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Biosecurity Risk of South American Leaf Blight caused by *Microcyclus ulei* on Rubber: an Indonesia Perspective

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Abstract

South American Leaf Blight, caused by the fungal pathogen *Microcyclus ulei*, represents one of the most destructive diseases affecting *Hevea brasiliensis*. Although the pathogen is endemic to South America, its potential introduction into Southeast Asia particularly Indonesia, the world's leading natural rubber producer poses a severe biosecurity threat. This review synthesizes current knowledge on the biology and epidemiology of *Microcyclus ulei*, evaluates global pathways for transboundary spread, and assesses Indonesia's vulnerability based on climatic suitability, plantation structure, and trade exposure. The study also examines national regulatory systems, surveillance mechanisms, and diagnostic capabilities, comparing them with lessons from endemic countries such as Brazil and Colombia. Finally, the review outlines strategic recommendations for strengthening Indonesia's preparedness, including enhanced border controls, molecular diagnostics, emergency response frameworks, and multi-stakeholder coordination.

Keywords – blight diseases – rubber production

Introduction

South American Leaf Blight is widely recognized as one of the major limiting factors in global rubber production. Caused by *Microcyclus ulei*, the disease wiped out large-scale *Hevea brasiliensis* plantations in South America during the 20th century, leading to a near collapse of the region's natural rubber industry (Lieberei 2007). As a result, global rubber production shifted to Asia, where Indonesia and Malaysia collectively contribute more than 70% of world output.

Indonesia's rubber sector plays a critical economic role, supporting smallholder livelihoods, providing export revenues, and feeding downstream industries. Despite being South American Leaf Blight free, Indonesia remains at risk due to increased trade and mobility, climate suitability, and biological characteristics of *Microcyclus ulei* that allow long-distance dispersal via spores, contaminated materials, and infected germplasm (Chee 1976). In regions of Indonesia such as Sumatra and Kalimantan, the combination of monsoonal rainfall patterns and intensive rubber cultivation can further increase the likelihood of South American Leaf Blight establishment, should the pathogen be introduced, by sustaining prolonged periods of canopy humidity and reducing the natural barriers to fungal development (Rangka et al. 2019). Climatic suitability assessments also

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indicate that Southeast Asian rubber belts fall within the high-risk agro ecological zones due to their temperature and humidity profiles, underscoring Indonesia's vulnerability despite being historically South American Leaf Blight free.

In addition, the epidemiological features of *Microcyclus ulei*, including its ability to produce large quantities of airborne ascospores and the pathogen's survival on infected leaf debris, further amplify its transboundary biosecurity risk. Studies have shown that South American Leaf Blight spores can survive under a wide range of environmental conditions and remain viable during long-distance travel, particularly in association with contaminated clothing, vehicles, or nursery stock (Ribeiro & Pommer 2004). These factors underline the importance of stringent quarantine measures, enhanced surveillance, and strengthened regional cooperation to prevent the introduction of SALB into Southeast Asia, where its arrival could cause severe socio-economic impacts on smallholder-dependent rubber industries (Furtado et al. 2016).

Given these factors, a comprehensive understanding of South American Leaf Blight biosecurity risk from an Indonesian perspective is essential. This review integrates biological, epidemiological, regulatory, and operational aspects to assess the country's preparedness and provide evidence-based recommendations.

Epidemiology of *Microcyclus ulei*

Epidemiologically, South American Leaf Blightoutbreaks often emerge in regions where extended leaf wetness periods overlap with phenological stages of young, expanding rubber leaves tissues exceptionally susceptible to infection (Lieberei 2007). Studies across Brazil, Colombia, and Peru have demonstrated that disease severity correlates strongly with rainfall patterns, relative humidity above 90%, and temperatures ranging from 20–28°C, which support rapid fungal development and successive infection cycles (Jaimes & Aranzazu 2010). This climatic sensitivity partly explains why South American Leaf Blight has remained confined to the American tropics despite multiple opportunities for transcontinental spread. Nevertheless, global trade and human-mediated movement of germplasm, latex products, and contaminated materials continue to pose significant biosecurity risks, particularly for rubber-producing regions in Asia and Africa (Dean 2020).

The global biology and epidemiology of *Microcyclus ulei* reveal a pathogen that is ecologically adapted to humid tropical environments, epidemiologically dynamic, and genetically diverse characteristics that collectively make South American Leaf Blight one of the most significant biosecurity threats to the global rubber industry. *Microcyclus ulei* is a complex lifecycle involving conidial and ascosporic stages that facilitate both short and long-range dispersal. The pathogen infects young leaves of *Hevea brasiliensis*, causing defoliation, reduced photosynthesis, and severe yield losses. Under conducive environmental conditions characterized by high humidity and moderate temperatures, infection cycles accelerate, leading to epidemic outbreaks (Lieberei 2007). The taxon is known for its high genetic variability, which enables rapid adaptation to new hosts and environments. Studies have demonstrated the emergence of multiple physiological races, complicating breeding programs and raising concerns about potential establishment in non-endemic regions (Pires et al. 2013). Dispersal occurs primarily through air currents, rain splash, and human-assisted movement of infected plant materials. Although natural ocean barriers limit direct spread from South America to Asia, global trade continues to present possible introduction routes.

Spread Pathways and Risk Factors

The primary pathways associated with South American Leaf Blight introduction to Asia include:

Movement of Planting Materials

The movement of planting materials such as budwood, seedlings, scions, and other vegetative propagules is a critical role in the long-distance dissemination of *Microcyclus ulei*, the causal agent of South American Leaf Blight. Historical analyses have shown that the earliest introductions of

South American Leaf Blight into new regions were strongly associated with the unregulated transport of infected Hevea germplasm from South America to Asia during the early 20th century. Although *Microcyclus ulei* spores have limited natural dispersal capacity over oceans, the pathogen can easily hitchhike on asymptomatic or latently infected planting materials, making human-mediated movement the primary pathway for transcontinental spread (Gasparotto & Pereira 2010).

The latent infection phase presents a significant regulatory challenge. Several studies indicate that *Microcyclus ulei* can remain undetected within young leaf tissues or dormant buds, allowing infected materials to pass through phytosanitary checks if not subjected to molecular diagnostics or extended quarantine observation (Roux et al. 2015). This silent phase underscores the importance of rigorous biosecurity protocols, as infected propagules can introduce the pathogen into South American Leaf Blight free regions where environmental conditions favour rapid establishment and epidemic development.

International cooperation frameworks such as the International Plant Protection Convention and regional biosecurity arrangements emphasise stringent certification systems and post-entry quarantine for rubber germplasm to prevent inadvertent dissemination. Countries in Asia, including Indonesia, Thailand, and Malaysia, have adopted strict import restrictions and surveillance practices specifically designed to monitor the entry of Hevea planting materials. These measures align with risk assessments showing that even a single infected scion or budwood shipment can trigger widespread outbreak potential in climatically suitable areas (Ristaino et al. 2021).

Contaminated Equipment, Clothing, and Packaging

The unintentional movement of *Microcyclus ulei* inoculum through contaminated equipment, workers' clothing, and packaging materials represents a critical yet often underestimated biosecurity pathway. Field tools, tapping knives, pruning shears, harvesting bags, and vehicle tires can retain fungal spores particularly conidia and ascospores that are capable of surviving for extended periods under humid conditions common in rubber-growing environments (Junqueira et al. 2017). Human-mediated transfer becomes especially significant in plantation settings where routine movement between blocks or between different estates increases the likelihood of mechanical dissemination.

Fig. 1 – Symptom of South American Leaf Blight shown by leaf defoliation (FAO 2007).

Furthermore, spores may adhere to clothing fibres, footwear, and personal protective equipment used by workers, contractors, or inspectors moving between rubber-producing regions. Studies on similar foliar fungal pathogens have shown that spore adherence to fabric and equipment surfaces can facilitate long-distance spread if proper decontamination protocols are not enforced (Jeger et al. 2018). In the context of international trade, packaging materials such as wooden crates, cardboard containers, and jute sacks pose additional risks, as they may become contaminated during handling, storage, or transport in endemic areas. Spores present on these materials can survive transit periods and potentially establish infection when reaching suitable hosts in new locations (Ploetz 2007).

Environmental Suitability and Climate Change

Environmental suitability has long been recognised as one of the primary determinants driving the establishment, survival, and epidemiological intensity of *Microcyclus ulei* in rubber-growing regions. The pathogen thrives under warm, humid conditions with frequent rainfall, prolonged leaf wetness, and shaded canopy structures microclimatic elements characteristically associated with tropical rainforest ecosystems (Gasparotto & Pereira 2010). These conditions promote sporulation, spore germination, and infection efficiency, enabling rapid pathogen cycling in susceptible *Hevea brasiliensis* plantation.

For Southeast Asia, including Indonesia, climate projections suggest an overall trend towards higher humidity and more intense rainfall events in major rubber belts such as Sumatra and Kalimantan, which could significantly increase landscape-level suitability for South American Leaf Blight establishment (IPCC 2021). Coupled with dense canopy structures in smallholder plantations and limited genetic resistance in local *Hevea* cultivars, climate-driven environmental changes may elevate the biosecurity threat posed by accidental introduction of *Microcyclus ulei* spores or infected germplasm. As a result, climate change adaptation must be integrated into long-term surveillance and quarantine strategies to better anticipate shifting ecological risk profiles. Climatic modeling suggests that several regions in Southeast Asia, including major rubber-growing areas of Sumatra and Kalimantan, are ecologically compatible with *Microcyclus ulei* establishment (Rao & Uma 2017).

I.legal or Unregulated Germplasm Exchange

Illegal or unregulated germplasm exchange constitutes one of the most critical biosecurity pathways for the transboundary movement of *Microcyclus ulei*, the causal agent of South American Leaf Blight. The unauthorized distribution of seeds, budwood, and other vegetative planting materials often transported without phytosanitary certification greatly increases the likelihood of inadvertently introducing the pathogen into South American Leaf Blight free regions. Furthermore, planting materials may harbour latent infections, making unregulated germplasm movement a high-risk epidemiological conduit.

Informal trade channels, including exchanges among private collectors, small-scale agribusiness networks, or shipments routed through non-official entry points, frequently bypass national quarantine controls (Singh et al. 2017). Gasparotto and Pereira (2010) further demonstrated that the persistence of *Microcyclus ulei* spores under humid conditions enables long-distance survival during transport, thereby increasing the efficiency of pathogen dispersal through unregulated germplasm pathways.

Air Transport and Long-Distance Spore Movement

Airborne dispersal represents one of the most critical pathways for the long-distance spread of *Microcyclus ulei*, as fungal spores can be transported across extensive geographic barriers through prevailing atmospheric currents. Numerous studies have shown that ascospores of South American Leaf Blight possess morphological features such as low mass and hydrophobic surfaces that enhance their ability to remain suspended in the air for prolonged periods, increasing the likelihood of intercontinental dispersal (Gasparotto & Pereira 2010).

In tropical regions like Southeast Asia, monsoonal wind patterns and recurrent cyclonic systems can further elevate the potential risk of aerial introduction. Modelling research highlights that windborne inoculum from distant regions may survive long flights when humidity is high, temperatures are moderate, and UV exposure is reduced by cloud cover conditions common in the equatorial belt (Isard et al. 2005). These factors collectively underscore the importance of strengthening aerial biosecurity surveillance, including the use of spore traps, atmospheric monitoring, and predictive modeling tools, to mitigate the risk of South American Leaf Blight entering South American Leaf Blight free countries such as Indonesia. Although less likely, atmospheric currents can theoretically carry spores across continents, as documented for other fungal pathogens (FAO 2017). The combination of these factors elevates the biosecurity threat for Indonesia despite geographical separation from endemic regions.

Risk Assessment for Indonesia

Indonesia's vulnerability is shaped by a confluence of biological, ecological, and socio-economic factors:

Climatic Suitability and Plantation structure

Indonesia's climatic profile characterised by persistently high temperatures, abundant rainfall, and year-round humidity is inherently conducive to the establishment of *Microcyclus ulei*, the causal agent of South American Leaf Blight. Numerous studies have demonstrated that the pathogen thrives in environments with warm temperatures (22–28°C), high leaf wetness duration, and frequent precipitation, all of which enhance the germination and viability of ascospores and conidia (Lieberei 2007). These conditions are closely aligned with the climatic regimes of major Indonesian rubber-growing regions such as Sumatra and Kalimantan, where mean annual rainfall often exceeds 2,500 mm and relative humidity routinely surpasses 80%.

Moreover, climatic variability associated with global climate change is expected to heighten Indonesia's vulnerability. Projections for the region show increasing rainfall intensities and extended wet seasons, which may prolong leaf wetness periods and promote more frequent infection cycles (IPCC 2022). As noted by Gasparotto and Pereira (2010), South American Leaf Blight epidemics are strongly correlated with wet, warm microclimates typically found in dense plantationsconditions that may intensify with anticipated climatic shifts. Therefore, Indonesia's agro-ecological landscape, combined with ongoing climate trends, reinforces the importance of maintaining stringent biosecurity measures to prevent the introduction of *Microcyclus ulei* into an environment already highly suitable for its establishment. Ecological niche modelling reveals that Indonesia's humid tropics, particularly in Sumatra, Kalimantan, and Sulawesi, provide favorable conditions for South American Leaf Blight infection and epidemic development (Rao & Uma 2017).

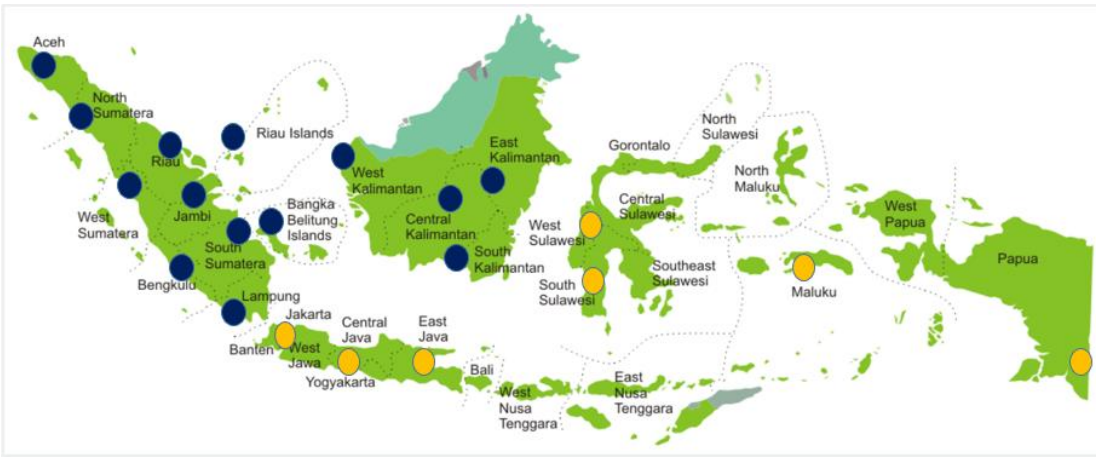

Fig. 2 – Rubber plantations across Indonesia.

Indonesia's reliance on genetically uniform clones in extensive monoculture plantations increases risk of rapid disease spread once introduced (Priwiratama et al. 2023). The structural characteristics of Indonesia's rubber plantations substantially influence the potential establishment and spread of *Microcyclus ulei*. Many commercial plantations in Sumatra, Kalimantan, and parts of Sulawesi are designed with high tree density, uniform age structure, and closed canopy formations, all of which create humid microclimates favourable for the infection cycle of South American Leaf Blight (Figs 2 and 3). Dense planting restricts air circulation and prolongs leaf wetness duration factors that significantly enhance ascospore germination and increase the likelihood of successful colonisation by *Microcyclus ulei* (Junqueira et al. 2017).

In addition, monoclonal planting systems commonly used in Indonesia heighten epidemiological risk. Hevea clones selected for high latex productivity often exhibit narrow genetic diversity, leaving plantations more vulnerable to invasive pathogens (Lieberei 2007). Historical outbreaks in South America demonstrated that uniform genetic backgrounds facilitated rapid and devastating South American Leaf Blight epidemics, as genetically similar trees responded similarly to infection pressures (Buriticá & Rivera 2011). This raise concerns that large-scale monoclonal blocks in Indonesia could amplify epidemic potential should *Microcyclus ulei* be introduced. Furthermore, mature plantation structure characterised by tall, overlapping canopies creates shaded environments with consistently high relative humidity and reduced evaporative drying. Gasparotto and Pereira (2010) highlight that these conditions are ideal for ascospore maturation and dispersal, as well as secondary conidial spread. Such microenvironmental characteristics closely mirror the ecological conditions in the Amazon Basin where South American Leaf Blight is endemic, suggesting that Indonesia's plantation architecture is inherently susceptible to supporting pathogen life cycles.

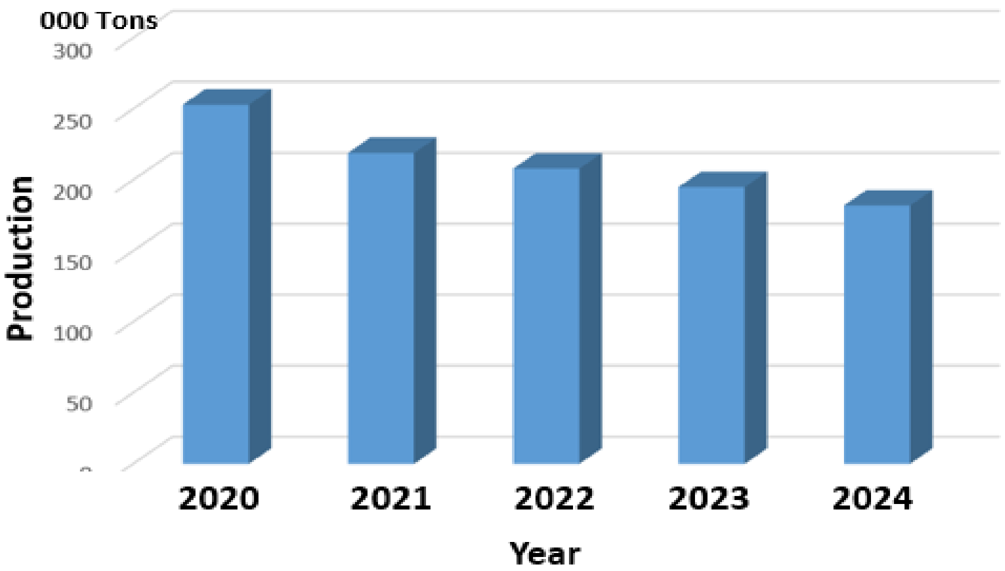

Fig 3 – Indonesian Rubber Production on 2020–2024.

Trade Exposure

Indonesia's expanding participation in global trade networks significantly increases the country's exposure to potential introduction pathways of *Microcyclus ulei*, particularly through intensified commercial exchanges with South American Leaf Blight endemic regions in Latin America. Although Indonesia maintains strict phytosanitary import regulations, high trade volumes inherently elevate the probability of unintentional introduction of fungal propagules associated with rubber-related commodities, auxiliary agricultural products, and logistical materials (Wingfield et al. 2015).

The risk is especially pronounced in the movement of *Hevea* breeding materials, research specimens, and specialized nursery stocks, as these are known to be high-risk pathways for the transboundary spread of South American Leaf Blight when not adequately screened (Anderson et al. 2017). Even when live plant imports are highly regulated, indirect trade channels such as packaging materials, mixed cargo shipments, and transshipment hubs may function as overlooked conduits for contaminated debris or microscopic spores (Brasier 2008). These trade-related dynamics demonstrate that Indonesia's exposure to South American Leaf Blight is not solely determined by direct importation of rubber materials but is shaped by the broader structure of global commerce, supply chains, and the biosecurity vulnerabilities embedded within them. Strengthening port-based inspections, enhancing international cooperation, and maintaining rigorous phytosanitary certification systems are therefore essential components for mitigating trade-driven introduction risks. Despite strict regulations, Indonesia imports research materials, rubber germplasm, and machinery that may pose entry risks if improperly sanitized.

Regulatory and Technical Capacity

Indonesia operates under a strong legal framework through the Plant Quarantine Law, but diagnostic infrastructure, rapid response systems, and cross-sectoral coordination require continued strengthening to match international best practices. Indonesia's regulatory and technical capacity plays a decisive role in determining the country's resilience against the introduction of *Microcyclus ulei* and the subsequent establishment of South American Leaf Blight. While Indonesia has instituted comprehensive phytosanitary regulations under the Plant Quarantine Act and related ministerial decrees, gaps in implementation, surveillance technology, and diagnostic capability remain critical challenges (Sutrisno et al. 2020). Effective prevention of exotic plant pathogens demands not only strong legislation but also adequate institutional resources, specialized personnel, and continuous technical upgrading.

A robust biosecurity framework requires the integration of advanced detection tools, including molecular diagnostics and spore trapping technologies, which are essential for early identification of South American Leaf Blight, especially given the pathogen's capacity for asymptomatic latency during early infection stages (Roy et al. 2004). However, disparities in laboratory capacities, variability in human resource competencies, and uneven distribution of diagnostic infrastructure across Indonesia's vast archipelago hinder rapid detection and coordinated response (Sembiring et al. 2018).

Potential Economic Impact

South American Leaf Blight invasion could lead to massive losses in latex production, smallholder livelihoods, and national export revenues mirroring the historical collapse of rubber plantations in the Amazon. The potential economic impact of South American Leaf Blight incursion in Indonesia would be profound, given the country's status as one of the world's leading natural rubber producers and exporters. Historical evidence from Latin America shows that South American Leaf Blight can cause catastrophic yield losses up to 75% in susceptible *Hevea* clones leading to large-scale plantation abandonment and severe economic decline in rubber-dependent regions (Gasparotto & Pereira 2010). For Indonesia, where millions of livelihoods rely on rubber cultivation, an outbreak could trigger significant disruptions across the agricultural economy, industrial supply chains, and rural socio-economic systems.

Smallholder farmers, who account for more than 80% of Indonesia's rubber production, would be the most affected. Experiences from other plant disease epidemics show that smallholders often lack financial buffers, adaptive technology, and access to rapid replanting programs, making them disproportionately vulnerable to income shocks (Hanley et al. 2020). A severe South American Leaf Blight outbreak could therefore exacerbate rural poverty, reduce household purchasing power, and intensify socio-economic inequality.

Biosecurity Preparedness, Surveillance, and Mitigation Strategies

Indonesia's prevention strategy must prioritize a multi-barrier, risk-based approach:

Strengthening Border Biosecurity

Strengthening border biosecurity is a critical pillar in preventing the introduction of *Microcyclus ulei* into Indonesia, particularly given the country's extensive international trade networks and increasing mobility of people and goods. Effective border control systems rely on a combination of regulatory instruments, robust inspection mechanisms, and risk-based screening procedures to detect and intercept high-risk plant materials before they enter domestic ecosystems

(Hallman & Blackburn 2016). For pathogens such as *Microcyclus ulei*, which can travel via infected planting materials, contaminated personal belongings, or spores adhering to packaging, stringent border protocols are essential to maintain a South American Leaf Blight free status (Gilligan et al. 2013).

Additionally, risk-communication strategies at ports of entry, including traveler declarations, signage, and targeted awareness campaigns, help reduce non-compliance and unintentional breaches by visitors or returning residents carrying agricultural items (McNeill et al. 2017). Strengthening interagency collaboration and adopting advanced detection tools such as portable PCR-based diagnostics would further increase Indonesia's capacity to rapidly identify *Microcyclus ulei* should an interception occur. Overall, the reinforcement of border biosecurity represents a foundational component of national mitigation strategies against South American Leaf Blight, enabling Indonesia to proactively safeguard its rubber industry against invasive fungal threats (Ploetz 2013). Enhanced inspection of passengers and cargo from Latin America, stricter controls on germplasm importation, and mandatory decontamination protocols for equipment and personal items.

Surveillance and Early Detection

Surveillance and early detection form the backbone of an effective national biosecurity system, particularly in preventing the establishment of *Microcyclus ulei*, the causal agent of South American Leaf Blight. Proactive surveillance enables authorities to identify incursions at their earliest stage, when eradication remains technically feasible and economically viable (Venette et al. 2010). As *Microcyclus ulei* can remain asymptomatic during initial infection phases, continuous monitoring of rubber-growing areas, nurseries, and import inspection sites is essential to detect latent infections or unusual foliar symptoms (Gasparotto & Pereira 2010).

In Indonesia, surveillance systems must integrate both passive and active components. Passive surveillance, relying on reporting by farmers, plantation workers, and local agricultural officers, increases the chances of detecting unexpected or emerging symptoms in the field (Miller et al. 2021). Meanwhile, active surveillance conducted through systematic field inspections, spore trapping, and regular sampling enables authorities to track potential pathways of introduction and detect the presence of airborne spores or contaminated materials before disease spread intensifies (Aime & Piepenbring 2018).

Diagnostic Capacity and Laboratory Readiness

Diagnostic capacity and laboratory readiness are fundamental components of national preparedness against *Microcyclus ulei*, the causal agent of South American Leaf Blight. Accurate and timely diagnosis is essential for confirming suspected infections, initiating rapid response measures, and preventing the establishment of the pathogen within Indonesia's rubber production landscapes (Hodgetts et al. 2016). Given that early symptoms of South American Leaf Blightcan resemble other foliar diseases, laboratory confirmation using validated diagnostic protocols is critical to avoid misidentification and delays in containment efforts (Cao et al. 2019).

Comprehensive laboratory readiness involves not only access to advanced molecular tools but also well-trained personnel capable of executing complex diagnostic workflows. Modern diagnostic platforms including polymerase chain reaction (PCR), quantitative PCR (qPCR), and next-generation sequencing enable rapid detection of *Microcyclus ulei* even at low inoculum levels or in asymptomatic tissues (Ristaino et al. 2021). Establishing standardized operating procedures and quality assurance protocols helps ensure that diagnostic results are accurate, reproducible, and compatible with international phytosanitary standards (IPPC 2021). Furthermore, the distribution of diagnostic facilities across strategic regions strengthens response capability by reducing sample transport time and supporting real-time pathogen surveillance. Decentralized laboratories with rapid screening capacity, supported by national reference laboratories for confirmatory testing, provide a resilient framework for addressing potential incursions (Perez et al. 2020). Mobile laboratories and portable diagnostic tools may also be deployed during emergency situations to perform on-site testing in high-risk plantation zones or border inspection sites (McCartney et al. 2018).

Emergency Response and Contingency Planning

Emergency response and contingency planning are critical components of a resilient national biosecurity framework, ensuring that Indonesia can respond rapidly and effectively should *Microcyclus ulei* the causal agent of South American Leaf Blight be detected. A well-established contingency plan provides structured guidance for containment, eradication, communication, and recovery actions, minimizing the likelihood that an incursion escalates into widespread establishment (Waage & Mumford, 2008). Given the destructive potential of South American Leaf Blight on rubber production, immediate and coordinated intervention is essential to prevent irreversible economic and ecological impacts.

Contingency planning also requires simulation exercises and scenario-based training to evaluate operational readiness and identify gaps in response capacity. Regular emergency drills allow relevant agencies quarantine services, local governments, research institutions, and plantation operators to practice coordinated actions under realistic conditions, improving both technical proficiency and interagency collaboration (Baker et al. 2020). Establishing clear thresholds for action, such as detection of confirmed infected tissues or positive molecular diagnostic results, reduces delays in decision-making and ensures that eradication efforts begin at the earliest possible stage (Hulme 2020).

Educational campaigns using workshops, field demonstrations, digital platforms, and printed materials help disseminate critical information on disease pathways, prohibited materials, and safe plantation practices. Such targeted outreach has been shown to improve compliance with phytosanitary regulations and reduce inadvertent transport of contaminated materials (McNeill et al. 2017). For Indonesia, raising public awareness among rubber farmers, plantation workers, and nurseries is especially important due to their close interaction with planting materials and their central role in early symptom recognition.

Based on the review findings, there are proposed to enhance Indonesia's South American Leaf Blight preparedness and response capacity:

1. Strengthen pre-border and at-border biosecurity control.
2. Enhance national surveillance and early warning systems.
3. Develop and operationalize a national South American Leaf Blight emergency response plan.
4. Strengthen planting material biosecurity and genetic resistance program.
5. Integrate climate and ecological risk modelling into national policy-agency coordination.

Conclusion

South American Leaf Blight, caused by *Microcyclus ulei*, remains the most significant biosecurity threat to the global natural rubber industry. Although the pathogen is geographically restricted to the Americas, its biological characteristics, diverse spread pathways, and global mobility patterns create a tangible risk for accidental introduction into Southeast Asia, including Indonesia.

Indonesia's ecological conditions, large-scale monoculture plantations, and extensive reliance on clonal rubber varieties make the country particularly vulnerable to South American Leaf Blight establishment. The economic implications of an incursion would be profound, potentially disrupting export revenues, compromising smallholder livelihoods, and destabilizing downstream industries. While Indonesia maintains a strong legal foundation through the national plant quarantine system, several operational gaps persist in border surveillance, molecular diagnostics, stakeholder coordination, and contingency readiness.

This review underscores the need for a holistic, science-based approach to South American Leaf Blight prevention. Lessons from endemic regions in South America highlight the importance of early detection, continuous surveillance, resistant cultivar development, and strict regulation of germplasm movement. Strengthening Indonesia's biosecurity framework requires sustained investment, inter-agency collaboration, and integration with international phytosanitary standards. Preventing the entry of *Microcyclus ulei* is not only a national agricultural priority but also a strategic imperative for safeguarding the global natural rubber supply chain.

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