium was done in 1945 by Langford who used a medium containing malt and extracts of rubber leaf. Since then extracts of rubber leaves of different ages were tried. Similarly, various vitamins and amino acids were also experimented with inconclusive results. Eventually Chee successfully cultured *M. ulei* on potato sucrose medium. The concentration of sucrose in PSA varied from 2.5 g to 5 g per litre. Panvit, a commercial multivitamin and mineral had also been used to enhance growth.

Growth of *M. ulei* on artificial medium

The growth of M. ulei in artificial medium is very slow and it is normal that it is hardly visible within the blackish stroma above the surface of the medium. The diameter of the colony is about 2 mm in 10 days and 2 cm in a month. The appearance of the colony also varies with the physiological races of M. ulei. Race 2 tends to grow into the medium while the growth of other races is superficial.

M. ulei had also been cultured on liquid medium. Growth in liquid PSA is good. Growth is better if the mycelium is floated on the surface of the medium thickened by adding 0.5 g/l agar. Cultures of *M. ulei* are normally maintained in the dark at 24ºC. For longer storage, sporulating colonies are submerged in sterile mineral oil however rejuvenation of these cultures is very slow.

Production of spores in vitro

Poor production of spores in vitro has been one of the limiting factors in the study of M. ulei. Several factors influence sporulation:

> Generally, sporulation is low in medium supporting good growth of M. ulei. Modified PSA and PSA amended with peptone or a brand of dog food increased spore production. The age of culture at the time of initiation of sporulation also influences the amount of spores produced. Maximum spores were produced from 2-3 weeks cultures. Light also influences spore production. Conidia production increases when the cultures were exposed to UV light for 45 min per day for 14 days. Cultures grown in the dark also produce more conidia when exposed to fluorescent light 60-90 min/day for 14 days. Alternatively, the cultures can be grown on PSA in the dark for 12 days and later exposed to fluorescent light for 1 h/day for 2 days.
>
> Nowadays *M. ulei* can be cultured on artificial medium with ease. Rubber growing countries should be aware on the movement of these cultures into their region.

Book IV

Contingency plan for South American leaf blight (*Microcyclus ulei*)

(prepared by the APPPC Workshop on Pest Incursion and Eradication in September 2010)

CONTENTS OF BOOK IV

Page

CONTENTS *(continued)*

Page

CONTINGENCY PLAN FOR SOUTH AMERICAN LEAF BLIGHT (*MICROCYCLUS ULEI*)

1. Purpose of this contingency plan

This contingency plan provides background information on the pest biology and available control measures to assist with preparedness for an incursion of South American Leaf Blight (SALB) (*Microcyclus ulei*). It provides guidelines for steps to be undertaken and considered when developing action against this pest. The technical information contained within this plan has been taken from the pest risk analysis (PRA) that was prepared by rubber (*Hevea brasiliensis*) growing member countries of the Asia and Pacific Plant Protection Commission (APPPC); namely Thailand, Indonesia, Malaysia, India, China, Viet Nam and Sri Lanka. The PRA was developed to provide the scientific justification for standards that will be developed by the APPPC and member countries to manage the trade-related phytosanitary risks of South American Leaf Blight (SALB). Associated standards on diagnostics, surveillance, import regulation, control and eradication would provide guidelines to further assist countries efforts to safeguard against the incursion of SALB into the PRA area.

2. Pest information/status

2.1 Pest details

Microcyclus ulei (Boddie, 1850)

2.1.1 General information

Pest identity and taxonomy

Pathogen:	*Microcyclus ulei* (P. Henn.) v. Arx
Order:	Ascomycetes
Family:	Dothideales
Synonyms:	Dothidella ulei (Henn. 1904) *Melanopsammopsis ulei* (Henn.) Stahel 1917 *Aposphaeria ulei* Henn. 1904 (conidial state: *Fusicladium macrosporum* Kuyper 1912)
Common name:	South American Leaf Blight (SALB) *Microcyclus ulei* is a major pathogen of rubber.

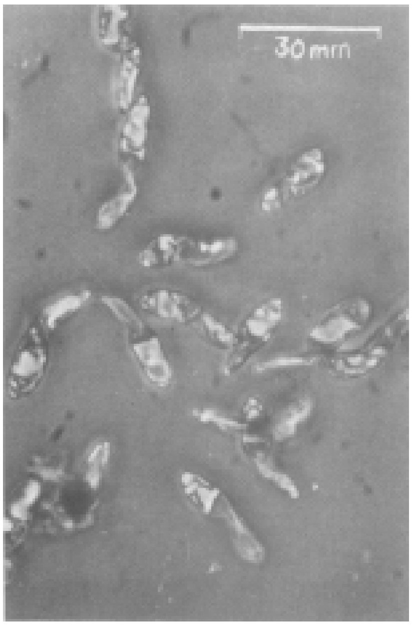
Spore production, germination and infection

The causal pathogen *Microcyclus ulei* is known to only infect species within the genus *Hevea*. It produces three types of spores; conidia on immature leaves; pycnospores on newly matured leaves; and ascospores on fully matured leaves. The main propogules are conidia and ascospores (Plate 1b, d). Pycnospores do not appear to germinate and do not therefore constitute an effective agent of disease dissemination (Plate 1c).

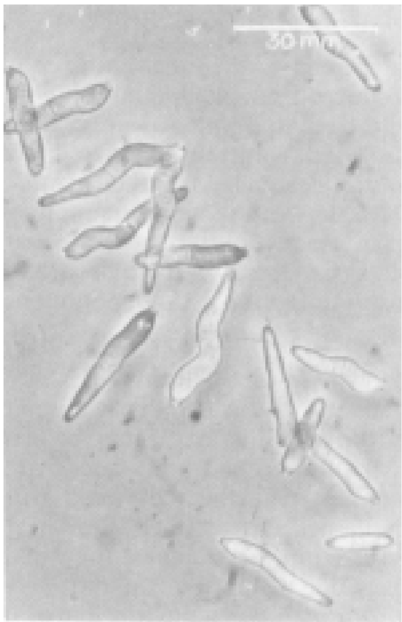
The conidia and ascospores infect the young developing leaves causing distortion followed by necrosis of the lamina (Plate 2). Affected leaves will abscise if infection is severe. Repeated defoliations and twig dieback weaken the tree and may sometimes cause its death (Plate 3) (Chee and Holliday 1986).

The primary stage of the disease on young leaves is characterized by the appearance of lesions covered by dark grey powdery masses of conidia on the abaxial leaf surface. Sporulation lasts for 2 to 3 weeks, later it becomes sparse and eventually no more conidia are produced. The conidia are disseminated by wind, vectors and water.

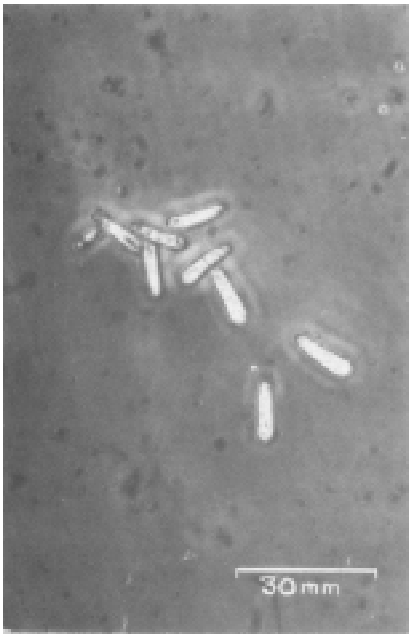
Plate 1. Conidia, pycnospores and ascospores (from Chee & Holliday 1986)



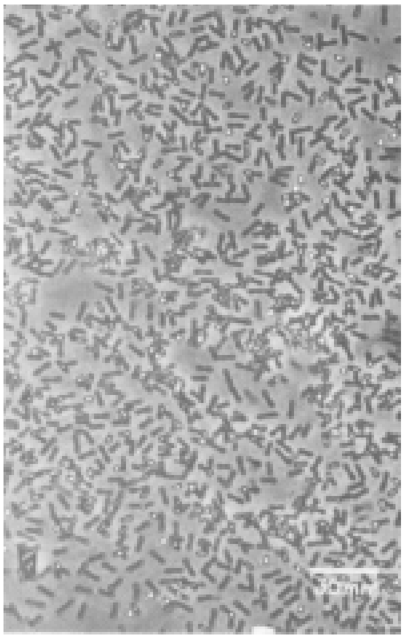
a) Dry, collapsed conidia



b) Turgid conidia



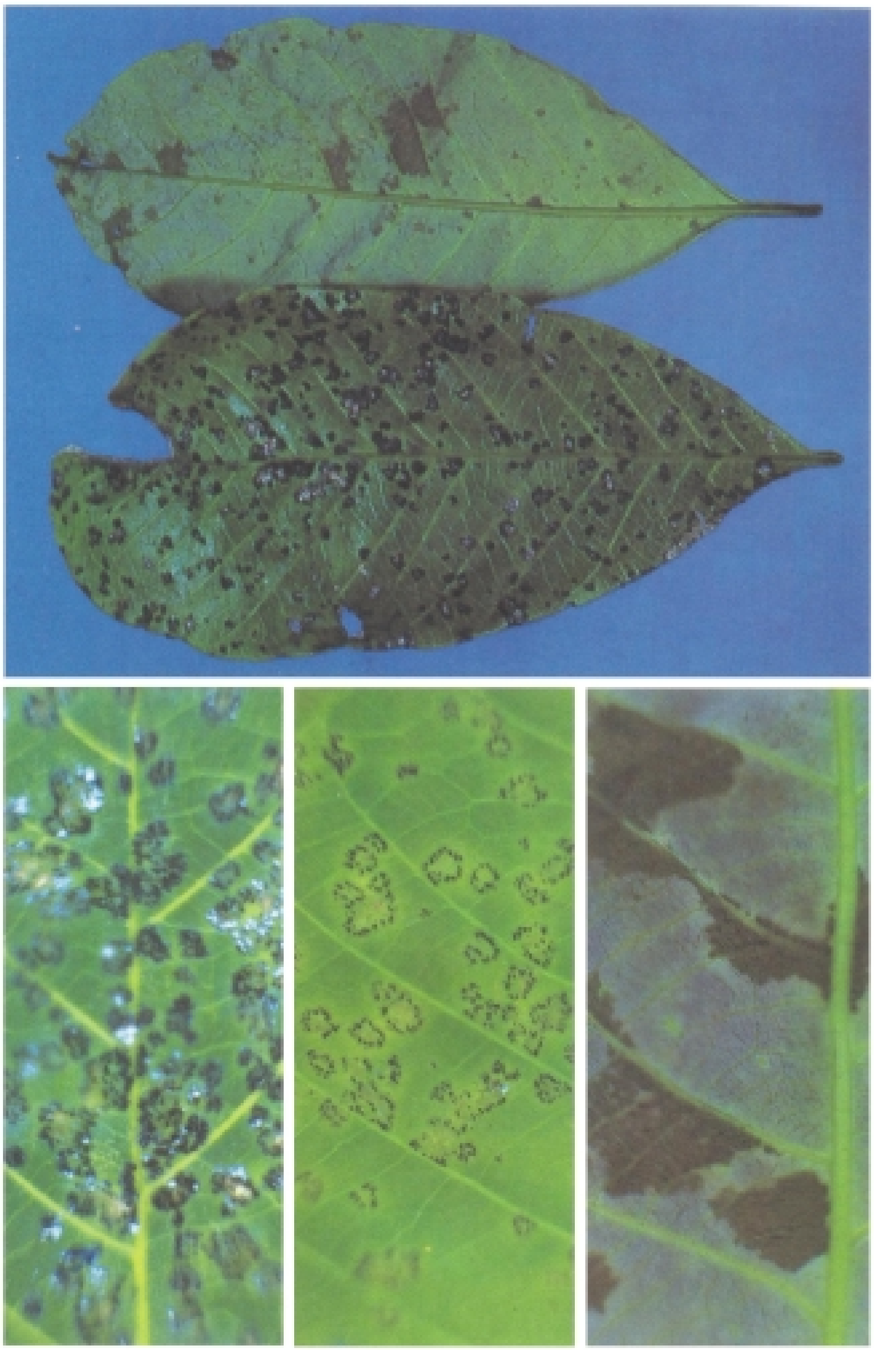
c) Pycnospores



d) Ascospores

The ascospores play an important role in the survival of the fungus from one season to the next. The viability of detached conidia and ascospores is affected by moisture and temperature. The optimum temperature for growth, sporulation and infection is 24ºC. Conidia and ascospores germinate in 3-4 hours at 24ºC. The optimum temperature range for ascospore germination is 19ºC to 25ºC, but none germinate at 26-32ºC. Water, in the form of dew or rain for about 8 hours, is considered necessary for germination, the formation of an aspersorium, infection hypha and penetration. Penetration is direct and through the leaf cuticle. Conidia begin to form within a week of infection and the perfect state mature about 8-9 weeks later. In infected rubber plantations ascospores are present throughout the year with peak concentrations occurring during the wet seasons. The wet season also marks the period of maximum production and dispersal of conidia (Chee 1976a, c).

Plate 2. Foliar signs of SALB (from Chee & Holliday 1986)



Clockwise: a) Conidial lesions and ascostromata on leaf surfaces; b) close up of conidial lesions; c) and d) pycnidia and ascostromata on mature and old leaves respectively.

The optimum temperature for germination of conidia is about 24ºC (Holliday 1970; Chee 1976a; Kajornchaiyakul *et al.* 1984; Gasparotto *et al.* 1989a). Sporulation was found by Kajornchaiyakul *et al.* (1984) to be totally inhibited at 20ºC. However, some isolates of *M. ulei* are able to infect and produce spores at 16ºC (Gasparotto and Junqueira 1994). These differences seem to reflect physiological differences between isolates from different ecological regions.

Dry conidia need to be wetted and require 6-8 hours of high relative humidity after deposition for infection. Gasparotto and Juniqueira (1994) found that one isolate of the pathogen did not need more than 3 hours of leaf wetness for infection and other isolates could infect within 4 hours. It is assumed that the different periods of leaf wetness required for infection are related to the virulence of the isolates and the susceptibility of the

Plate 3. Plants infected with SALB

Immature rubber plant infected with SALB **Matured rubber trees infected with SALB**

clones used. Optimum temperature for infection ranges from 19-25ºC, but little infection occur at 26-29ºC and none at 30-32ºC. After inoculation high disease intensity was observed on plants incubated at 19-22ºC or 23-25ºC. Lesions developed best at 23-25ºC. Conidial sporulation occurred at 19-28ºC and was increased by high humidity especially at 23-25ºC (Kajornchaiyakul *et al.* 1984). Ascospores are released in rapid succession when leaves are wetted at sub-ambient temperature (14ºC). Leaves which fall during wintering discharge ascospores readily after rain (Chee 1976a, b). During wet weather secondary infections from leaf diseases such as Collectotrichum and Oidium can occur causing secondary leaf fall (Chee 1990).

Ascospores are released from dark green leaves throughout the dry season (Chee 1976c; 1980a). Under moist conditions at 24ºC, perithecia on green leaves lose their viability after 12 days and after 9 days for perithecia on fallen brown leaves. In Brazil, epidemics of the disease occur when daily temperatures are under 22ºC for longer than 13 hours, relative humidity is over 85 percent for a period of over 10 hours, and rainfall exceeds 1 mm per day the preceding 7 days (Rocha and Vasconcelos 1978).

Spore survival and adaptability

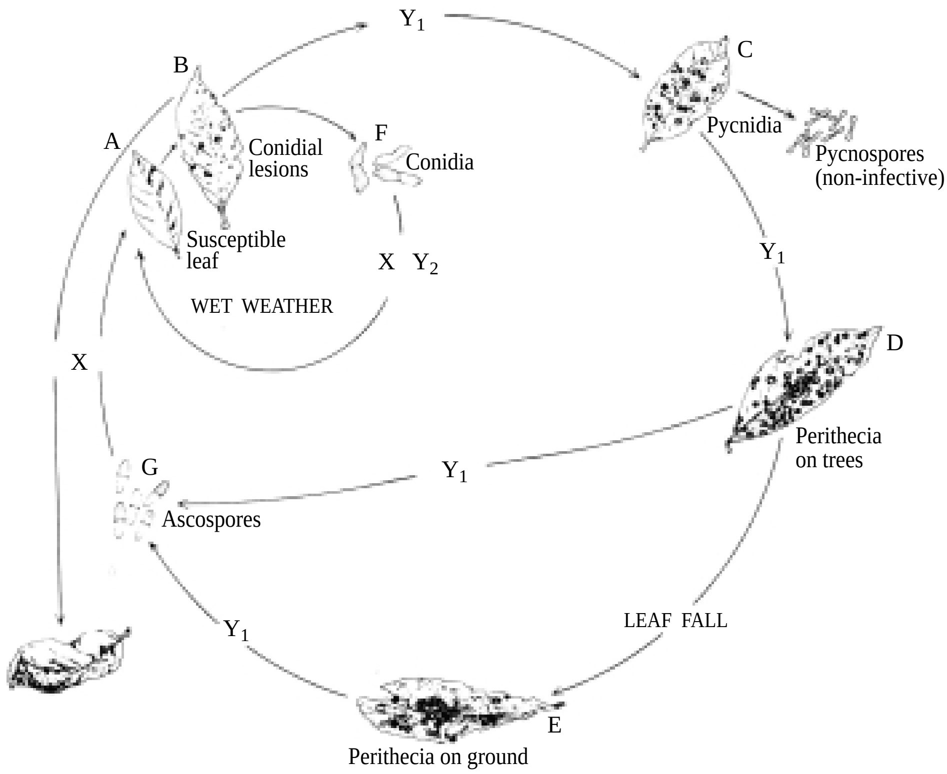
The detached conidia stored at 24ºC between 65-85 percent relative humidity remained viable after 3 weeks. The conidia still attached on leaf lesions when stored under desiccation, 9 percent of the conidia still germinated after 16 weeks. Fresh conidia produced under optimum conditions can survive over a week on leaves, clothes, polyethylene, artificial leather, glass, mature Hevea leaves, metal, paper as well as soil (Zhang *et al.*1986). Conidia recovered from these materials were tested for viability by their ability to germinate. These recovered single conidia were transferred to leaf discs in laboratory infection tests to determine their ability to infect host material. No infection occurred (Darmono and Chee 1985; Chee pers. com. 2007).

2.1.2 Life cycle

Plant infection requirements

Junqueira *et al.* (1986) determined that the optimum inoculum concentration was 2 x 105 conidia/ml, with higher concentrations inhibiting conidial germination and reducing the diameter of lesions. Outdoor (natural) light reduced viability more quickly than reduced-light (indoor) or no-light conditions. It is expected that for successful infection, with an inoculum concentration similar to that noted above, a spore loading equivalent to that generated from perithecia on a leaf segment at least 1 cm^2 would be required. This in effect means that for the purposes of this risk analysis it will be assumed that leaf segments of less that 1 cm^2 would not lead to successful infection under normal circumstances. This technical estimation is supported by the general experience of a number of workers (Chee, pers. com.).

Plate 4. Disease cycle of SALB (from Chee & Holliday 1986)



Population variation

Isolates of *M. ulei* grown on agar culture exhibit morphological differences and also differ in the rate of sporulation. Numerous strains have been observed. Over the years clones resistant to SALB succumbed to infection one after another and this was found to be due to evolution of new physiological races breaking down the resistance. Eight races were found initially (Chee *et al.* 1986), and four more have been added (Rivano 1997). Additionally geographical strains have been noted in Brazil (Chee pers. com. 2007).

2.2 Affected hosts

2.2.1 Host range

Host species: *Hevea brasiliensis* Muell. Arg. (Commercial species)
Hevea benthamiana Muell. Arg.
Hevea guianensis Aubl.
Hevea spruceana (Benth.) Muell. Arg.

2.2.2 Geographic distribution

SALB is present in all countries in Central and South America where rubber IS present, whether cultivated or wild. In 2003 Brazil's total rubber planted area was 108 373 ha, of which Sao Paulo state had 33 477 ha, Bahia 29 314 ha and Mato Grosso 25 536 ha. The area under production was 103 586 ha; dry rubber production was 156 318 tonnes. Brazils own production for 2003 was 94 000 tonnes; and in 2004 was 100 000 tonnes. In the second largest rubber planting state Bahia, despite ravages by SALB and low rubber yield (estate: 1 000-1 200 kg/ha/yr; smallholder: 500-600 kg/ha/yr), rubber cultivation is still being attempted. Commercial rubber area in the northern states is negligible. Although indigenous wild populations exist, Amazonas' 540 ha of rubber in 1995 has dwindled to 28 ha today.

2.2.3 Symptoms

Part of plants affected: Young leaves severely affected. The young tissue of petioles, stems, inflorescences and fruit pods is less affected.

The disease is only seen on young leaves of the plant (less than 10-15 days old) and can be a risk to mature plants that have begun to shed leaves annually. The first signs are discoloured green masses on the leaves that become a dark grey powdery mass as the fungus starts to produce conidia. These spots can grow together, consuming the leaf causing it to die and fall.

2.3 Entry, establishment and spread

2.3.1 Entry potential

Table 3. Summary of the assessment of entry

Vector	Probability of association	Probability of transit by Sea/Air	Probability of transfer to a suitable host	Conclusion of probability of entry
Host material (*Hevea* species)				
Budded stumps or budwood	High	High / High	High	High
Foliage (stem and leaf material not for planting)	High	High / High	Low (<1 cm^2)	Low (<1 cm^2)
Flowers, fruit and seeds	Moderate	Low / Moderate	Low	Low
Plants *in-vitro*	Negligible	N/A / N/A	N/A	Negligible
Wood	Negligible	Negligible / Negligible	Negligible	Negligible
Non-host material				
Inanimate goods or non-host organic material	Low	Negligible / Negligible	N/A	Negligible
Inanimate goods or non-host organic material contaminated by host plant material	Moderate	Low / Moderate	Low (<1 cm^2)	Low (<1 cm^2)

2.3.2 Establishment potential

Rating: High

The establishment potential is high once infected budded material has been moved into an area and planted.

2.3.3 Spread potential

Rating: High

Infection and establishment of SALB requires the presence of susceptible young foliage, wet weather and suitable temperature (22ºC-28ºC). Depending on the local climatic conditions, after the annual wintering, rubber trees refoliate from February to April. There are abundant rubber plantations throughout the PRA area, and host plants (Hevea species) can be found in urban plantings and forest areas.

In South American countries the initial spread is believed to have originated from wild rubber trees, but spread to Trinidad and Central American and to Bahia and Sao Paulo areas of Brazil was presumably through infected material when attempts were made to grow rubber in these regions. The spread of disease to Haiti is speculated to be through the spores brought over by wind and rain from Guyana or Trinidad and Tobago. Spread of the disease from Amazon basin to the surrounding areas was possibly caused by long distance dissemination by wind and rain and deposition of spores from infected plants in the field (Holliday, 1970).

Climatic conditions especially rainfall in Asian countries are similar with SALB endemic regions of the Amazon. SALB occurs in epidemic proportions in the months which have 18 days of high relative humidity (exceeding 85 percent) for 10 hours. The climatic condition in many parts of Asian countries is similar to SALB endemic region in Brazil (Chee 1980b). Lin (2006), using Geographic Information System (GIS) analysis to compare the climatic records of 12 rubber growing countries in the PRA area, including Thailand, Indonesia and Malaysia, with SALB endemic regions, confirmed the climatic suitability of SALB to these countries. The criteria used in the analysis were:

- Average temperature of March, April and May (refoliation in Northern Hemisphere) is higher than 18.5ºC; the average temperature of September, October and November (refoliation in Southern Hemisphere) is higher than 18.5ºC.
- Annual rainfall is higher than 760 mm.
- There is no more than 6 consecutive months with less than 42 mm per month of rainfall.

2.3.4 Economic impact

Rating: High (only for rubber producing countries)

Natural rubber is one of the most important commercial commodities in Asia, particularly Southeast Asia. Presently, the rubber areas in Asia are free from SALB. If SALB were to establish and spread in the PRA areas the potential consequences would be expected to include:

1. Increased cost of production with lower productivity
   - additional disease and weed control costs
   - shortage of raw material for rubber and rubber wood based industries
   - poor stand and wood quality when infected trees suffer dieback
2. Adverse financial effects
   - reduction in country’s revenue from rubber and rubber wood exports including effects on growers and rubber manufacturing sectors
   - loss of income due to unemployment of rubber smallholders
   - escalating rubber wood prices because of low supply.

2.3.5 Environmental impact

Rating: Unknown (depending on nature of the response)

Given the limited range of hosts for this pathogen it is likely that the environmental impact would be low id untreated. If treated, chemical contamination may occur and soil disturbance may cause environmental impact.

2.3.6 Overall risk

Rating:

2.4 Diagnostic information (there is gap for specific diagnostic protocol)

2.4.1 Diagnostic protocol

Is not limited to but should include:

- Cultural characteristics
- Morphological characteristics (EM optical microscopes)
- Molecular characteristics
- Serological characteristics (ELISA)
- Pathogenecity test

2.5 Response checklist

These are guidelines only as every situation will be different. The following checklist provides a summary of generic requirements to be identified and implemented within a Response Plan:

- Inform stakeholders, Minister, industry and householders
- Contact trading partners
- Confirm identity of pest with second expert
- Destruction methods for plant material and disposable items
- Disposal procedures
- Quarantine restrictions and movement controls
- Decontamination and farm cleanup procedures
- Diagnostic protocols and laboratories
- Identifying research lab
- Trace back and trace forward procedures
- Protocols for delimiting, intensive and ongoing surveillance
- Zoning
- Reporting and communication strategy

2.6 Delimiting survey and epidemiology study

Delimiting surveys should comprise local surveys around the area of initial detection concentrating on areas of obvious damage. Delimiting surveys are critical to determine the extent of spread of the pest and provide information for review and further development of the Response Plan. Size of survey should be 3 km radius (speculative) around known infected sites and should include any trace forward and linked sites.

2.6.1 Sampling method

Sampling of 600 trees per 10 ha blocks. Trees to be chosen randomly and closely inspected especially new growth and young leaves.

2.6.1.1 Number of specimens to be collected

Collect symptomatic material only.

2.6.1.2 How to collect plant samples *(will be included in diagnostic protocol)*

Plant material with suspect infection should be picked and placed between sheets of dry paper to prevent rapid drying.

2.6.1.3 How to preserve plant samples

For discussion as above

2.6.1.4 How to transport plant material

Secure and safe packaging should aim to ensure safe transport and handling. IATA 650 provides a guide.

Legal permits to move material may be needed.

2.6.2 Epidemiological study

Any epidemiological study of South American Leaf Blight will need to consider damage to the host plant, links between affected sites such as mechanical transmission via machinery or harvesters. These factors would need to be considered against the biology of the organism (including survival potential, rate of reproduction and methods/rates of dispersal) along with biotic and abiotic factors of its environment (including host plant availability, climate, geographical features, predators, parasites and pathogens).

2.6.3 Models of spread potential

Spread is by plant material or by wind borne rain and splash dispersal. Potential is for great distances as demonstrated by movement through central and south America. Pathogen may be carried on baggage, shoes and clothes. Climatic conditions are important, especially rainfall humidly and temperature. The presence of natural barriers such as deserts, mountain range and seas will inhibit long range spread. Spread is also by transporting plant material although seeds may carry surface contamination but can be cleaned with bleach.

2.6.4 Pest Free Area guidelines

The establishment and maintenance of Pest Free Areas (PFAs) can be a resource-intensive process. Prior to development of a PFA due consideration should be given to alternative methods (e.g. treatments, enclosed quarantine) that achieve an equivalent biosecurity outcome to a PFA. A benefit-cost analysis is useful for this purpose.

Where an evaluation justifies the establishment and maintenance of a PFA the requirements of ISPM No. 4 (IPPC, 1995) should be met. In defining and establishing the pest free area due consideration of the biological characteristics of South American Leaf Blight along with the climatic and geographic features of the area, will need to be given.

Additional information is provided by the IPPC (1995) in Requirements for the Establishment of Pest Free Areas. This standard describes the requirements for the establishment and use of pest free areas as a risk management option for phytosanitary certification of plants and plant products. Establishment and maintenance of a PFA can vary according to the biology of the pest, pest survival potential, means of dispersal, availability of host plants, restrictions on movement of produce, as well as PFA characteristics (size, degree of isolation and ecological conditions).

2.7 Availability of control methods

Prevention and Treatment the fungus can be controlled by a number of fungicides depending on each countries' legislation, including:

Contact fungicides
Systemic fungicides
(benomyl
carbendazim
chlorothalonil
fenarimol
mancozeb
propiconazole
thiophanate methyl
triadimenol
triadimephon
triforin.)

2.7.1 General procedures for control

- Keep traffic out of affected areas and minimize movement in adjacent areas
- Adopt best-practice farm hygiene procedures to retard the spread of the pathogen between fields and adjacent farms
- After surveys are completed, destruction of the infested crop is an effective control
- Quarantine areas quickly put in place to restrict and control the movement of regulated articles (e.g. host plant material and machinery) within and out of the affected area
- Ongoing surveillance of affected plantations to ensure *M. ulei* is eradicated

2.7.2 Control if small areas are affected

Where the incursion is restricted to a small area the likelihood of eradication is generally greater than for a large area. Initial control efforts should presume eradication is the aim. If area is small the infected material may be burned after felling and spraying.

2.7.3 Control if large areas are affected

Where the incursion has spread extensively control efforts may be targeted towards containment rather than eradication. The decision to eradicate or contain will need to be made on a case-by-case basis. Aerial application of fungicide may be required to suppress disease. Alternate option to destroying trees may be defoliation.

2.7.4 Cultural control

Cultural control techniques for SALB are used in South America where the disease is prevalent. South American literature should be referenced. *Selection for resistant varieties (Sri Lanka).*

2.7.5 Host plant resistance

Historically breeding for disease resistance was continuously frustrated by the concurrent evolution of new physiological races of the pathogen that are capable of breaking down the resistance. No rubber clones can therefore escape infection over the long term. The rubber in Southeast Asia and the PRA area was introduced from South America and it was perhaps fortunate that SALB did not establish during this introduction period.

2.7.6 Chemical control

As with other control methods the use of chemicals should form part of an integrated approach to pest management, thereby ensuring resistance does not build up in the target pest.

Prevention and Treatment the fungus can be controlled by a number of fungicides depending on each countries' legislation, including:

Contact
Systemic
(Benomyl
biteranol
carbendazim
chlorothalonil
fenarimol
fenbuconazole
mancozeb
myclobutinol
propiconazole

thiophanate methyl
triadimenol
triadimephon
triforin)

In southern Bahia (Brazil), no satisfactory control level was reached using benomyl, carbendazim or thiophanate methyl (Santos and Pereira,1985), probably because of fungicide-resistant strains.

In seed gardens, clonal gardens and young developing plantations, terrestrial sprayers, tractor-mounted pneumatic sprayers or atomisers can be used. Chemical control is difficult. However, in productive rubber plantations: the trees are up to 25 m high and conventional spraying equipment does not reach the canopy. Aerial spraying, used in south east nahia, is extremely expensive and not economically feasible for smallholding and medium sized plantations especially when the plantations are dispersed and at far distances from one another.

The time and equipment used for fungicide application depends on the developmental stage of the plants and the plantations. In seed gardens and clonal gardens in areas of high disease occurrence, spraying must be done weekly in the rainy season and at fortnightly intervals during the dry season. In adult plantations spraying must be done during the refoliation period at weekly intervals until the leaves reach their mature state. It is difficult to reach the canopy using normal spraying equipment.

2.7.7 Mechanical control

Cultural practice has little value in control measures. Fungicide spraying is effective to certain extent, but the cost of chemical control is high and method of application is difficult because of uneven terrain and tree height.

M. ulei is no respecter of reputation or money. When Henry Ford tried to establish the ill-conceived Fordlandia rubber plantations in the Amazon Basin in the 1920s South American Leaf Blight devastated the seedlings. The plan was not helped by attempting to apply North American farming methods to the complex ecosystems of the Amazon.

2.7.8 Biological control

There is no record of effective biological controls of SALB. There is no known natural enemy or other biological control agent for SALB. Work with *Dicyma pulvinata* does not appear to have produced successful results (Chee pers. com.). However, *D. pulvinata* may serve as an important component of integrated pest management and has been developed for potential commercial use (Bettiol, 1996).

3. Course of action – eradication methods

Additional information is provided by the IPPC (1998) in Guidelines for Pest Eradication Programmes. This standard describes the components of a pest eradication programme which can lead to the establishment or re-establishment of pest absence in an area. A pest eradication programme may be developed as an emergency measure to prevent establishment and/or spread of a pest following its recent entry (re-establish a pest free area) or a measure to eliminate an established pest (establish a pest free area). The eradication process involves three main activities: surveillance, containment, and treatment and/or control measures.

3.1 Destruction strategy

3.1.1 Destruction protocols

- Disposable equipment, infested plant material should be disposed of by autoclaving, high temperature incineration or deep burial
- Any equipment removed from the site for disposal should be double-bagged

Trees should be sprayed with fungicide if small enough. All trees should be felled and larger trees sprayed with fungicide when on the ground.

Material should be left to gain exposure to UV radiation and allowed to desiccate.

Material should be windrowed when dry enough to burn, in the intervening period all material should be sprayed with an appropriate fungicide at fortnightly intervals. Alternately material may be buried if space allows.

The fungicide application is to prevent viable ascospores becoming air borne on hot currents.

Area of destruction around a single known infected tree to be 100 metre (speculation; research needed) radius.

3.1.2 Trash Management

Trash (leaf and plant material) should be raked and burned soon after trees are windrowed and burned.

3.1.3 Inspection of regrowth

Inspection for regrowth material should take place every fortnight and regrowth treated with herbicide. Regrowth should be sampled and tested at a rate of 600 samples per 10 ha block. Negative results will support a case for replanting host material in the future and underpin a case for declaration of area freedom.

3.1.4 Decontamination protocols

Machinery, equipment and vehicles in contact with infested plant material or present within the Quarantine Area should be washed (or alternatively steam cleaned) to remove plant material using high pressure water or scrubbing with products such as a farm degreaser or a 1 percent bleach (available chlorine) solution in a designated wash down. General guidelines for wash down areas are as follows:

- Located away from crops or sensitive vegetation
- Readily accessible with clear signage
- Access to fresh water and power
- Mud free, including entry and exit points (e.g. gravel, concrete or rubber matting)
- Gently sloped to drain effluent away
- Effluent must not enter water courses or water bodies
- Allow adequate space to move larger vehicles
- Away from hazards such as power lines
- Waste water, soil or plant residues should be contained (see Appendix 18 of Plant Health Australia (2008))
- Disposable overalls and rubber boots should be worn when handling infested plant material in the field. Boots, clothes and shoes in contact with infested plant material should be disinfested at the site with an appropriate fungicide or double-bagged to remove for cleaning

3.1.5 Priorities

Specific priorities for eradication

- Confirm the presence of the pest
- Prevent the movement of plant within and out of the area
- Prevent movement of vehicles and equipment through affected areas
- Priority of eradication/decontamination of infected host material

3.1.6 Plants, by-products and waste processing

- Material should be destroyed as above except smaller Infested plant material which can be destroyed by (enclosed) high temperature incineration, autoclaving or deep burial

3.1.7 Disposal issues

In plantations, the pathogen survives on old leaves by producing the secondary stage of stromata. The stromata are alive on the leaves that are on the trees or have fallen to the ground, and will continue to eject ascospores from the perithecia contained in the stromata. Therefore all trash must be raked and destroyed as described previously.

3.2 Quarantine and movement controls

3.2.1 Quarantine priorities

- Plant material at the site of infestation to be subject to movement restrictions
- Machinery, equipment, vehicles and disposable equipment in contact with infested plant material to be subject to movement restrictions

3.2.2 Movement control for people, plant material and machinery

Movement controls need to be put in place to minimize the potential for translocation of the pest as a contaminant of plant material or other articles.

Fresh conidia can survive for 1 week on clothes, polythene, artificial leather, glass, mature leaves, metal paperl. Therefore movement of people, vehicle and machinery, from and to affected plantations must be controlled to ensure that infested or plant debris is not moved off-farm on clothing, footwear, vehicles or machinery. The following measures can be used to effect controls on movement:

- Signage to indicate quarantine area and/or restricted movement in these zones
- Fenced, barricaded or locked entry to quarantine areas
- Movement of equipment, machinery, plant material or soil by permit only
- Clothing and footwear worn at the infested site should either be double-bagged prior to removal for decontamination or should not leave the farm until thoroughly disinfested, washed and cleaned
- All machinery and equipment should be thoroughly cleaned down with a pressure cleaner prior to leaving the affected farm. The clean down procedure should be carried out on a hard surface, preferably a designated wash-down area, to avoid mud being re-collected from the affected site onto the machine

3.3 Zoning

The size of each quarantine area will be determined by a number of factors, including the location of the incursion.

3.3.1 Destruction zone

A destruction zone of 100 metres radius is recommended if windborne movement is not suspected. Surveillance and sampling should commence on the outside of the zone at the same time as destruction commences at the centres, the closest point to known infection. Destruction should encompass residential (non-commercial) properties if these fall within the 100 metres radius and have SALB hosts.

Legislation is an important consideration when undertaking destruction of both commercial and on commercial host material.

A smaller zone may be considered if the initial infection can be directly linked to a single point of entry within a short timeframe (i.e. not windborne). Factors relevant to this consideration are weather in the intervening period and life stage of the host and pathogen.

3.3.2 Quarantine zone

The Quarantine Zone is defined as the area where voluntary or compulsory restraints are in place for the affected property(ies). These restraints may include restrictions or movement control for removal of plants, people or contaminated equipment from an infested property. The quarantine zone should contain adequate signage.

The Quarantine Zone should be 3 km radius from the infected site. Three km radius represents 2 826 ha. This should be mapped and monitored regardless of the disease status. Intensive monitoring should be carried out within the area and fungicide should be applied.

3.3.3 Buffer zone

A Buffer Zone may or may not be required depending on the incident. It is defined as the area in which the pest does not occur but where movement controls or restrictions for removal of plants, people or equipment from this area are still deemed necessary. The Buffer Zone may enclose an infested area (and is therefore part of the Control Area) or may be adjacent to an infested area. The buffer zone must be subject to intensive surveillance to ensure the destruction area is adequate in size.

3.3.4 Restricted area

The Restricted Area is defined as the zone immediately around the infected premises and suspected infected premises. The Restricted Area is established following initial surveys that confirm the presence of the pest. The Restricted Area will be subject to intense surveillance and movement control with movement out of the Restricted Area to be prohibited and movement into the Restricted Area to occur by permit only. Multiple Restricted Areas may be required within a Control Area.

3.3.5 Control area

Encompasses all other zones and is usually defined in legal terms, shires, counties, states, provinces or prefectures. The Control Area is defined as all areas affected within the incursion. The Control Area comprises the Restricted Area, all infested premises and all suspected infested premises and will be defined as the minimum area necessary to prevent spread of the pest from the Quarantine Zone. The Control Area will also be used to regulate movement of all susceptible plant species to allow trace back, trace forward and epidemiological studies to be completed.

3.4 Decontamination and farm clean up

Decontamination practices are aimed at eliminating the pest thus preventing its spread to other areas.

Collect plant material and burn or destroy if small holding.

3.4.1 Decontamination procedures

General guidelines for decontamination and clean up:

- Fungicide application until burning can take place
- Raking trash and leaf litter to be burned
- Inspection and herbicide treatment of regrowth
- Keep traffic out of affected area and minimize it in adjacent areas
- Adopt best-practice farm hygiene procedures to retard the spread of the pest between fields and adjacent farms

- Machinery, equipment, vehicles in contact with infested plant material or soil or present within the Quarantine Area, should be washed to remove plant material using high pressure water or scrubbing with products such as detergent, a farm degreaser or a 1 percent bleach (available chlorine) solution in a designated wash down area as described in 3.1.4

3.4.2 Decontamination if pest is identified in a small or large areas

Where the infestation appears recent and linked to a specific pathway then procedure will be as before but the 3 km radius will be assessed and may be smaller or larger.

3.4.3 General safety precautions

For any chemicals used in the decontamination, follow all safety procedures listed by the chemical manufacturers. Personal protective clothing must be used. Environmental impacts should be considered.

3.5 Surveillance and tracing

3.5.1 Surveillance

Detection and delimiting surveys are required to delimit the extent of the outbreak, ensuring areas free of the pest retain market access and appropriate quarantine zones are established.

Initial surveillance priorities include the following:

- Surveying all host growing properties in the pest quarantine area
- Surveying all properties identified in trace forward or trace back analyses as being at risk
- Surveying all host growing properties that are reliant on trade with interstate or international markets which may be sensitive to *SALB* presence
- Surveying commercial nurseries selling at risk host plants
- Surveying other host growing properties, backyards and abandoned commercial plantings
- Consider use of spore traps

Trace forward and trace back should take priority and include all material that has left the property since and before the incursion was detected. Trace forward properties should be sampled at the same rate i.e. 600 trees per 10 ha block.

3.5.2 Survey regions

Establish survey regions around the surveillance priorities identified above (Section 3.5.1). These regions will be generated based on the zoning requirements (see Section 3.3), and prioritised based on their potential likelihood to currently have or receive an incursion of this pest. Surveillance activities within these regions will either allow for the area to be declared pest free and maintain market access requirements or establish the impact and spread of the incursion to allow for effective control and containment measures to be carried out.

Steps outlined in Table 1 form a basis for a survey plan. Although categorised in stages, some stages may be undertaken concurrently based on available skill sets, resources and priorities.

Table 1. Phases to be covered in a survey plan

Phase 1	• Identify properties that fall within the buffer zone around the infested premise • Complete preliminary surveillance to determine ownership, property details, production dynamics and tracings information (this may be an ongoing action)
Phase 2	• Preliminary survey of host crops in properties in buffer zone establishing points of pest detection
Phase 3	• Surveillance of an intensive nature, to support control and containment activities around points of pest detection
Phase 4	• Surveillance of contact premises. A contact premise is a property containing susceptible host plants, which are known to have been in direct or indirect contact with an infested premises or infested plants. Contact premises may be determined through tracking movement of materials from the property that may provide a viable pathway for spread of the pest. Pathways to be considered are: ❍ Items of equipment and machinery which have been shared between properties including bins, containers, irrigation lines, vehicles and equipment ❍ The producer and retailer of infested material if this is suspected to be the source of the outbreak ❍ Labour and other personnel that have moved from infested, contact and suspect premises to unaffected properties (other growers, tradesmen, visitors, salesmen, crop scouts and harvesters) ❍ Movement of plant material from controlled and restricted areas ❍ Storm and rain events and the direction of prevailing winds that result in air-borne dispersal of the pest during these weather events
Phase 5	• Surveillance of gardens and public land where plants known to be hosts of SALB are being grown
Phase 6	• Agreed area freedom maintenance, pest control and containment

3.5.3 Post-eradication surveillance

The inspection of regrowth should continue for a length of time calculated by weather and likely breakdown of spores and spore viability – 19 weeks being the longest demonstrated so far.

Planting of sentinels on site should be consider using the same criteria as pest entry quarantine inspection to prove absence of disease (6 new leaf cycles)

Surveillance of the buffer zone should continue for the same period of time also allowing for weather to provide optimum growth conditions and enhance the visibility of disease if present. The period of pest freedom sufficient to indicate that eradication of the pest has been achieved will be determined by a number of factors, including the life cycle duration of the pest in the prevailing climatic conditions of the area, the previous level of infestation and the control measures applied. As a guide, the period of pest freedom required to confirm eradication should be no less than two generations of the pest where all conditions are taken into account.

- Establishment of sentinel plants at the site of infestation
- Maintain good sanitation and hygiene practices throughout the year
- The monitoring traps or sentinel plants should remain in place and be inspected on a fortnightly basis for a further 6 weeks and then on a monthly basis
- Surveys comprising plant sampling for SALB to be undertaken for a minimum of 12 months after eradication has been achieved or in accordance with IPPC PFA guidelines.

4. References

Pest Risk Analysis for South American Leaf Blight (SALB) of Rubber (*Hevea*) prepared by the APPPC **http://www.fao.org/docrep/010/ai003e/AI003E25.htm**

APPENDICES

Appendix 1

STANDARD DIAGNOSTIC PROTOCOLS

Appendix 2

EXPERTS, RESOURCES AND FACILITIES

The following tables provide lists of experts (Table 2) and diagnostic facilities (Table 3) for use in professional diagnosis and advisory services in the case of an incursion.

Table 2. Experts who can be contacted for professional diagnostic and advisory services

Expert	Place	Details
Plant Pathologists	Rubber Research Institute of Malaysia, KL & Sungei Buloh	
Plant Pathologists	Department of Agriculture, Malaysia	
Surveillance team	DOA, Malaysia	

Table 3. Diagnostic service facilities

Facility	Place	Details
Diagnostic Lab	KL	

Appendix 3

COMMUNICATIONS STRATEGY

A communication strategy is the use of a combination of communication facets (frequency, direction, modality, and content).

1. Internal Communication Plan

Ensure that all parties involved are aware of the latest contingency plan and are briefed accordingly.

2. External Communication Plan

Informative leaflets/pamphlets on the regulated pest should be produced and distributed in all ports of entry.

Communication should include related agencies that will be involved in an incursion e.g., Military agencies, export agencies or Foreign Affairs and Trade agencies.

Appendix 4

MARKET ACCESS IMPACTS

Restrictions on export on agricultural products to rubber growing countries can be expected for nursery stock, budwood and budded stumps, however processed rubber or latex products will not carry the disease and their markets should not be affected.

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