Journal of Sustainability Science and Management
Volume 20 October 10, 2025: 2181-2196
eISSN: 2672-7226

POLICY AND LEGAL IMPLICATIONS FROM BIOPESTICIDE FUNDING AGAINST OIL PALM BAGWORMS IN MALAYSIA

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http://doi.org/10.46754/jssm.2025.09.011
Submitted: 2 June 2024 Revised: 26 January 2025 Accepted: 25 March 2025 Published: 15 October 2025

Abstract: Malaysia's adoption of Integrated Pest Management (IPM) necessitates the use of biopesticides, specifically *Bacillus thuringiensis (Bt)*, alongside chemical pesticides to combat bagworms in oil palm plantations. However, there are fragmented policy and legal frameworks governing the use of Bt within IPM, which incurs higher costs than traditional chemical pesticides. In light of the fiscal constraints faced by the Malaysian Government, this paper explores both public and private funding models in this context and examines the policy and legal implications of these models, particularly in balancing accountability, financial sustainability, and related socio-economic considerations. This paper employs a doctrinal/black letter approach to analyse Malaysia's policy and legal documents concerning the palm oil industry, plant protection, pesticide regulations, and public funding. It finds a necessity for Public-Private Partnerships (PPP), but notes that the current scope of PPP policy, law, and practice in Malaysia is limited to project contracts rather than service and goods contracts. The most recent PPP policy document suggests a broader framework for PPP implementation in Malaysia. In response, national farmers' organisations could play an active role alongside other relevant stakeholders in the oil palm bagworm sector to ensure that PPP implementation aligns with the legitimate objectives of funding initiatives for biopesticide use.

Keywords: Biopesticide law, integrated pest management; palm oil law, public funds law and policy, Public Private Partnership (PPP).

Introduction

The palm oil industry is crucial to Malaysia's economy, being the world's second-largest producer (Cheah *et al*., 2023; Schouten *et al*., 2023). In 2022, the industry contributed 4.9 percent of Malaysia's total Gross Domestic Product (GDP) (Chik *et al*., 2023). In 2019, there were 5.90 million hectares of oil palm plantations in Malaysia, which included private plantations, organised smallholders, and independent smallholders. Private estates comprised 3,605,436 hectares, accounting for 61.1% of the total oil palm planted area in Malaysia. Independent smallholders managed 986,331 hectares, equivalent to 16.7% of this area, while organised smallholders owned 1,308,390 hectares, constituting 22.1% of the total (Parveez *et al*., 2020).

Bagworms are defoliating pests that have reduced palm oil yields in Malaysia by up to 30% to 40% (Kamarudin *et al*., 2017). Gazetted as a dangerous pest, bagworms are subject to prohibitions and actions required for their elimination under Section of the Plant Quarantine Act 1976, aimed at protecting relevant plants. Like many countries and in line with international recommendations, Malaysia has adopted Integrated Pest Management (IPM) in its palm oil sector (Desa *et al*., 2021). IPM involves the use of biopesticides alongside chemical pesticides to combat bagworms in oil palm plantations (MPOB, 2016). In fact, IPM may necessitate a reduction in the use of chemical pesticides, allowing for pest elimination while minimising harm to beneficial

plants and organisms (Stenberg, 2017). This approach highlights the growing importance of biological control in the fight against bagworms.

Within Malaysia's regulatory framework, IPM is positioned between hard law and soft law approaches to regulation. This applies equally to bagworm management using biopesticides, which are integral to IPM. A biopesticide is defined as an agent used to manage or counteract plant pests, mass-produced, and derived from natural products or living microorganisms (Chandler *et al*., 2011; Elnahal *et al*., 2022). Biopesticides encompass various types, including pheromones, botanicals (plant products), microbes, and plant-incorporated protectants (genetically engineered crops) (Koul, 2023).

In this context, the focus is on microbes, specifically *Bacillus thuringiensis (Bt)*, which is used to combat oil palm bagworms (MPOB, 2016; Kamarudin *et al*., 2017; Ahmad *et al*., 2021). BT is a type of bacteria that is harmless to humans, non-target insects, the environment, and the ecosystem. Its application involves methods such as mist blowing or spraying (from ground or aerial sources) (Sulaiman & Talip, 2021). The hard law approach is reflected in two IPM-related legislations: The Plant Quarantine Act 1976 (PQA 1976) and the Pesticides Act 1974, which regulates pesticide use. BT, as an insecticide, is covered by the Pesticides Act 1974. Both the PQA 1976 and the Pesticides Act 1974 are administered by the Department of Agriculture, under the Ministry of Agriculture and Food Security.

The focus of this paper is on microbes, specifically *Bacillus thuringiensis (Bt)*[1], which is used to combat oil palm bagworms (MPOB, 2016; Kamarudin *et al*., 2017; Ahmad *et al*., 2021). BT is a type of bacteria that is harmless to humans, non-target insects, the environment, and the ecosystem, and is applied using mist blowers or spraying techniques (either from the ground or aerially) (Sulaiman & Talip, 2021). The hard law approach is exemplified by two pieces of legislation related to Integrated Pest Management (IPM): The Plant Quarantine Act 1976 (PQA 1976) and the Pesticides Act 1974, both of which govern the use of pesticides. As an insecticide, BT is regulated under the Pesticides Act 1974. The Department of Agriculture, which operates under the Ministry of Agriculture and Food

The soft law approach outlines the methods for operationalising biopesticide usage within Integrated Pest Management (IPM). This responsibility falls to the Malaysian Palm Oil Board (MPOB), established by the MPOB Act 1998 and functioning as an agency under the Ministry of Plantation and Commodities. The funding of biopesticides can pose a challenge for public administration. The cost of using Bacillus thuringiensis (BT) is generally higher than that of chemical pesticides (Rani *et al*., 2021; Ayilara *et al*., 2023). Although the registration costs for biopesticides have been argued to be lower than those for conventional chemical pesticides (Chandler *et al*., 2011), the environmental evaluation of biopesticides has primarily focused on safety rather than efficacy. Testing for efficacy could potentially increase costs beyond those of chemical pesticides (Kumar & Singh, 2014).

High costs can arise during the research, development, and commercialisation stages of BT, largely due to the challenges in aligning objectives among stakeholders involved in these processes (Fenibo *et al*., 2022). Marketers often dispute the findings of researchers and regulators, leading to a loss of confidence among end users in the efficacy of the final products (Kumar & Singh, 2014; Fenibo *et al*., 2022). In addition to the substantial expenses related to licensing new pesticides, the approval process can take several years (Fenibo *et al*., 2022). These factors, alongside others specific to various regions, contribute to the higher costs of biopesticide products (Fenibo *et al*., 2022). Moreover, the perception of biopesticides as having a "slow action" and the social acceptability of these

[1] The word *Bt* will be spelt BT from now onwards.

products compared to traditional and widely accepted synthetic chemical pesticides are significant aggravating factors (Fenibo *et al*., 2022).

In smallholding farms where BT is employed, it remains unclear who will shoulder the costs of spraying BT on infested plants. Given the fiscal constraints and the need for fiscal consolidation faced by the Malaysian Government (Ni, 2019; Rahim *et al*., 2020), as well as the increasing debts and rescue spending impacting Malaysia's credit ratings (Lee, 2020; Loong & Wan Usamah, 2022), this paper explores funding models within this context. It examines the use and non-use of public funds, including the Public-Private Partnership (PPP) model. Additionally, this paper investigates the legal challenges associated with this model in balancing sustainable and socio-economic objectives.

Materials and Methods

In terms of research methodology, this paper adopts a doctrinal or black letter approach. Doctrinal research is a library-based study that involves gathering materials from libraries, archives, and databases. Its aim is to discover, explain, examine, analyse, and systematically present the facts, principles, provisions, concepts, theories, or working of specific laws or legal institutions (Yaqin, 2007). This approach includes cross-referencing of specific rules with more general underlying legal principles, creating a cohesive and rational system of regulation (Salter & Mason, 2007). To discuss funding issues related to the use of biopesticides, this paper will employ doctrinal legal research, focusing on the exposition of legal rules within on the framework of public funding specific to the production and application of biopesticides in oil palm plantations. To support this analysis, secondary data[2] will be sourced from both legal and non-legal documents.

Legal documents are written sources of law that arise from laws, rules, and regulations enacted by Parliament and those established by the Executive branch of government, such as Ministries. In contrast, non-legal documents do not serve as formal sources of law but can still have a legal effect in a more nuanced way, categorising them as part of soft law.

The black-letter approach should be approached with caution due to its tendency to overlook non-legal factors, such as political and economic influences (Salter & Mason, 2007). When considering the funding issues related to the use of biopesticides against bagworms, it is important to recognise the administrative concepts and market elements involved in the process. However, this paper adopts a purely doctrinal approach, supported by document analysis. Document analysis involves examining both legal and non-legal documents across categories (i), (ii), (iii), and (iv) to identify gaps in the laws and regulations concerning the funding of biopesticide use. The nature of these documents will be classified according to the distinctions of hard law and soft law.

Results

Based on the documents analysed above, we find that they can be divided into four broad categorisations:

(i) Laws and regulations governing the palm oil industry in Malaysia, which include: (a) the Malaysian Palm Oil Board Act 1998, (b) Malaysian Palm Oil Board (Quality) Regulations 2005, (c) Malaysian Palm Oil Board (Cess) Order 2019, Order 3, (d) MPOB Standard Operating Procedures (SOP) Guidelines for Bagworm Control, and (e) Malaysian Sustainable Palm Oil (MSPO) Documents.

[2] The documents contain both information and data. The legal documents do not contain data except legal information only. This is because data should involve meaningless but unorganised, disorderly or raw information, something which is not found in the legal documents above.

(ii) Malaysian plant protection laws and regulations, specifically the Plant Quarantine Act 1976 and Plant Quarantine Regulations 1981.

(iii) Laws and regulations on pesticides, which encompass biopesticides, including the Pesticides Act 1974 and Guidelines for Biopesticide Registration 2016.

(iv) Policies, laws and regulations related to public funding, including the Federal Constitution 1957, Financial Procedure Act 1957, Treasury Directive and Circulars, Audit Act 1957, Ministerial Functions Act 1969, and Delegation of Powers Act 1956.

This paper also finds a mixture of hard law and soft law documents that directly impact the use of biopesticides against oil palm bagworms. Among the hard law documents are the Acts of Parliament in categories (i) Palm Oil Industry Laws and Regulations, (ii) Plant Protection Laws, and (iii) Pesticide Laws and Regulations. The hard law element is evident in regulations that penalise landowners, including smallholders, who fail to take action regarding infestations category (ii), as well as in laws that impose strict controls on pesticide use category (iii).

However, the hard law and soft law documents in categories (i), (ii), and (iii) do not adequately address the funding issues related to biopesticides. The MPOB SOP Guidelines on Bagworm Control, which is a non-binding instrument, mention that the use of Bacillus thuringiensis (BT) is a crucial component of integrated pest management (IPM) measures (MPOB, 2016). In fact, according to the SOP Guidelines, the application of BT, which includes aerial spraying and knapsack spraying in selected areas, is currently being conducted by the MPOB itself (MPOB, 2016). However, there is a lack of hard law and soft law documents that establish rules and procedures for funding the implementation of BT spraying. Although there are hard law documents related to funding category (iv), none include provisions that address the needs arising from biopesticide use. Under the Malaysian Palm Oil Board (Cess) Order 2019, Order 3, the MPOB is empowered to collect cess, which involves a payment of 14 ringgit for every metric tonne of crude palm oil produced by a farmer. This Order suggests a potential source of funding for the MPOB to allocate towards the implementation of BT spraying, but there is no explicit provision that obliges the MPOB to do so.

Returning to the categories of documents analysed above, this paper finds that the legitimate objectives of each category are distinctive and can be explained as follows (Table 1).

This paper concludes that it is necessary to refer to category (iv) documents, which focus on the methods of raising and allocating funds for implementing BT spraying. It remains uncertain whether the funding should be restricted to public sources or if private capital should also be considered.

Discussion

The funding for the use of biopesticides, specifically Bacillus thuringiensis (BT), which is a microbe, requires an understanding of the stages involved in its development. The first stage is the development of microbes intended to combat oil palm bagworms. This development is typically conducted by researchers at universities and public research institutes, although collaborations with commercial entities may also occur. The Research and Development (R&D) activities surrounding BT must also consider commercialisation, which leads to mass production for eventual use by end users.

[3] There is an issue whether the Guidelines is binding as hard law instrument. Legal instruments can be divided into hard law and soft law. Hard law refers to legally binding acts including strong enforcement mechanism such as regulations, directives and decisions, see Terpan & Saurugger (2021). Soft law refers to non-legally binding instruments such as recommendations, code of conduct, general policies and non-binding policy guide, see Terpan (2023), pp. 44-53.

Table 1: Connection between policy/law instruments and legitimate objectives

Categories	Policies and Laws	Legitimate Objectives	Reasoning
Category (i)	Law and regulations on palm oil industry in Malaysia (a) Malaysian Palm Oil Board Act 1998	Regulated Sector	Palm oil is designated as commodity and for Malaysia's economic interests, it being overseen by Ministry of Plantation and Commodities, and not the Ministry of Agriculture and Food Security.
Category (ii)	Malaysian plant protection law and regulations	Plant Protection and Food Security	Although plant protection covers all food and non-food types of plant, the law protects national crops particularly food crops from agricultural pests. Hence plant quarantine law is under the jurisdiction of Ministry of Agriculture and Food Security.
Category (iii)	Law and regulations on pesticides which should cover biopesticides	Human Safety and Environment Protection	Pesticide law regulates production, manufacturing, processing, marketing, sales, transportation, storage and usage of among others, chemicals for the sake of human health and environment.
Category (iv)	Policy, laws and regulations related to public funding	Public Finance Accountability	The policy, laws, regulations and directives regulate national finance so that proper rules and procedures for collection of national revenue and disbursements and spending public funds.

However, researchers and biocontrol businesses often lack a solid strategy when developing their products (Koul, 2023). Therefore, to create a viable biopesticide, appropriate technology tailored to the specific microbe is essential (Koul, 2023). For instance, while BT is a safe microbe, the costs associated with production and formulation, particularly regarding separation or purification methods, can hinder its widespread adoption (Koul, 2023).

This situation presupposes a cross-participation between upstream and downstream markets that will influence product marketability, with outcomes affected by market dynamics at both levels. It is crucial to consider the commercial nature of the services or products involved. Under competition law, a service or product is considered commercial if it is offered to consumers within a specific market, although it can also be provided in the exercise of public authority (Ahamat & Rahman, 2017; Rahman & Ahamat, 2021). Currently, there is a mixed participation between upstream and downstream players, as well as between public and private entities. This fluidity extends beyond the production of BT. When it comes to delivering BT to farmers or planters, even greater budgetary and funding challenges arise. This is particularly true for initiatives that integrate BT into Integrated Pest Management (IPM) for smallholding oil palm farmers, as the costs involved may not be recoverable by commercial parties without government subsidies. Additionally, rising input costs and limited access to low-cost technology options further complicate the situation (Singh *et* al.,

2014; Mandal *et* al., 2023). The necessary mixed participation of public and private entities across the upstream-downstream divide may exacerbate the budgetary and funding challenges.

There are two dimensions to addressing these challenges in terms of policy and law. The first dimension involves public funding, while the second does not. The use of BT against oil palm bagworms is part of IPM, and the associated costs might be borne by the relevant public agency responsible for the palm oil industry in Malaysia, namely the Malaysian Palm Oil Board (MPOB). The development of the relevant BT microbe falls within the scope of the MPOB's functions as stipulated by the MPOB Act 1998, which includes the legitimate objective of "regulated sector" policy and law. The 1998 Act specifically refers to the MPOB's responsibilities concerning research and development (R&D) and the commercialisation of research findings [Section 4 (b) and (e)]. Furthermore, another important function involves providing extended services for operationalising the IPM using BT, including the mass production of BT and its application on oil palm plants. This function is covered by Section 4(f), which pertains to the provision of technical, advisory, and consultancy services to the oil palm industry. The term "services" implies that the MPOB may charge for any services rendered.

Funding is not an issue for large oil palm plantations in Malaysia, which have successfully adapted to the latest pesticide application technologies, including automation and artificial intelligence (Loh *et al*., 2022). However, it remains uncertain whether smallholder planters are prepared to bear the costs of effective measures against bagworms. This paper does not examine the specific amount required for the use of BT but notes that aerial spraying is expensive due to the involvement of aircraft.

Use of Public Funds

Malaysia does not have a centralised law in the form of statutory enactments governing the use of public funds, including public procurement matters. Instead, the controlling rules take the form of quasi-legislation (Rahman & Anuar, 2018). Such control remains essential due to the understanding that public funds are derived from taxpayers, who are increasingly concerned about how their money is spent (Verploegh *et al*., 2023). Despite the lack of a centralised law, there are policies, laws, and rules that govern the allocation and distribution of public money in Malaysia, which fall under the legitimate objective of "public finance accountability" (Bari, 2002; Rahman & Anuar, 2018).

The ongoing issue is that, as countries like Malaysia attempt to justify regulation without being firmly based on legislation (statutes), there is a persistent contest between regulatory efficiency and regulatory accountability within the "Regulatory State" (Cohen, 2016; Jarvis, 2017). It can be argued that rules are enforced more effectively not through statutes but through administrative orders, as these offer greater flexibility for changes and address the challenges of finding alternatives to paternalistic regulation (Thaler & Sunstein, 2003; Hands, 2020). Paternalism in regulation suggests that regulatees should be given choices that better suit their interests (Thaler & Sunstein, 2003; Hands, 2020). However, allowing regulation to operate independently of legislative scrutiny may result in deficits in democratic accountability and reputational risks (Bach *et al*., 2020; Fjørtoft & Michailidou, 2021). Furthermore, evidence indicates that blunt force regulation merely consolidates leaders' control over the bureaucracy, without streamlining the economy or enhancing regulatory efficiency (Kamp, 2021).

The Malaysian Federal Constitution of 1957 does not mention the word "people", but it does guarantee freedom of business with certain limited exceptions (Bari, 2002). The Malaysian government system is rooted in the British model (also known as the Westminster system), not only regarding law but also the bureaucratic structure, which has been modified as necessary (Bari, 2002). Malaysia adheres to the British regulatory model, characterised by regulation through direct actions and designs.

Since the Malaysian government operates similarly to the British government, Parliament has jurisdiction over various aspects of public finance: (1) revenue collection, (2) appropriation of collected funds, (3) issuance of funds to spending authorities, and (4) auditing of government financial transactions (Stout, 1953). The legal framework that provides (or rather controls) the source of authority (known in Malay as *punca kuasa*) to the government regarding public finance is summarised in the chart below:

The Financial Procedure Act 1957 regulates public finances in Malaysia, specifically concerning the collection, custody, and payment of public funds (Haron, 2023). Parliament exercises control by tabling the National Annual Budget, which allocates funds to each Minister based on the functions, powers, and responsibilities outlined in the Ministerial Functions Act 1969 and its associated Federal Government Orders, the most recent being Order No. 2023. Addressing the challenges associated with oil palm cultivation, the development and further applications of BT fall under the areas of concern outlined in the MPOB Act 1998. This includes aspects such as registration, licensing, research and development, as well as other regulatory matters related to the palm oil industry, including plantation, processing, and production, all of which are the responsibility of the Minister of Plantation and Commodities.

However, regulatory strategies must navigate the complexities of policy objectives and the various interests involved, as illustrated in Table 1. The primary task of the MPOB is to ensure the resilience of the palm oil sector, yet the statutory body must also consider plant security (plant protection and food security), human safety, and environmental protection objectives, which fall outside its direct responsibilities. Additionally, government grants to departments, agencies, and statutory bodies are becoming increasingly limited (Ni, 2019). While there may be opportunities for more effective implementation of cess money collection (Louhichi *et al*., 2022), this could place additional burdens on smallholders who are already facing challenges due to manpower shortages (Parveez *et al*., 2023). Consequently, attention may now shift to the Department of Agriculture (DoA). Under the Ministerial Functions Act 1969, the Minister of Agriculture and Food Security oversees the DoA and is responsible for executing functions and powers under the Plant Quarantine Act 1976 and the Pesticides Act 1974.

The Plant Quarantine Act 1976 imposes obligations (Section 11) on the owner or occupier of oil palm land infested with a dangerous pest to notify the DoA, follow its instructions, and assist in eradicating the pest. The Pesticides Act 1974 governs the importation and manufacture of pesticides through a registration process (as detailed in Part III of the Act). Both pieces of legislation provide a framework for revenue generation for the DoA, particularly through fines for non-compliance with notification and cooperation duties, as well as the BT registration requirement that impacts both producers and users of biopesticides. In this context, the use of unregistered pesticides constitutes an offence. BT is classified as a scheduled pesticide under Section 2 and the First Schedule of the Pesticides Act 1974.

Can the revenue from the aforementioned fines be used to finance bagworm management and eradication? According to Section 11 of the Plant Quarantine Act 1976, the responsibility for pest destruction falls to the Department of Agriculture (DoA). However, in the case of bagworms, integrated pest management (IPM), which includes the use of biopesticides (microbes), is conducted by the Malaysian Palm Oil Board (MPOB). Both agencies have coordinated their efforts, yielding positive results (Shukor, 2022). When considering shared funding, it is essential to recognise the differing structures of the DoA and MPOB. The DoA is a government department, and any revenue it generates reverts to the Federal Consolidated Fund, as stipulated by the Federal Constitution of 1957 and the Financial Procedure Act of 1957 (Ismail & Pratomo, 2021). In contrast,

the MPOB is a statutory body that maintains a separate fund established by its governing statute, and any revenue it generates is allocated to this fund unless specified otherwise by statutory provisions (See, 2015). Despite these separate funds, the management of a statutory body's financial resources remains subject to Treasury Directives and Circulars, which are also governed by the Financial Procedure Act of 1957 (Yahya et al., 2022). Thus, the funds could be classified as public money for the purposes of national audit under the Audit Act of 1956.

Non-Use of Public Funds – Public Private Partnership (PPP)

There is a body of literature discussing public-private partnerships (PPPs) in the context of biopesticides and bioinsecticides in agriculture. Generally, PPPs have played a significant role in modernizing agriculture, enhancing the sustainability of agribusiness (Rankin *et al*., 2016; Sandøy, 2018; Agarwal *et al*., 2023; Ikenga *et al*., 2024). They facilitate the commercial production and research and development of biopesticides, which are essential for crop protection in regions such as sub-Saharan Africa, Southeast Asia, and India (Ayyappan *et al*., 2007; Srinivasan *et al*., 2019). By testing technologies, especially biopesticides and their commercialization, PPPs can reduce costs while preserving the economic advantages of sustainability (Ayyappan *et al*., 2007) and support technology adoption that aligns with local conditions (Mangeni, 2019). Key characteristics of PPPs include written agreements, a defined legal framework, transparency, trust, and long-term commitment, which can also resonate with smallholders' goals for sustainable farming (Sandøy, 2018). However, challenges such as risk sharing, realistic common goals, and smallholder involvement require further attention (Sandøy, 2018).

In Malaysia, contextualizing these issues presents a significant challenge. In the Asia-Pacific region, PPP projects are largely justified by the need for private investment in sectors like infrastructure (Kawamura, 2020; Sharma, 2022). These projects often prioritise market considerations over social ones, leading to concerns regarding monopoly and competition laws (Wisuttisak & Rahim, 2018; Bhattacharjea *et al*., 2019; Wisuttisak *et al*., 2021). This contrasts with Africa, where international organisations and NGOs play a substantial role in PPPs (Sims & Kienzle, 2017; Mangeni, 2019; Awuku *et al*., 2022). Despite the market-driven perspective of PPPs, a social focus remains crucial in Malaysia to address smallholders' concerns about the costs and challenges associated with using biopesticides against pests like bagworms.

Currently, Malaysia lacks specific legislation regulating PPPs. However, the Public Private Partnership Unit (UKAS), a division of the Ministry of the Prime Minister's Department, oversees PPPs and has issued several policy documents, including:

- Guidelines on PPP (Document 1),
- PPP Working Framework Implementation Guide 3.0 (PPP 3.0) (Document 2),
- Privatisation Master Plan (Document 3), and
- Guidelines on Changes in Concession Company Shareholders (Document 4) (Unit Kerjasama Awam dan Swasta (UKAS), 2024).

These documents, particularly Document 1, outline the key principles and structural elements that should guide PPP *projects* in Malaysia. The main principles include (a) socio-economic impact, (b) value for money and cost savings for the government, (c) timely project delivery and improved service levels, and (d) enhanced accountability, efficiency, and effectiveness. Deploying PPPs as a financing mechanism for research and development, commercialization, mass production, and the application of biopesticides on smallholding farms can yield positive socio-economic impacts and save government funds (financial sustainability). However, the prevailing PPP model in Malaysia tends to focus on private investment in infrastructure projects,

necessitating a discussion on the regulation of government contracts in

Amidst the extensive public procurement rules in Malaysia, outlined by the Treasury Directive and Circulars under the Financial Procedure Act 1957, there exists a 'special regulatory regime' for Public-Private Partnership (PPP) projects. The Treasury Directive defines "procurement" to include PPPs, which are governed by directives and guidelines issued by the Malaysian Treasury (UKAS, 2023). According to Document 1 of the Guidelines on PPP issued by UKAS, PPP is characterised as a "method" of public procurement, contrasting it with "conventional" public procurement processes. However, PPP projects remain subject to national audit rules under the Audit Act 1956. Government contracts in Malaysia are categorised into goods, services, and works. The current structure of PPPs under the UKAS Guidelines is primarily aligned with the works category of government contracts. Document 1 explicitly states: *"Ia menetapkan beberapa prinsip utama kaedah perolehan dan pelaksanaan projek infrastruktur sektor* awam" (It stipulates several main principles on the method of procuring and implementing public sector infrastructure projects).

The use of bagworm biopesticides by smallholders encompasses both goods and services purchases. The goods aspect involves acquiring tangible biopesticide products, including the microbes, while the services component includes research and aerial spraying services. The design and structure of the PPP model in Malaysia should evolve beyond just infrastructure and works projects (Rafie & Shuib, 2018) to also encompass goods and services purchases. Therefore, the potential development of Malaysia's PPP Guidelines warrants close attention.

Focusing on Document 2, the PPP Working Framework Implementation Guide 3.0 (PPP 3.0), the recommendations for improving PPP implementation may expand the nature and scope of PPP projects in Malaysia. Notably, it emphasises a people-centric approach where "people" are defined not only as end users but also as owners or funders of the relevant PPP project. This role can be fulfilled by farmers' organisations, which straddle the line between profit-oriented business corporations (regulated by the Companies Act 2016) and non-profit associations (regulated by the Societies Act 1966).

In Malaysia, farmers' organizations are established under the Farmers' Organisation Act 1973, allowing them to engage in both non-profit and profit-oriented activities. These organisations operate at three levels: National, state, and area (Amin *et* al., 2022). At the national level, the National Farmers' Organisation (NAFAS) addresses social, socio-economic, and economic objectives (Pertubuhan Peladang Kebangsaan (NAFASa), 2024). One socio-economic function includes establishing the National Farmers' Fund (*Dana Peladang Kebangsaan*), aimed at consolidating, mobilizing, and strengthening farmers' savings, financing, and investment capacity in Malaysia (Pertubuhan Peladang Kebangsaan (NAFASb), 2024).

Additionally, NAFAS engages in economic activities and has subsidiaries, including Agricultural Chemicals (M) Sdn Bhd, of which NAFAS is a shareholder (Pertubuhan Peladang Kebangsaan (NAFASc), 2024). This involvement illustrates NAFAS's experience in pesticide formulation, suggesting the potential to expand into biopesticide mass production. However, this paper does not explore the operational testing of such potential, as NAFAS's existing model in chemical pesticides relies on joint collaboration with foreign investors and trading companies (Pertubuhan Peladang Kebangsaan (NAFASc), 2024), indicating a similar approach may be applicable for biopesticides.

Nevertheless, the Malaysian PPP documents suggest that some novel issues regarding substantive principles may arise from these potential ventures. One key principle aims to integrate Environmental, Social, and Governance (ESG) considerations into PPP project implementation. Specific corporate

governance reforms may be necessary to enhance the alignment of social and environmental objectives associated with the use of biotechnology (BT), particularly if the Integrated Pest Management (IPM) is executed correctly. However, assessing the correctness of IPM implementation poses a challenge due to the absence of clear, consistent, and uniform concepts of IPM globally. Additionally, such corporate governance reforms must address the "governance" aspect, which, in this context, pertains to combating corruption. In 2023, farmers' organisations at all three levels were gazetted as public bodies under Section 71(1) of the Malaysian Anti-Corruption Commission Act 2009 (Yahya, 2023). This could expand the scope of anti-corruption cases beyond just the officers of farming organisations appointed by the Farmers Organisation Board, the agency that oversees farmers' organisations in Malaysia.

In the context of PPP, there can be a fine line between the regulatory and market functions exercised by farmers' organisations. The drive for income generation can lead to a convoluted performance of social-regulatory and market functions by these bodies. Ideally, the social-regulatory functions should translate into ongoing support, including financial assistance to smallholders, which is a vital aspect of the biopesticides PPP arrangement. Under PPP 3.0, implementation should aim to achieve objectives of accessibility, equity, and sustainability.

However, as evidenced in certain agricultural and commodity sectors in Malaysia, government-initiated projects have often suffered from inefficiency or under-utilisation. For instance, by the end of 2023, over 20,000 business premises, particularly in rural areas of Malaysia, fell into the category of "white elephant" projects (Asrol, 2023). These projects may also be susceptible to rent-seeking behaviour and may be subcontracted to "real" market players. In many cases, market players must absorb business risks in ventures that may not yield attractive returns, yet still require significant fulfillment of socio-economic demands. A suitable reward mechanism or incentive must be established, compliant with laws and regulations.

Contractual negotiations can occur between relevant public bodies, the biotechnology industry, and farmers' organisations. The model for industry rewards should be developed after clarifying the source of authority (*punca kuasa*), which may require prior Cabinet approval involving all interested ministries. The reward system, which must be included in the contract terms, should be proportional to the costs and risks borne by the industry, considering the high costs of research and development. It should also differentiate between the development of chemical and biopesticides to ensure that all contributors to both the process and output are included in the context of the latter.

Furthermore, considerations must be made regarding the use of public funds and whether farmers should contribute to a specific fund that acts as a savings or investment tool for them. Transparency and adherence to the laws regulating the market and public bodies should be explicitly outlined in the contract, which will be negotiated by all involved parties.

Conclusions

Public funding remains crucial for supporting biopesticide production and usage; however, simply allocating public funds will not provide a comprehensive solution to the issues faced, particularly by smallholders. Large plantations and certain types of smallholder farms threatened by bagworms may not easily benefit from publicly funded biopesticide controls. Nevertheless, an outbreak will not spare any location, regardless of whether action has been taken or who sponsors it. While the distribution of publicly funded initiatives may be limited, no area can afford to be excluded. Consequently, the importance of public-private partnerships (PPPs) is growing, yet the existing policies and laws are inadequate to address the concerns of both industries and farmers. This does not suggest a halt to the entire process; rather, the regulatory focus for PPP implementation

should shift from rule-making and sanctions to negotiation.

Despite the absence of comprehensive hard law governing PPPs in Malaysia, numerous successful concession contracts have been established between the Government and various business or industry players. However, to effectively combat the bagworm issue, unique and innovative criteria may need to be developed for these contracts and their associated guidelines. It remains unclear whether farmers or their associations can be included as parties to these contracts. If the answer is negative, they could at least be designated as beneficiaries of the contracts, provided there are clear guidelines in place. Ultimately, the policy and legal direction should ensure that the outcomes of PPP negotiations, particularly regarding services to manage bagworms, reflect a balance between public finance accountability and the three legitimate regulatory objectives: sector regulation, plant protection and food security, and the protection of human health and the environment.

In light of these conclusions, this paper recommends the establishment of specific regulations for PPPs in the palm oil agriculture sector, enabling all private sector participants to benefit from tax incentives and other subsidies in the long term. It is time for Malaysia to implement clearer rules as the role of private sector players, including foreign investors, continues to grow in both hard and soft infrastructure projects. These rules should delineate the rights and obligations of all parties, ensuring proportionate returns on labour and investment while safeguarding public and national interests.

Additionally, this paper advocates for regulations governing PPP schemes that accommodate various levels of farmers through a cooperative model, allowing all cooperative members to benefit from the funds. Proper procedures must be established to ensure that these funds are utilised solely for pest biocontrol purposes, encompassing both process and outcome dimensions that ultimately empower farmers to achieve self-sufficiency.

Acknowledgments

This paper was supported by the Universiti Kebangsaan Malaysia (UKM) Research University Grant (*Geran Universiti Penyelidikan (GUP)*) Project titled "Legal Framework for Oil Palm Bagworm Eradication Regulation in Malaysia", Project Code: GUP-2022-062.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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