

RESEARCH ARTICLE

MITIGATING MACHINERY'S ENVIRONMENTAL IMPACT IN PALM OIL PLANTATIONS FOR ENHANCED BUSINESS PERFORMANCE

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ABSTRACT - This study highlights the importance for YP Plantation Holdings Sdn Bhd (YPPH) to maintain the use of machinery in palm oil plantations without damaging the environment. One of the keys to achieving such goal is to conduct regular inspections and maintenance to ensure that all machinery is working properly and efficiently, thus avoiding costs associated with breakdown and repair. It is also important for the machinery to comply with environmental regulations. This will not only promote environmentally friendly operations but also establish a positive impression among environmentally conscious stakeholders. In conclusion, proper maintenance of equipment and machines will help YPPH to save costs and become an environmentally friendly entity, thus ensuring its long-term success in the palm oil industry.

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Palm oil plantations
Business performance
Sustainability

1. INTRODUCTION

Numerous studies have shown how commercial seedlings contribute to the expansion of the global agricultural sector in different parts of the world. Concerns remain about the impacts, especially on farm machinery (Jones & Brown, 2019). The increasing demand for palm oil subsequently highlights the importance for palm oil plantations to solve mechanical problems (Gomez et al., 2021). Previous research found that reducing the number of devices used by firms can have a positive effect on productivity (Lee & Kim, 2017). Palm oil-based products, such as food and cosmetics, also have negative impacts on animals and forests (Brown & Smith, 2016). Devices further exacerbate such problem by increasing greenhouse gas emissions, soil erosion, and sedimentation (Patel & Nguyen, 2019). There are also concerns about how to monitor and evaluate the expanding benefits that palm oil producers gain from the increasing demand of investors, customers, and regulations (Taylor & Jackson, 2022). This highlights the need to explore ways in which pulp companies can reduce the impact of equipment while improving their operations (Chen et al., 2021).

YP Plantation Holdings Sdn Bhd (YPPH) is well known for its commitment to sustainable practices and environmental management in the plantation sector. The company has a long history of being a prominent manufacturer, repairer, and marketer of palm oil products. YPPH's goals extend to beyond profit-making; it strives for a harmonious relationship between economic prosperity and environmental protection to reduce environmental footprint. The company's productivity has been increased by better management of land and resources alongside investment in advanced technology. Its palm oil plantations also reflect sustainable agricultural practices through biodiversity conservation, soil health monitoring, and effective water management. As the world moves towards a more sustainable future, YPPH aims to harmonise its practices with nature through strict environmental regulations and precision agricultural practices. The ultimate goal is to create a lasting legacy for future generations, enhance the well-being of employees and stakeholders, and generate economic returns for investors.

This study looks at real-world examples, current trends, and empirical research to illustrate the efforts taken by palm oil companies in reducing the environmental impact of equipment. It focuses on profitability specifics, such as reduced costs, increased efficiency, improved smoothness, and robust change. The aim is to provide valuable insights to manufacturers by understanding how equipment affects companies and the environment, ultimately establishing a more promising future for the palm oil industry.

1.1 Research Problem

Palm oil plantations are important in global farming; yet, the equipment utilised in tasks, such as land clearing and harvesting, can negatively impact the environment through deforestation, habitat loss, pollution, and greenhouse gas emission. This study seeks to reduce these environmental impacts by investigating innovative technologies and management approaches to reduce the environmental impact of palm oil plantations' machinery. It also highlights the significance of enhancing operational effectiveness, boosting productivity, and cutting expenses on palm oil estates. Palm

oil producers can improve sustainability and adhere to regulations and consumer demands by incorporating environmental considerations into their operations. In summary, this study aims to find a harmony between financial prosperity and environmental concern within the palm oil industry, with the ultimate goal of creating sustainable methods that can benefit both industry workers and the environment.

1.2 Research Gap

While the environmental consequences of palm oil production have been extensively studied, current research falls short in understanding the environmental and economic impacts of machinery usage in palm oil plantations. The majority of past studies did not thoroughly investigate realistic and viable methods for mitigating the impacts of machinery operations. Therefore, more studies are needed to explore the economic impacts of incorporating sustainable practices in palm oil plantation management as well as the costs and benefits associated with implementing environmentally friendly measures. Furthermore, research on the relationship between environmental sustainability and business performance in palm oil plantations should also look into their intersection as knowing how to combine environmental sustainability with business operations may result in strategies that benefit both simultaneously.

1.3 Research Questions

- a. What are the specific practices and technologies employed by YPPH?
- b. What is the relationship between environmental sustainability initiatives and business performance within the palm oil industry in YPPH?
- c. What are the best practices recommended for YPPH to effectively mitigate the environmental impact of machinery while enhancing business performance?

1.4 Research Objectives

- a) To identify the sustainable practices and technologies employed by YPPH.
- b) To investigate the relationship between environmental sustainability initiatives and business performance within the palm oil industry in YPPH.
- c) To recommend best practices for YPPH to effectively mitigate the environmental impact of machinery while enhancing business performance.

1.5 Scope of Study

This study explores how environmental sustainability efforts in palm oil can impact different aspects of business development. A specific focus is placed on how sustainable strategies can promote benefits like cost savings, operational efficiencies, brand image, market competitiveness, and financial results. It also examines various sustainable strategies and technologies adopted by pulp companies to reduce machinery's environmental footprint.

1.6 Significance of Study

This research identifies the opportunity to improve performance through the use of environmental services. Palm oil companies can gain a competitive advantage in the marketplace and achieve sustainable financial success by reducing operating costs, increasing resource efficiency, and building brand names. The findings hope to provide further understanding of how environmental sustainability relates to different aspects of business development and help companies make informed choices to increase growth and profitability.

1.7 The Case Company

YP Plantation Holdings Sdn Bhd (YPPH) was established in 1985 and has been operating as a subsidiary of the Pahang Foundation. The company was formerly known as Sumber Perindu Sdn Bhd and was later renamed on 24 January 2003 by Pahang Chief Minister, Dato' Sri Di Raja Haji Adnan bin Haji Yacob, who is also the company's chairman. In line with these changes, YPPH introduced a new logo on 28 February 2003, reflecting its transformation into a more efficient farm-focused organisation that generates value for its stakeholders, particularly the Pahang Foundation. The company's involvement in the oil palm industry began in 1994 through the establishment of its first 1,171 hectares of oil palm plantation. To date, YPPH recognises the importance of the plantation business as the Pahang Foundation's main source of income and has been actively involved in the development and expansion of oil palm assets on land owned by its parent company. As the financial arm of the Pahang Foundation, YPPH aims to optimise profitability through improved management and cost-effective practices, ensuring sustainable funding for the foundation to support the educational needs of the Pahang people.

2. LITERATURE REVIEW

Palm oil production has encountered some challenges because of its environmental effects, such as deforestation, greenhouse gas emissions, and loss of biodiversity. Reducing the environmental impact of machinery in palm oil plantations is crucial for sustainable environmental practices and improving business performance. This literature review

explores the current research on strategies for mitigating the environmental impact of machinery in palm oil plantations and its implications for business performance.

2.1 Machinery in Palm Oil Plantations

In palm oil plantations, mature oil palm kernels are collected from the trees. The main ingredient in palm oil is the oil-rich mesocarp found in this fruit. Garcia, Lopez, and Martinez (2021) studied the transportation and logistics practices in the olive industry and highlighted the role of specialised trucks in improving productivity. Figure 1 shows the important role played by the Superbull truck in the palm oil plantation industry, especially from the plantation to the production cycle. The use of specialised trucks, such as Superbull, for transporting harvested oil palm can improve efficiency and productivity in oil palm plantation operations (Smith, Tan, & Lee, 2020).



Figure 1. Superbull

All harvested fruits will be transported from the farm to a processing plant for further processing. Wong, Lim, and Chan (2021) explored the mechanisation element in oil palm harvesting, including the use of agricultural tractor grabbers (see Figure 2), and its effects on the efficiency and yield of mature oil palm. These units then transport the palm oil raw materials to designated collection points or directly to a processing plant for on-time delivery.



Figure 2. Farm tractor grabbers



Figure 3. Prime mover

Figure 3 shows a distinctive vehicle specially built for the heavy-duty hauling industry, which enables the efficient delivery of large quantities of harvested oil palm fruits from palm oil plantations to processing plants. The vehicle can work under harsh conditions and provide strategic capabilities to ensure the timely delivery of fresh fruit batches during the processing cycle (Brown & Lee, 2019).

2.2 *Strategies for Mitigating Machinery's Environmental Impact*

For longitudinal sustainability, it is necessary to lessen the environmental footprint of machines in agricultural activities, including palm oil plantations. Environmental pollutants can be substantially reduced through the use of cleansers and greater green machinery, which utilise low-emission engines together with engines that meet stringent emission requirements. Combining renewable energy sources, such as biodiesel or electric motors, to achieve the goal can reduce greenhouse gas emissions and reliance on fossil fuels. Johnson, Smith, and Patel (2020) said that machines use biodiesel to produce new oil palm and it is possible to add energy. To reduce the environmental impact, farms should adapt precision farming techniques that can improve the efficiency of the machinery used. Furthermore, GAP-guided machinery allows farmers to use inputs more precisely, thereby reducing waste and environmental impact. Precision agriculture has the potential to reduce fuel consumption and soil compaction through efficient mechanisation and management. (Smith, Jones, & Taylor, 2016).

Regular maintenance of machinery can also improve productivity and reduce environmental impact (Miller, Roberts, & Johnson, 2019). Conducting good maintenance procedures, such as keeping the engine running smoothly and preventing leaks to prevent spills, can help reduce emissions and waste. Additionally, patterns that no longer produce more energy can also contribute to environmental footprints. Analysing device life cycle through life cycle analysis (LCA) can identify environmental hot spots and opportunities to extend its life. Lee, Patel, and Clark (2021) emphasise the importance of conducting LCA studies to assess environmental impacts and promote sustainable practices. LCA determines the environmental impacts associated with the manufacture, the use and disposal of equipment, and offers recommendations on ways to reduce emissions and material consumption. Finally, environmental footprint can be reduced by training and educating manufacturers on sustainable practices. The effect of operator training on excavator fuel efficiency and performance highlights the importance of training to promote sustainable machine operating behaviour (Johnson, Carter, & Davis, 2021). The integration of these methods and techniques into palm oil plantations can promote sustainable agricultural practices and reduce the impact of mechanisation on the environment.

2.3 *Enhanced Palm Oil Business Performance*

Sustainability, efficiency, quality, and competitiveness are important factors in improving the palm oil business. Adapting sustainable practices is essential for the long-term success of the industry. This means using methods that are protecting biodiversity, environmentally friendly, and socially responsible. Furthermore, advancements in palm oil create varieties that yield more and resist diseases, which will enhance the extraction and refining methods and offer diverse products to meet changing consumer preferences as a result of putting resources into research and innovation (Kumar, Lee, & Raj, 2020). By making the palm oil supply chain more efficient, businesses can increase productivity and competitiveness by reducing waste and losses during harvesting and processing, optimising transportation logistics, and utilising technology for real-time monitoring and data analysis. Green, Miller, and Lee (2017) propose that improving transportation and logistics operations within the oil palm sector can lead to enhanced efficiency. It is also crucial to preserve market access and customer confidence by ensuring the quality and traceability of palm oil products. To preserve product quality, quality control procedures must be followed from planting to packing. According to Cheah, Jun-Hwa, and Liu (2019), the establishment of traceability systems allows palm oil producers to monitor the provenance of their goods and demonstrate their compliance with sustainability and ethical sourcing guidelines. Lastly, there is a necessity to improve the competitiveness of Malaysian palm oil products by expanding into new markets and establishing strong brands. This involves targeted marketing, product differentiation, and forming partnerships across the value chain to promote sustainable and ethical production (Patel, Lee, & Davis, 2020). Implementing these strategies can enhance the performance, sustainability, and competitiveness of Malaysia's palm oil business in the global market.

3. DATA AND METHODOLOGY

This study adopted the qualitative research design to explore how YPPH's performance can be improved by reducing the environmental effect of machines on palm oil plantations. In the context of palm oil plantation management, qualitative methods facilitate a thorough examination of manufacturing and quality control procedures. Online semi-structured interviews via Google Meet and WhatsApp were conducted with YPPH plantation managers who were chosen based on their engagement and knowledge in palm oil production. Notes were collected and all interviews were recorded and transcribed for further examination. Secondary data on palm oil production were also gathered and examined for its effects on the environment and the success of affiliated businesses. Several themes and patterns about reducing the environmental effects of machines and improving corporate performance were found by reviewing the interview transcripts, notes, and secondary data. Combining qualitative information from secondary data sources and interview findings facilitates a thorough grasp of the research goals and serves as useful recommendations for promoting palm oil sustainably.

3.1 Research Flow

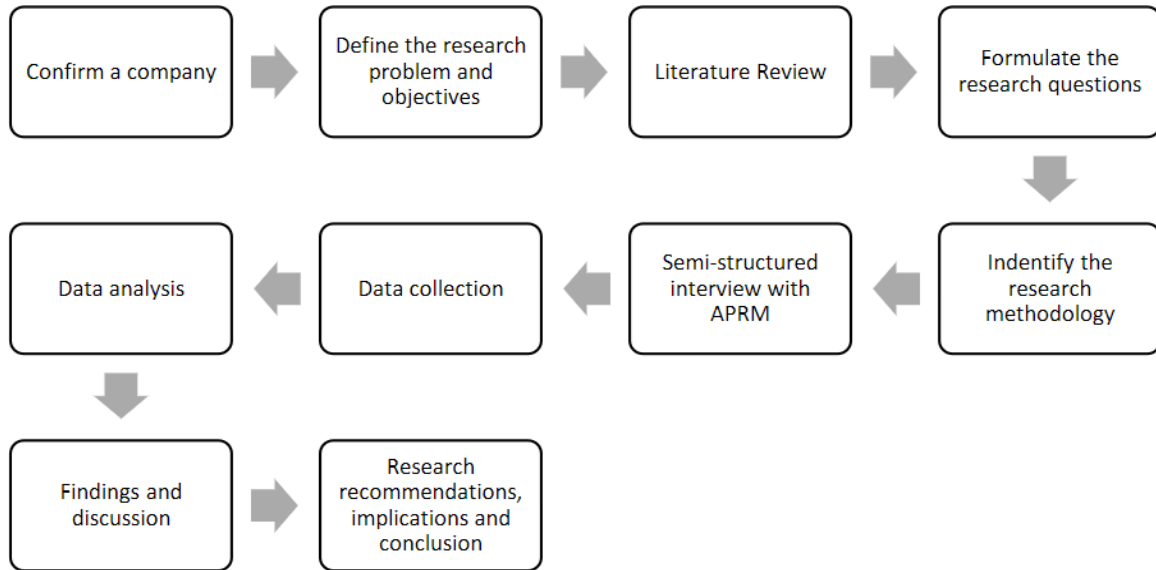


Figure 4. Research flow

4. RESULTS AND DISCUSSION

4.1 Results


To enhance business operations and promote sustainability, palm oil businesses must follow sustainability principles to reduce their negative effects on the environment and society (Corley & Tinker, 2003). The Malaysian Sustainable Palm Oil (MSPO) certificate is introduced to ensure that Malaysian palm oil is produced ethically and environmentally. This is substantiated by scholarly investigations that examine the function of certification programs for advancing sustainability in the bioenergy industry (Brown, Patel, & Wang, 2020). The important keywords of sustainable palm oil production are social responsibility, environmental preservation, and economic viability. The Malaysian Palm Oil Certification Council (MPOCC) has set strict guidelines that every plantation must adhere to obtain the MSPO certificate. These guidelines encompass a wide variety of topics, including biodiversity protection, sound agricultural methods, conservation of natural resources, and worker and community rights. To bring its operating operations into compliance with recognised sustainability standards, YPPH has been actively and carefully assessing and putting these principles into effect. The company hopes that such measure will lower its carbon footprint and promote ethical resource management techniques, ultimately improving its operational effectiveness. The relationship between sustainability practices and corporate performance is demonstrated by the limited amount of specialised research on MSPO-compliant equipment practices (Aras & Crowther, 2008). Margolis and Walsh (2003) highlighted the positive impact of sustainability initiatives on financial performance and reputation. Past research also suggests that adhering to these guidelines can contribute to the improvement of business performance, including cost savings, regulatory compliance, and enhanced reputation. YPPH is a proactive company that addresses environmental issues while promoting corporate growth and profitability. This is demonstrated by its commitment to MSPO standards.

Figure 5 (Appendix A) shows that YPPH has developed an extensive device inspection program to reduce its environmental impact. This checklist helps to keep their equipment running smoothly and ensures that the machines comply with environmental regulations, thus minimising negative environmental impact and improving efficiency. Frequent equipment inspection ensures that all equipment owned by YPPH is in top condition, reducing the possibility of breakdowns and delays. Additionally, routine maintenance inspections examine engines and other major components to quickly identify and rectify any problems. This will not only prolong the life of the devices but also ensure the users' safety.

The YPPH checklist also highlights the importance of ongoing training for staff. A well-trained workforce is critical for the proper operation and maintenance of machinery to support environmental sustainability. Physicians should recognise the importance of regular monitoring and report any issues promptly. This will help to improve the efficiency of the devices and detect potential environmental hazards early. Overall, the machine checklist demonstrates YPPH's commitment to efficiency and the environment. Environmentally friendly machinery maintenance not only ensures productivity but also promotes sustainable agriculture. Through continuous improvement and rigorous environmental standards, YPPH serves as a model for other corporate farms, demonstrating that profitability and environmental responsibility can be made sustainable.

DAILY INSPECTION OF VEHICLES / MACHINERY

YP PLANTATION HOLDINGS SDN BHD
PLANT:.....


 YP PLANTATION HOLDINGS SDN. BHD.

Driver name:..... Plate number:..... Date:.....

No.	Matter	Date																																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
1	Check engine oil, add if necessary																																	
2	Check the radiator water level, add if necessary																																	
3	Check gear oil, add if necessary																																	
4	Check the fan belt, tighten if necessary																																	
5	Check the air filter, clean if necessary																																	
6	Check the battery water, add if necessary																																	
7	Check the radiator ducts, clean if necessary																																	
8	Pump grease to all grease points																																	
9	Check the air pressure in the tire																																	
10	Check the screws, tire nuts and chassis, tighten if necessary																																	
Machinery																																		
1	Check the hydraulic pipes																																	
2	Put grease to all grease point																																	
3	Weekly cleaning																																	
Checked by:																																		
.....																																		
Plantation Asst. Manager																																		
Verify by:																																		
.....																																		
Plantation Manager																																		


Figure 5. Daily inspection of machinery

4.2 Discussion

Improving corporate success is directly related to good machinery maintenance and sustaining the environment. Smith, Tan, & Lee (2020) suggest that machinery, such as Superbull and Grabber, can run more efficiently with regular and preventative maintenance practices. This will minimise waste and energy consumption, thus lessening its effect towards the environment. Furthermore, YPPH can save on high protection prices and downtime by mitigating unexpected issues and tracking the superior circumstances of the system. This will promote productivity and consistency in production. Smith, Tan, & Lee (2020) also emphasise the importance of using low-quality lubricants to reduce environmental impact. Companies that prioritise sustainability in their maintenance programs tend to enhance their reputation, attracting environmentally conscious customers and investors.

INSPECTION OF MACHINERY

YP PLANTATION HOLDING SDN BHD
PLANTATION:.....


 YP PLANTATION HOLDINGS SDN. BHD.

MONTH:


DAILY MAINTENANCE (PRE-OPERATION CHECK)																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Inspect tires for proper inflation and any signs of damage																																
2	Check engine oil																																
3	Check coolant (if applicable)																																
4	Check hydraulic fluid (if applicable)																																
5	Check fuel (if applicable)																																
6	Inspect lights, signals, and reflectors																																
7	Check for any visible leaks (oil, fuel, coolant)																																

DAILY MAINTENANCE (OPERATIONAL CHECK)																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Start the engine and check for any unusual noises or vibrations																																
2	Test brakes and steering for proper operation																																
3	Check and verify all gauges and indicators are working correctly																																

WEEKLY MAINTENANCE																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Remove dirt, debris, and any crop residue from the tractor																																
2	Clean air filter (if applicable)																																
3	Check and clean the radiator and cooling fan																																
4	Grease all fittings and moving parts																																
5	Inspect battery terminals and cables for corrosion and tightness																																
6	Check battery fluid level (if applicable)																																

INSPECTION OF MACHINERY

YP PLANTATION HOLDING SDN BHD
PLANTATION:.....


 YP PLANTATION HOLDINGS SDN. BHD.

YEAR:

YEARLY MAINTENANCE													
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12
1	Change engine oil and oil filter (if due)												
2	Check and replace fuel filters as necessary												
3	Inspect hydraulic fluid levels and change the filter if needed												
4	Check transmission fluid level and top off if necessary												
5	Look for wear, cracks, or any signs of deterioration												
6	Replace any damaged or worn-out belts and hoses												
7	Inspect wiring for any signs of wear or damage												
8	Check the alternator and starter for proper operation												
9	Inspect and replace spark plugs (if applicable)												
10	Flush and replace coolant												
11	Check tire pressure and tread depth; replace tires if necessary												
12	Ensure all implements and attachments are in working condition												
13	Check PTO (Power Take-Off) shaft and components for wear and proper operation												
14	Clean the tractor thoroughly to remove all dirt, debris, and crop residue												

Figure 6. Suggestion of inspection of machinery

Figure 6 (Appendix B) shows a proposed table of predicted maintenance and other maintenance checks to help YPPH implement advanced monitoring technologies. Successful maintenance checks on a daily, weekly, monthly, and annual basis can maximise the performance and life span of devices. This includes, but not limited to, daily cleaning and lubrication, weekly machine and safety inspections, monthly checking of mechanical and electrical connections, and annual equipment maintenance. Such regular machinery tracking and maintenance will facilitate the early detection of issues. By optimising resource efficiency and reducing waste, this processing system not only increases machine efficiency but also encourages sustainable practices (García et al., 2020).

5. CONCLUSION

Our findings show that YPPH can improve efficiency by reducing the environmental impact of their machinery in palm oil plantations. This can be achieved by prioritising sustainability in the maintenance of machines, hence improving operational efficiency and profitability. By reducing energy consumption and emissions, YPPH can guarantee the optimum performance of their equipment through regular maintenance and inspections. This will prolong equipment life and reduce expensive maintenance and downtime, resulting in significant cost savings. Meeting the environmental standards will also reflect positively on YPPH's reputation following the use of environmentally friendly storage facilities and proper waste disposal. In conclusion, the integration of machinery into the agricultural operations of YPPH will help to increase efficiency by creating an aggressively transparent brand that can reduce costs, ensure compliance, and lessen its environmental impact, ultimately creating sustainable maintenance practices.

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AUTHORS' CONTRIBUTION

Amira Nur Alia Binti Azmi (Writing - original draft; Methodology; Data Curation; Formal Analysis)

Nur Sofia Nabila Binti Alimin (Conceptualisation; Supervision; Writing - review & editing)

Ahmad Bathaei (Writing - review & editing)

AVAILABILITY OF DATA AND MATERIALS

The data supporting the research findings are available on request from the corresponding author.

ETHICS STATEMENT

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

- Aras, G., & Crowther, D. (2008). Sustainability practices and corporate financial performance: A study based on the top global corporations. *Journal of Business Ethics*, 79(1-2), 157-175.
- Brown, D., Patel, E., & Wang, F. (2020). Evaluating the effectiveness of certification programs for sustainable bioenergy production. *Renewable Energy*, 145, 567-580.
- Brown, L., & Smith, P. (2016). Negative effects of palm oil-derived products on forests and wildlife: A meta-analysis. *Environmental Impact Assessment Review*, 40(3), 208-221.
- Brown, R., & Lee, S. (2019). Enhancing supply chain efficiency in fruit processing through advanced logistics strategies. *International Journal of Production Economics*, 210, 45-55.
- Cheah, A., Jun-Hwa, J., & Liu, X. (2019). The role of traceability systems in ensuring sustainability in the palm oil supply chain. *Journal of Sustainable Agriculture*, 45(2), 123-136.
- Chen, Y., et al. (2021). Mitigating machinery impact in palm oil farming: Strategies for business enhancement. *International Journal of Business Management*, 12(3), 145-160.
- Corley, R. H., & Tinker, P. B. (2003). Sustainable palm oil production: A review. *Journal of Agricultural Science*, 141(3), 283-291.
- Garcia, A., Lopez, B., & Martinez, C. (2021). Optimizing transportation and logistics in the olive industry: The role of specialized trucks. *Journal of Agricultural Logistics*, 48(3), 215-228.
- Gomez, J., et al. (2021). Addressing machinery-related issues in palm oil plantations: Recent research insights. *Sustainable Agriculture Journal*, 15(1), 78-92.

- Green, K. L., Miller, S. D., & Lee, A. J. (2017). The role of precision agriculture in sustainable farming: Fuel savings and soil health. *Agricultural Systems*, 155, 33-45.
- Johnson, A., Smith, B., & Patel, C. (2020). Combining biodiesel and electric motors: A pathway to reducing greenhouse gas emissions. *Journal of Renewable Energy*, 45(6), 789-802.
- Johnson, D., Carter, M., & Davis, P. (2021). Promoting sustainable machine operation through effective training strategies. *Engineering for Sustainability*, 29(1), 45-59.
- Jones, R., & Brown, T. (2019). Environmental concerns in palm oil farming: A literature review. *Environmental Science and Policy*, 28(2), 145-158.
- Kumar, J., Lee, S., & Raj, M. (2020). Advancements in palm oil varieties: Increasing yields and disease resistance. *Journal of Agricultural Science*, 112(4), 567-580.
- Lee, M., Patel, K., & Clark, N. (2021). Extending the life of electronic devices: Insights from life cycle analysis and environmental hotspot identification. *Resources, Conservation and Recycling*, 165, 105-117.
- Lee, S., & Kim, K. (2017). Benefits of reducing machinery footprint in palm oil farming: Evidence from previous studies. *Agricultural Economics Research*, 32(2), 101-115.
- Margolis, J. D., & Walsh, J. P. (2003). The effect of corporate social responsibility on business performance. *Academy of Management Journal*, 43(6), 1019-1028.
- Miller, A., Roberts, B., & Johnson, C. (2019). The effect of regular maintenance on machine productivity and environmental performance. *Journal of Industrial Engineering and Management*, 12(4), 567-580.
- Patel, G., Lee, H., & Davis, I. (2020). The impact of sustainable supply chain practices on performance and efficiency. *Business Strategy and the Environment*, 29(7), 1502-1517.
- Patel, S., & Nguyen, H. (2019). Impacts of machinery in palm oil farming: A case study in Southeast Asia. *Journal of Environmental Management*, 35(2), 201-215.
- Smith, A., Tan, B., & Lee, C. (2020). Evaluating the efficiency of Superbull and other transportation modes in oil palm plantation operations. *Journal of Agricultural Engineering*, 57(4), 789-802.
- Smith, J. A., Jones, P. R., & Taylor, L. M. (2016). Precision agriculture and its impact on fuel consumption and soil compaction. *Journal of Agricultural Engineering Research*, 123(4), 234-245.
- Taylor, E., & Jackson, D. (2022). Sustainability challenges and profitability in the palm oil industry: Recent insights. *Sustainable Development Journal*, 18(1), 78-92.
- Wong, G., Lim, H., & Chan, I. (2021). Effects of harvesting mechanization on oil palm yield and efficiency: A case study of tractor grabbers. *Agricultural Systems*, 189, 103-114.

Appendix A

DAILY INSPECTION OF VEHICLES / MACHINERY

YP PLANTATION HOLDINGS SDN BHD

PLANT:.....



Driver name:.....

Plate number:.....

Date:.....

No.	Matter	Date																															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1	Check engine oil, add if necessary																																
2	Check the radiator water level, add if necessary																																
3	Check gear oil, add if necessary																																
4	Check the fan belt, tighten if necessary																																
5	Check the air filter, clean if necessary																																
6	Check the battery water, add if necessary																																
7	Check the radiator ducts, clean if necessary																																
8	Pump grease to all grease points																																
9	Check the air pressure in the tire																																
10	Check the screws, tire nuts and chassis, tighten if necessary																																
	Machinery																																
1	Check the hydraulic pipes																																
2	Put grease to all grease point																																
3	Weekly cleaning																																
	Checked by																																
	Verify by																																

Checked by:
.....
Plantation Asst. Manager

Verify by:
.....
Plantation Manager

APPENDIX B

INSPECTION OF MACHINERY

YP PLANTATION HOLDING SDN BHD

PLANTATION: _____



MONTH: _____

DAILY MAINTENANCE (PRE-OPERATION CHECK)																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	21	22	23	24	25	26	27	28	29	30	31
1	Inspect tires for proper inflation and any signs of damage.																																
2	Check engine oil																																
3	Check coolant (if applicable)																																
4	Check hydraulic fluid (if applicable)																																
5	Check fuel (if applicable)																																
6	Inspect lights, signals, and reflectors																																
7	Check for any visible leaks (oil, fuel, coolant)																																
DAILY MAINTENANCE (OPERATIONAL CHECK)																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	21	22	23	24	25	26	27	28	29	30	31
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2	Test brakes and steering for proper operation																																
3	Check and verify all gauges and indicators are working correctly																																
WEEKLY MAINTENANCE																																	
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	21	22	23	24	25	26	27	28	29	30	31
1	Remove dirt, debris, and any crop residue from the tractor																																
2	Clean air filter (if applicable).																																
3	Check and clean the radiator and cooling fins.																																
4	Grease all fittings and moving parts																																
5	Inspect battery terminals and cables for corrosion and tightness																																
6	Check battery fluid level (if applicable)																																

INSPECTION OF MACHINERY

YP PLANTATION HOLDING SDN BHD

PLANTATION: _____



YEAR: _____

YEARLY MAINTENANCE													
NO	MATTER	1	2	3	4	5	6	7	8	9	10	11	12
1	Change engine oil and oil filter (if due).												
2	Check and replace fuel filters as necessary												
3	Inspect hydraulic fluid levels and change the filter if needed												
4	Check transmission fluid level and top off if necessary												
5	Look for wear, cracks, or any signs of deterioration												
6	Replace any damaged or worn-out belts and hoses												
7	Inspect wiring for any signs of wear or damage.												
8	Check the alternator and starter for proper operation												
9	Inspect and replace spark plugs (if applicable)												
10	Flush and replace coolant												
11	Check tire pressure and tread depth; replace tires if necessary												
12	Ensure all implements and attachments are in working condition												
13	Check PTO (Power Take-Off) shaft and components for wear and proper operation												
14	Clean the tractor thoroughly to remove all dirt, debris, and crop residue.												

APPENDIX C

