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Short Communication

The Initiative to Further Enhance Technology Adoption in the Malaysian Oil Palm Industry

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Abstract: The oil palm industry is facing highly severe labour shortages where most labourers involved in the plantation consist of foreign workers. The usage of manual labourers revealed several negative drawbacks which has caused lower productivity in the oil palm industry. Hence, the Malaysian Palm Oil Board (MPOB) has made continuous efforts to enhance the efficiency of oil palm plantations by providing assistance in mechanisation and engineering technologies. This covers from the early stage of oil palm cultivation such as land preparation, fertiliser deployment, fresh fruit bunch (FFB) harvesting, FFB evacuation and up to the clearing of old palm trees. This article aims to highlight the strategies of the Mechanisation and Automation Research Consortium of Oil Palm (MARCOP) through collaborative efforts and engagements with all relevant parties and agencies for the development of technical and economically viable mechanisation technologies to be adopted by the industry. The consortium's goal is to investigate mechanisation and automation technologies for oil palm plantations in order to increase productivity, with a particular emphasis on the operation of harvesting FFBs, and to reduce reliance on manual harvesters. Furthermore, the consortium provides a technology development fund to eligible applicants for the development of cost-effective and versatile FFB harvesting technologies.

Keywords: MARCOP; technology adoption; mechanisation and automation; harvesting technology; agricultural plantation

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1. Introduction

Malaysian oil palm plantations are in urgent need of foreign labour as there has been a shortage of immigrant workers since 2020. According to the Malaysian Palm Oil Association (MPOA), the situation in plantations has deteriorated to a labour shortage of approximately 75,000 harvesters, up from 40,000 previously, resulting in a 20 % loss of yield

since the foreign labour intake freeze was implemented on March 18, 2020 (Cheryl Poo, 2021). Due to these issues, technology and innovation have become essential for the smooth operation of oil palm plantations, which are currently facing a critical labour shortage, and to ensure the competitiveness of the Malaysian oil palm industry in the global market (Ghulam *et al.*, 2021).

The Engineering and Processing Research Division under the Malaysian Palm Oil Board (MPOB) has pioneered continuous efforts to enhance the running efficiency of oil palm plantations by providing assistance in mechanisation and engineering technologies. This covers from the early stage of palm oil cultivation such as land preparation, fertiliser deployment, oil palm fresh fruit bunch (FFB) harvesting, FFB evacuation and up to the clearing of old palm trees. In an oil palm plantation, oil palm trees can be categorised into 3 stages, which are immature palms (up to 2 years old palm trees), mature palms (3 to 25 years) and old palms (more than 25 years) (Lewis *et al.*, 2020). During the immature palms stage, the plantation requires land preparation, seedling transplant, crop cover establishment, palm tree maintenance (fertiliser, pesticide and herbicide applications) and plantation maintenance (for roads and drains). Mature palms on the other hand not only require pesticide and herbicide applications, as well as road and drainage facilities, but also FFB harvesting and evacuation (Murphy *et al.*, 2021). As for the old palms, clearing them to restart planting the next generation of palms is needed where all of these activities require intensive labour force. However, the plantation industry is facing highly severe labour shortages. The current labour involved in the plantation consists of foreign workers which have caused several negative setbacks. The usage of manual labour is also inefficient, thus lowering the productivity of the palm oil industry. In addition, there has been concern on the safety and health issues of these foreign workers who were easily exposed to COVID-19 during the pandemic in the past two years (Wahab, 2020).

The mechanisation element has been introduced into the oil palm plantation and with the addition of this element, the number of imported labour workforce can be significantly reduced (Kushairi *et al.*, 2019). This in turn will lead to less social problems associated with foreign labour workers. In addition, the lack of foreign workers flooding the workforce market will enable the locals to fill in the void left by their foreign counterparts. Hence, the issue of currency outflows can be tackled simultaneously. The other benefits that the plantation industry gains from mechanisation are an increase in productivity, reduction of operational cost, achieving operational sustainability and improvement in the working timeline. As for the workers, mechanisation can secure jobs for locals, increase the take-home pay due to the higher expertise needed, hasten the field work, increase safety and limit

hazardous elements in the plantation. Due to the vast sector of the plantation, the market for mechanisation is also proportionally vast as well. With the implementation of the Industrial Revolution 4.0, mechanisation can be further improved and its effectiveness and efficiency can be increased as well (Yang & Gu, 2021).

Thus, the objective of this article is to highlight the initiative to further enhance technology adoption in the Malaysian oil palm industry by the establishment of the Mechanisation Research Consortium for Oil Palm (MARCOP). The consortium carries out its functions through collaborative efforts and engagement with all relevant parties and agencies for the development of technical and economically viable oil palm mechanisation technologies to be adopted by the industry. MARCOP as a government-industry platform uses mechanisation and automation technologies to investigate, screen, design, and implement solutions for improving the productivity of Malaysia's oil palm plantation industry and thus reducing reliance on human labour. MARCOP is supported by matching grants from the Malaysian government and the Malaysian oil palm industry, and has appointed the Malaysian Palm Oil Board (MPOB) as the secretariat to manage the MARCOP fund application and approval process. The Consortium consists of multi-groups of expertise, such as for fundamentals and design, fabrication and verification; and commercialisation and implementation. Besides, the application of technologies for plantations, estates and smallholders could also be investigated and implemented based on their mechanisation experience. The consortium's goal is to investigate mechanisation and automation technologies for oil palm plantations in order to increase productivity, with a particular emphasis on the operation of harvesting fresh fruit bunches (FFB), and to reduce reliance on oil palm harvesters. Furthermore, the consortium provides a technology development fund to eligible applicants for the development of cost-effective and versatile FFB harvesting technologies.

1.1. Harvesting Technology in Oil Palm Industry

Mechanisation of the harvesting process has been adopted as a means to improve productivity and make tasks easier. This is supported by various studies that have shown that the adoption of new technology can increase labour productivity, reduce the number of foreign workers, improve time efficiency, provide better safety and health to harvesters, and solve several problems (Mohd Nawi *et al.*, 2016; Shuib *et al.*, 2011). Adopting recently developed technology can also quickly address a variety of issues, such as lowering the proportion of foreign workers and raising time-based efficiency. Additionally, technology plays a significant role in improving the harvester's safety and health (Lim *et al.*, 2021). This

is because harvesters in oil palm plantations must perform all of their work manually using tools like chisels and sickles to cut FFBs in the absence of mechanised technologies. Harvesters would be exposed to ergonomic risk factors like repetition, uncomfortable postures, static muscular loading, and severe exertion in the course of their overall work when harvesting oil palm (Harith *et al.*, 2021; Radzi *et al.*, 2022).

MPOB has been conducting research and development on farm mechanisation since the 1980s and has commercialised more than 40 machines for adoption by the oil palm plantation sector for its operations such as harvesting. Among the mechanisation technologies adopted are the harvesting machine called Motorised Cutter-CANTAZ™, in-field transporter (Grabber, Motorcycle Trailer, Beluga) and loose fruit collectors. Figure 1 shows some of the machineries for the harvesting technologies which have been or are being commercialised by MPOB (Azwan *et al.*, 2020; Deraman *et al.*, 2013; Jelani *et al.*, 2018; Shuib *et al.*, 2020).

Figure 1. MPOB machineries for harvesting technologies in the oil palm industry.

1.2. Challenges in Oil Palm Mechanisation

Oil palm mechanisation provides advantages such as increasing workers productivity, hastening fieldwork and improving the sustainability of the oil palm plantation operation. However, most technologies available are only suitable or applicable to certain plantation conditions. Besides, harvesters continue to favour manual handling compared to new existing harvesting technologies. This is consistent with the study by Abdullah and Samah (2013), which focused on the factors influencing farmers' adoption of new agriculture technologies. Their observation revealed that the attitudes of farmers and low levels of education are the two primary factors that influence farmers' acceptance of technology (Abdullah & Samah, 2013).

In the oil palm plantation, some issues have arisen from the workplace environment, and human-machine interactions which include the technical aspects or are technology related such as not user friendly, expensive, bulkiness, noise, vibration, as well as difficulty to access in the plantation. The implication of these problems could be devastating due to the scarcity of labour sources and this might jeopardise the overall operation in the field. Table 1 shows some of the previous studies on technology adoption in the oil palm plantation, and the reasons why harvesters refuse to use existing technologies (Abdullah & Samah, 2013). Several recommendations have been planned to further increase the level of mechanisation adaptation in oil palm plantations. This will involve interactions with farms and the industry in order to identify the real concerns that cause low oil palm mechanisation utilisation rates and to further formulate strategies for mechanisation technology adoption.

Table 1. Technical issues on previous technology adoption.

Technology	Technical Issues	Author(s)
Motorised cutter	• Vibration • Limited height of reach	(Jelani *et al.*, 2018)
Telescopic and elbow type arm harvester (for tall palms)	• High cost • Difficult to access from palm to palm	(Mohd Ramdhan & Abd Rahim, 2014)
Pruner and harvester machinery	• Limited height to reach 6-12m	(Intara *et al.*, 2013)
Manipulator automation for mechanical harvester	• High cost • Bulky and heavy	(Jayaselan *et al.*, 2012)
Automatic cutting system	• Heavy, weight 6.3kg • Vibration	(Shokripour *et al.*, 2012)
Hand-held mechanical cutter	• Vibration • Weight 5.5kg	(Jelani *et al.*, 2003)

2. Consortium Establishment Framework

The Mechanisation and Automation Research Consortium of Oil Palm (MARCOP) was established in 2021 with a budget of RM30 million from the government and contribution from the oil palm industry through matching grants. The aim of MARCOP is to advance the development of technical and economically feasible oil palm mechanisation technologies, particularly for the harvesting process. Furthermore, MARCOP will work on specific issues pertinent to the development and adoption of mechanisation technologies. The main concern of MARCOP is to protect the novelty and the patent right of the technologies through the evaluation of proposals submitted officially. In general, Table 2 summarises the expected outcome of the consortium through a Cause-and-Effect Analysis.

Table 2. Cause-Effect Analysis of MARCOP.

WHAT	Establishment of MARCOP is to act as a think tank on the research, development, commercialization, and innovation (R&D&C&I) of the oil mechanisation and automation for outcome deliverables.
WHY	To facilitate mechanisation technology adoption by smallholders' sectors and oil palm plantation sectors.
HOW	The consortium will evaluate and assess mechanisms to solve the issues and carry out the development process up to technology adoption. The Consortium will consist of multi-groups of expertise, such as for fundamentals and design, fabrication and verification; and commercialisation and implementation. Existing mechanisation fund will be utilised for the consortium activity and R&D&C&I.
WHEN	The project will start once approval is granted based on the agreed timeline.
WHO	The consortium will involve government research institutes, representatives from relevant Ministres, private sectors, higher learning institutes and fund trustees.
WHERE	Selected smallholders and plantation area and MPOB trial plots.

The main committee of the consortium is composed of representatives from relevant private sectors and trustees, together with government agencies and leaders from industry associations as illustrate in Figure 2. Thus, no participation from the technology developer or manufacturer in the consortium is required to avoid conflict of interest except the proposal could come from the consortium members or their networks (technologies provider). Hence, a non-disclosure agreement (NDA) between all parties involved will be used to facilitate the discussions.

MARCOP seeks to reduce the oil palm industry's reliance on foreign labour by encouraging the development of mechanisation and automation technologies, particularly in the harvesting process. In accomplishing this goal, the consortium has implemented a three-pronged strategy that includes short-term, intermediate-term, and long-term goals. The short-

term goal is to increase the productivity of existing harvesting tools so that the land-to-labour ratio for FFB cutting is 1:25. By implementing automation technologies such as ripeness detection, mapping systems, and artificial intelligence systems, the midterm goal is to increase productivity to a 1:50 land-to-labour ratio. The long-term goal is to use robotic technology to increase productivity in oil palm plantations to a 1:100 land-to-labour ratio. Figure 3 illustrates the strategies which have been gazette by the consortium's committee to achieve these targets such as conducting dialogues with technology suppliers, field demonstrations and conducting several workshops to identify technology constraints.

Figure 2. The Proposed members of the Mechanisation Research Consortium for Oil Palm (MARCOP)

Figure 3. Targets and strategies direction of MARCOP.

3. Implementation Process

In order to implement the consortium engagement, a discussion involving all the parties involved is conducted to detail out all the issues and related technology requirements. The discussion is aimed to prepare proposals which are related to their respective organisation

so that those proposals can be presented and evaluated by the members of the consortium before they can proceed to the next stage. During the discussion stage, the members of the consortium are able to brainstorm and identify all issues related to the slow adoption of mechanisation in oil palm plantations. This includes identifying all issues and challenges faced by plantations, estates and smallholders in relation to their mechanisation experience. The main objective of the discussion would be geared towards developing mechanisms for oil palm mechanisation technological development and adoption, as well as to evaluate technical projects on the development of mechanisation technologies.

Once all of the issues and related requirements are detailed out in structured proposals, they are forwarded to the presentation and evaluation stage. During this stage, the technology provider is also allowed to present their proposal if available. The best and suitable proposals are selected during this stage and they are submitted for the MPOB Board approval. Once the proposals are approved, they are considered as ongoing projects and are subjected to thorough monitoring until the projects are completed. If the project faces any issues or related failure, the project is tabled for discussion again as in the first step. Otherwise, if the project is completed, it will proceed to the commercialisation stage so that the technology can be made available to the public. Figure 4 shows the process flow of the consortium's implementation.

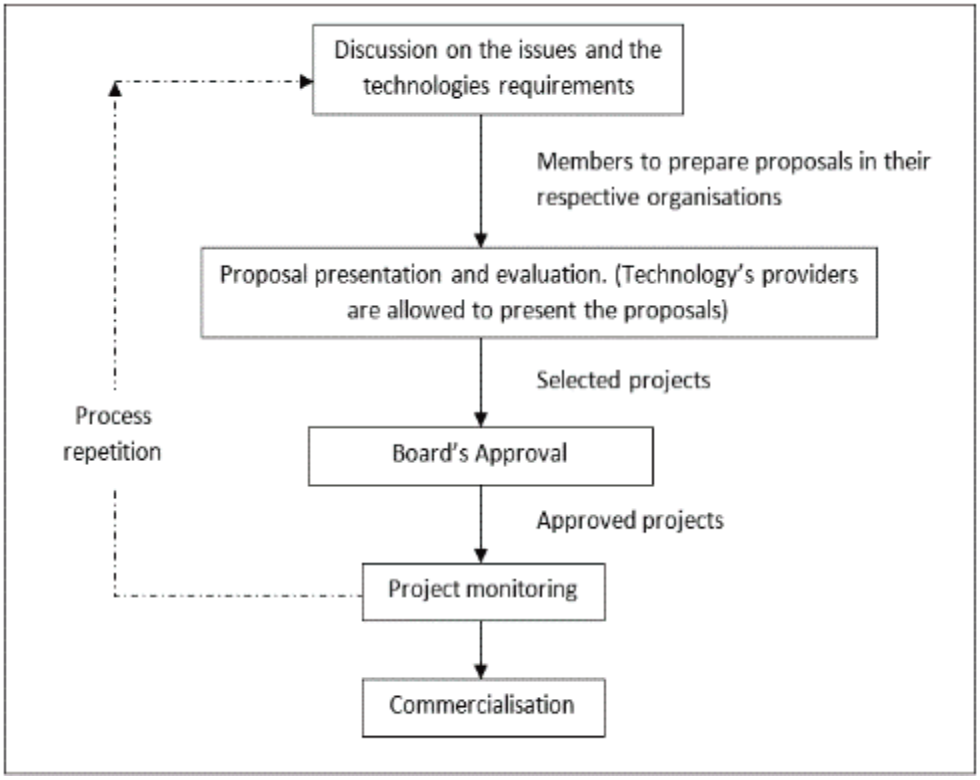

Figure 4. Proposed implementation process.

4. Conclusions

The Mechanisation Research Consortium for Oil Palm (MARCOP) is a collaborative effort and engagement with all relevant parties and agencies for the development of technical and economically viable oil palm mechanisation technologies to be adopted by the industry. The Consortium will consist of multi-groups of expertise, such as for fundamentals and design, fabrication and verification; and commercialization and implementation. Therefore, the approval has been highlighted from the Board of MPOB for the establishment of the MARCOP as an alternative to the Mechanisation Fund Committee and to utilise the fund for the research, development, commercialisation, and innovation (R&D&C&I) allocated by the government.

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