



Original Research Article

Factors Influencing the Implementation of Good Agricultural Practices (GAP) Among Independent Palm Oil Smallholders in Selangor

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Abstract: Palm oil is one of the most important agricultural commodities in Malaysia, and independent smallholders play a critical role in the sector's output and rural livelihoods. However, their productivity remains constrained by partial and uneven implementation of Good Agricultural Practices (GAP), despite long-standing efforts by public agencies to promote these practices. This study investigates the factors influencing the implementation of GAP among independent oil palm smallholders in Selangor. A cross-sectional survey was conducted between January and March 2019 using a structured, interviewer-administered questionnaire. A total of 120 usable responses were obtained from a simple random sample of independent smallholders drawn from a list provided by MPOB TUNAS. Implementation of GAP was measured as a composite score derived from five Likert-type items covering key practice domains, while age, perceived finance, labour, time, and knowledge were measured using single items. Descriptive statistics and multiple linear regression were employed to analyse the data. The results show that finance is the only variable with a statistically significant positive effect on the implementation of GAP, while age, labour, time, and knowledge are not significant predictors. These findings suggest that financial constraints are a more binding barrier to GAP implementation than basic knowledge or time-related limitations. The study provides empirical evidence to support more targeted extension strategies and financial support mechanisms, such as grants, soft loans, or cost-sharing schemes, to enable independent smallholders to implement GAP and strengthen the sustainability of Malaysia's palm oil sector.

Keywords: GAP; Smallholders; Palm Oil; Finance; Implementation.

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1. Introduction

1.1. Overview of the Malaysian Palm Oil Sector

A perennial tropical tree, the oil palm (*Elaeis guineensis*) is native to West Africa. In the early 1870s, the British introduced this palm tree to Malaysia as a decorative plant, which later developed into commercial plantations and a well-established industry. The fruits are like large reddish plums, grouped in substantial clusters, and can be harvested year-round as they ripen on each tree every 7–10 days. Each fruitlet consists of a hard seed wrapped in an endocarp, which is surrounded by a fleshy mesocarp. The seed and flesh yield oil when crushed at the mill, resulting in Crude Palm Oil (CPO). This oil undergoes refining and fractionation to produce Refined Bleached Deodorised Palm Oil (RBDPO), widely recognised as cooking oil globally. These processes also produce other by-products, including Refined Bleached Deodorised Palm Stearine and fatty acids, which are used in food processing and the oleochemical industry.

The oil palm industry has played a crucial role in the expansion of Malaysia's agricultural sector, affecting Gross Domestic Product (GDP), foreign exchange earnings through trade, and employment levels. The palm oil produced in Malaysia is exported to over 160 countries, including India, European countries, and China, and accounts for nearly 50% of the country's overall agricultural GDP. The Malaysian palm oil industry, which has developed rapidly over the last four decades, has witnessed increasing production volumes, especially through land exploration during the early years of expansion. Recent data indicate that Malaysia's palm oil production continues to outperform many other producing countries, with Malaysia achieving an FFB yield of 16.70 tonnes per hectare, with an oil extraction rate around 19%, compared to Indonesia's average of around 3.19 tonnes per hectare (MPOB, 2025; USDA FAS, 2024). However, as the industry faces insufficient land available for new cultivation, it is important to increase productivity within existing plantations. The adoption of Good Agricultural Practices (GAP) is one way to accomplish these objectives. Stakeholders have identified GAP as a critical intervention for bridging yield gaps in existing palm oil plantations (Mohd Suib *et al.*, 2023).

The two main players in Malaysia's oil palm plantation sector are large plantations/estates and smallholders. The smallholders can further be categorised into organised smallholders, who operate under the auspices of federal or state government agencies such as FELDA, RISDA, and FELCRA, and independent smallholders, who operate

their plantations individually. The Malaysian Palm Oil Board (MPOB), a government agency, has been entrusted with conveying information and technologies and providing advisory services to these independent smallholders, but is not directly involved in their operations and sales. The distribution of palm oil area by producer categories is illustrated in Table 1 below.

Table 1. Oil Palm Plantation Area Distribution by Category, 2022 (Hectares)

Category	2022	
	Hectares	%
Independent Smallholders	816,107	14.4
Organized Smallholders	667,868	11.8
Private and Government Agency Estates	4,190,766	73.8
Total	5,674,742	100.0

Source: MPOB (2023)

The independent smallholders account for just over 14% of the total land area planted with oil palm, about 800,000 hectares. Although independent smallholders constitute only 14% of the total land area, it is surprising that more than 350,000 smallholders cultivate oil palm across the country. Table 2 shows the breakdown of areas planted by independent smallholders by state in 2022.

Table 2. Independent Oil Palm Smallholders (ISH) in Malaysia (by planted areas), 2022

State	Hectares
Johor	147,342
Kedah	24,112
Kelantan	7,100
Melaka	9,738
Negeri Sembilan	21,044
Pahang	40,543
Perak	79,799
Perlis	159
Pulau Pinang	5,294
Selangor	19,233
Terengganu	11,089
Sabah	200,965
Sarawak	249,645
Total	816,107

Source: MPOB (2023)

Independent smallholders have more autonomy to decide on the land's usage, the variety of palm oil seeds to plant and the way to manage them. They operate (i.e., produce and sell) on their own, without any contracts with any mill or alliance. This group of smallholders occasionally receives support and extension services from government agencies, mostly the Malaysian Palm Oil Board (MPOB) (Vermeulen & Goad, 2006). Independent smallholders are small-scale production entities and are often characterised as inefficient and unproductive (Ab Rahman *et al.*, 2008; Bakhtary *et al.*, 2021). Although independent smallholders cultivate a much larger land area than smallholders under schemes (Vermeulen & Goad, 2006), independent smallholders typically achieve lower average yields, highlighting the need for improved practices and resources.

According to Ab Rahman *et al.* (2008), because they are not bound to any plantation scheme, they have limited access to assistance such as credit services, high-quality seedlings, fertiliser, and training. This contributes, to some extent, to the lower productivity of this group, as they produce lower-quality crops in smaller volumes (Petri *et al.*, 2024). They usually rely on traders and middlemen to purchase their fruits and transport them to local mills, rather than selling them directly to the mills (Nagiah & Azmi, 2013). This makes them more susceptible to volatility in FFB market prices. The uncertainties, in return, to a certain extent, affect the way in which the plantations are managed. Smallholders reportedly use any available seedlings on the market, regardless of quality, when cultivating new trees. The management of day-to-day plantation operations, such as fertiliser application and harvesting, is also not carried out on schedule and does not adhere to standard guidelines and procedures. It leads to insufficient nutrient supply to palm trees and unscheduled FFB harvesting (Ab Rahman *et al.*, 2008; de Vos *et al.*, 2023). Although smallholders have relatively low average production, they contribute a substantial volume of production and have played a significant role in the development of Malaysia's overall palm oil industry. Thus, it is important to understand their plantation practices to enhance their productivity and sustainability.

One way to improve yields is to refine farm practices, such as improved pruning methods, monitoring of irrigation and fertilisation routines, and pest and disease control (Donough *et al.*, 2009; Fairhurst & McLaughlin, 2009). GAP, especially the one that is fine-tuned to the oil palm cultivation, can be one of the ways in which the productivity of oil palm plantations can be enhanced (Mohd Suib *et al.*, 2023). However, according to Ismail *et al.* (2003), knowledge and awareness regarding GAP remain very low among smallholders, who do not realise that certain oil palm cultivation practices may have negative environmental effects. At the same time, smallholder farmers often lack sufficient agronomic knowledge. In addition, smallholders are vulnerable because they have little to no information about FFB market prices, pricing policies, and market opportunities (Vermeulen & Goad, 2006). Besides that, most smallholders lack proper documentation of their farming activities. This is either because they do not realise the benefits of properly recording and monitoring their plantation activities, or because they lack the knowledge and expertise to do so. This circumstance

prevents them from knowing the exact costs paid and the net profit earned. Training will be required to bridge this knowledge gap and is a critical aspect of assisting smallholders in implementing GAP (Mansor *et al.*, 2021).

Sustainable palm cultivation methods, which encompass sound agricultural practices, should be implemented to ensure the safe, high-quality production of palm oil, as per Wahid (2009). Broader debates on the social, environmental and economic implications of oil palm expansion highlight both significant risks and opportunities for producer countries (Sheil *et al.*, 2009). Furthermore, the production of high-quality palm oil can be facilitated by the following: the planting of high-quality oil palm seedlings, the application of fertiliser at appropriate rates, the control of soil erosion, the reduction of chemical use through integrated pest management, and the harvesting of ripe fruit bunches. MPOB has been trying to train the smallholders in GAP to develop sustainable palm oil cultivation practices. MPOB has launched the Palm Industry Code of Practice, which covers the palm oil production chain and focuses on GAP (Dahari *et al.*, 2011). According to Mohd Suib *et al.* (2023), plantation productivity could be enhanced, and production costs optimised for those who follow GAP.

1.2. Good Agricultural Practices (GAP)

According to the Food and Agriculture Organisation of the United Nations (FAO, 2003, 2007), the Good Agricultural Practices (GAP) approach is a recommendation to “*address environment, economic and social sustainability for on-farm production and post-production process resulting in safe and quality food and non-food agricultural products*”. Foundational guidance from the Food and Agriculture Organisation (FAO) frames GAP around the effective management of four core domains, which are soil, water, land, and contact surfaces and equipment to safeguard food safety and quality while sustaining agroecosystem functions and labour welfare (FAO, 2003, 2007). In operational terms, GAP advances risk-based management throughout the production chain, encouraging practices such as integrated pest management, integrated nutrient/fertiliser management, and conservation agriculture to optimise productivity without compromising ecological integrity or social objectives (FAO, 2007). Subsequent work has reinforced GAP's role as an operational framework for sustainable agriculture and food systems (FAO, 2016; Kharel & Parajuli, 2022).

Aligned with this framing, GAP can be conceptualised as a coherent hazard-management system that systematically identifies and controls risks associated with land, inputs, processes, and outputs, thereby delivering simultaneous gains in productivity, sustainability, quality, and safety (Othman, 2006). Malaysia has institutionalised these principles through public schemes such as Skim Amalan Ladang Baik Malaysia (SALM) and the national standard MS 1784:2016 for crop commodities (Department of Standards Malaysia, 2016), thereby translating GAP into auditable criteria for producers and post-farm handlers and providing credible indicators for downstream enterprises and consumers. Within the palm oil sector, the Malaysian Government and the Malaysian Palm Oil Board

(MPOB) have adopted the GAP framework as an industry-appropriate certification model intended to be accessible to estates and, critically, to smallholders, with the dual aims of enhancing productivity and ensuring adherence to environmental management requirements.

Under myGAP, oil palm smallholders are assessed against a set of farm-level criteria that translate the generic GAP principles into concrete management requirements. For the purposes of this study, the implementation of GAP was evaluated in six key domains that reflect the MPOB and Department of Agriculture guidance: (i) planting materials and field establishment (use of quality seedlings, appropriate spacing and upkeep of planting points); (ii) nutrient and fertiliser management (timely and appropriate fertiliser application based on field conditions); (iii) weed and groundcover management (maintenance of beneficial cover crops and control of competing weeds); (iv) integrated pest and disease management (monitoring and control of major pests and diseases using recommended practices); (v) harvesting and post-harvest handling (harvesting of ripe fresh fruit bunches, proper field collection and timely delivery to mills); and (vi) record-keeping and basic farm administration (maintaining farm records on inputs, yields and key field operations). Together, these domains capture the core agronomic and managerial practices that determine the productivity and sustainability of independent smallholder oil palm production.

Despite the availability of these guidelines, recent evidence suggests that the implementation of GAP among independent smallholders remains partial and uneven across domains. Studies in different Malaysian regions report that smallholders are more likely to adopt visible practices such as basic field upkeep and harvesting routines, but they lag in more knowledge-intensive requirements such as record-keeping, fertiliser planning and integrated pest management (e.g., Ismail *et al.*, 2003; Mansor *et al.*, 2021). Inadequate implementation can translate into lower and more variable yields, higher unit production costs and increased risks of off-site environmental impacts, all of which may weaken the competitiveness of smallholders in a market that is increasingly responsive to sustainability assurances such as myGAP and the Malaysian Sustainable Palm Oil (MSPO) certification (e.g., Mohd Suib *et al.*, 2023; Petri *et al.*, 2024). Recent studies underline that certification schemes such as MSPO can significantly reduce environmental impacts and improve profitability for independent smallholders, but uptake remains constrained by financial and organisational barriers (Kannan *et al.*, 2020; Bok *et al.*, 2022). More recent evidence also highlights low but gradually increasing adoption of myGAP and other sustainability standards among Malaysian smallholders, shaped by farm size, education and regional factors (Maspan & Halimoon, 2024; Khazanah Research Institute, 2024). Understanding the status of GAP implementation and the factors associated with higher adoption among independent smallholders in Selangor is therefore important for designing more targeted extension and support interventions.

Othman (2006) indicates that the Department of Agriculture (DOA) is instrumental in the extension programs in Malaysia. To achieve the goals of sustainable agriculture and rural development, several initiatives have been implemented for palm oil smallholders,

particularly independent smallholders. One of the objectives of the training program is to increase the awareness of GAP among smallholders and aid them in implementing the practice. Given evidence that many independent smallholders still only partially comply with GAP requirements (Mansor *et al.*, 2021), it is important to assess progress and the factors influencing GAP implementation among this group.

2. Materials and Methods

Figure 1 presents the conceptual framework used in this research. This framework describes the interrelated concepts and variables between the independent variable (IV) and the dependent variable (DV). There are 5 variables selected for investigation: Age, Finance, Labour, Time, and Knowledge.

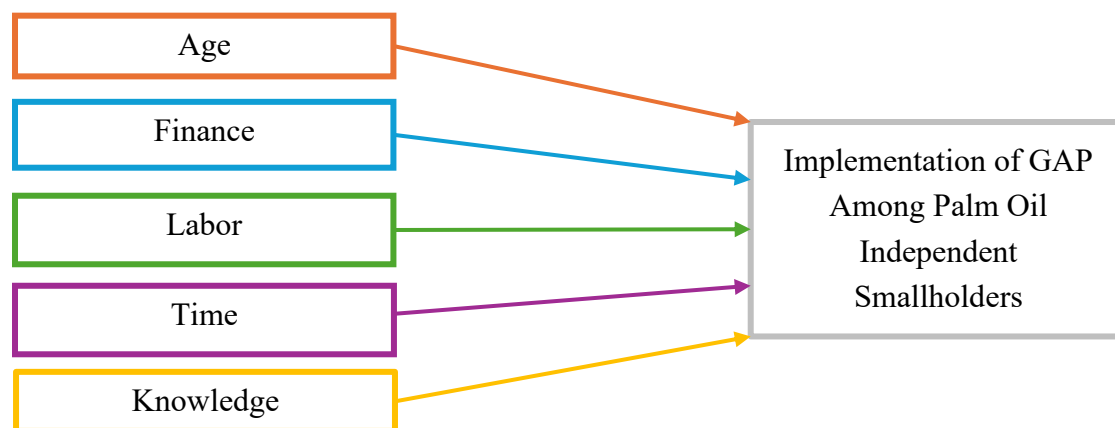


Figure 1. Conceptual Framework

Data were collected from independent smallholders in Selangor, Malaysia. Selangor was chosen for this study because it is considered a quite well-developed state in Malaysia. Therefore, it was assumed that the smallholders in this area would have received at least a basic level of primary education. Since the study seeks to investigate the implementation of GAP (rather than awareness), the authors agree that this characteristic is essential in choosing the sample. As of 2022, the number of independent smallholders in Selangor was estimated at just above 5,000, cultivating approximately 19,233 ha in total.

A survey method was used to gather the necessary information and data for the study. A closed-ended questionnaire was prepared and distributed during the personal interview. The number of questionnaires distributed was 400 sets. Given that the population exceeds 5,000, the population size is largely inconsequential, making a sample size of 400 sufficient (Sekaran & Bougie, 2010). The sampling technique used for the study was simple random sampling from the list of smallholders obtained from MPOB TUNAS. Response rate was 30%, i.e. 120 responses. The field survey was implemented over a three-month period between January and March 2019, during which trained enumerators administered the

questionnaire through face-to-face interviews with independent smallholders at MPOB's TUNAS service centres and selected villages within the study area. The questionnaire design was classified into four sections, which include:

- Basic demographic information. It consists of the respondent's profile, including gender, race, age, marital status, education level, monthly income, profession, household size, and sources of income, among others.
- The level of GAP implementation among smallholders.
- Factors that influence smallholders to implement Good Agricultural Practices (GAP). Questions are asked about cost, educational level (knowledge) and age that affected the production. The questions are also based on GAP codes, such as fertiliser management, farm management, weed management, cutting management, pest protection and disease control, harvesting, soil management, and record-keeping.
- The last section is about the opinions or views of smallholders about GAP

2.1. Operational Definitions and Measurement

Implementation of GAP was measured using a set of six Likert-type items in Section C of the questionnaire which asked respondents to indicate the extent to which they currently carry out recommended practices for (i) planting materials and field establishment, (ii) nutrient and fertiliser management, (iii) weed and groundcover management, (iv) pest and disease management, (v) harvesting and post-harvest handling and (vi) record-keeping on their oil palm plots. Each item was rated on a five-point scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). An overall implementation score was calculated for each respondent as the arithmetic mean of these six items, with higher scores indicating more comprehensive implementation of GAP. This continuous implementation score served as the dependent variable in the regression analysis.

Age was recorded in years and subsequently grouped into three categories (31–40 years, 41–50 years and ≥ 51 years) following the original project report classification. For the regression analysis, these categories were coded ordinally (1 = 31–40; 2 = 41–50; 3 = ≥ 51), so that a higher value reflects an older age group. Perceived financial capacity ("finance") was measured with a single item asking respondents to rate their agreement that they had adequate financial resources to implement recommended GAP practices (for example, purchasing quality planting materials, fertilisers and other inputs) on a five-point Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). Perceived labour availability ("labour") captured the extent to which respondents felt they had sufficient workers or family labour to carry out GAP activities on time, while perceived time availability ("time") captured whether respondents felt they had adequate time to supervise and manage their oil palm plots; both were measured with single five-point Likert items, with higher scores indicating greater perceived availability. Finally, "knowledge" was measured using a single five-point Likert-

scale item reflecting respondents' self-rated knowledge of GAP requirements for oil palm cultivation, with higher scores indicating greater perceived knowledge.

In line with this measurement strategy, age, finance, labour, time and knowledge are treated as single-item predictors that represent distinct aspects of farmers' resource endowments and capabilities, whereas implementation of GAP is treated as a multi-item scale representing the overall level of practice implementation at the farm level. The data were analysed using descriptive statistics and multiple linear regression in SPSS to examine the relationships between the independent variables and the continuous implementation of the GAP score.

3. Results and Discussions

Table 3 presents the demographic data of the respondents. More than 60% of the respondents are aged 51 and above. This is representative of the general smallholder population in Malaysia. The other 20% are aged between 41 and 50, and the remaining 17.5% are aged between 31 and 40. Most respondents are Malay, i.e., about 85% of the total. According to the table, only 20% of the respondents had no formal education, while the other 80% had at least a primary school-level education, of whom 5% had received a tertiary education. The responses were also dominated by married people, with almost 87% of respondents being married.

Table 3. Demographic data of respondents

Demographic Variable	Frequency	Percentage (%)
Gender		
- Male	95	79.2
- Female	25	20.8
Age		
- 31–40 years	21	17.5
- 41–50 years	24	20.0
- More than 51 years	75	62.5
Race		
- Malays	102	85.0
- Chinese	14	11.7
- Indian	4	3.3
Level of Education		
- No education	24	20.0
- UPSR	53	44.2
- PMR/SPM	35	29.2
- Certificated	2	1.7
- Degree	6	5.0

Demographic Variable	Frequency	Percentage (%)
Marital Status		
- Bachelor	4	3.3
- Married	104	86.7
- Divorced	3	2.5
- Others	9	7.5
Number of Households		
- Less than 2	16	13.3
- 2–4	57	47.5
- 5–8	42	35.0
- More than 8	5	4.2
Current Jobs		
- Smallholders	70	58.3
- Government	11	9.2
- Private	13	10.8
- Retired	18	15.0
- Housewife	8	6.7
Category of Smallholders		
- Full-time	90	75.0
- Part-time	29	24.2
- Others	1	0.8
Monthly Income		
- Less than RM 1000	24	20.0
- RM 1000 to RM 4000	83	69.2
- RM 5000 to RM 8000	13	10.8

The data also show that almost 60% of the respondents work only as smallholders, while the others are either retired, housewives, or involved in some form of government or private employment. Of these respondents, 75% operate oil palm plantations full-time. These are mainly those who reported their current job as a smallholder, retiree, or housewife. Since 75% of the respondents handle their plantations full-time, the answers to the questionnaires can be considered reliable, as minimal plantation management is outsourced, meaning they know the plantation practices quite intimately. Lastly, in terms of monthly income, where 80% of the respondents have a household income of more than RM1,000.

Table 4. Reliability of implementation of the GAP scale

Construct	Number of items	Cronbach's alpha
Implementation of GAP	6	0.864

A reliability test was conducted to assess the internal consistency of the multi-item scale measuring GAP implementation. Cronbach's alpha was computed for the six items in Section C that capture implementation of GAP across the key practice domains. The resulting alpha coefficient was 0.864, exceeding the commonly accepted threshold of 0.70 (Sekaran & Bougie, 2010) and indicating satisfactory internal consistency for the implementation scale. The predictor variables age, finance, labour, time and knowledge were measured using single items and therefore were not subjected to Cronbach's alpha; their content validity was established through expert review and pre-testing of the questionnaire.

The final analysis used regression to examine the relationship between the independent and dependent variables. A multiple linear regression was conducted to predict these relationships.

Table 5. Regression statistics

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1	0.410 ^a	0.168	0.131	0.34130

Table 6. ANOVA

Model	Sum of Square	df	Mean Square	F	Sig.
1 Regression	2.676	5	0.535	4.595	0.001 ^a
Residual	13.280	114	0.116		

Table 7. Coefficient

	Beta	T	Sig.
Age	-0.054	-0.301	0.764
Finance	0.249	2.162	0.033
Labor	0.043	0.259	0.796
Time	0.258	1.121	0.265
Knowledge	-0.066	-0.55	0.573

A significant regression equation was obtained, as shown in Table 1.6 ($F(5, 114) = 4.595, p < 0.001$), indicating that the set of predictors jointly explains a statistically significant proportion of the variance in the implementation of GAP. The model summary in Table 1.5 reports an R^2 value of 0.168, indicating that approximately 16.8% of the variation in the implementation of GAP among independent smallholders is explained by age, finance, labour, time and knowledge. The estimated regression coefficients are presented in Table 1.7. Among the five predictors, only finance has a statistically significant positive effect on GAP implementation ($\beta = 0.249, p = 0.033$), suggesting that smallholders with greater financial capacity tend to achieve higher levels of GAP implementation. In contrast, age, labour, time and knowledge do not exhibit statistically significant effects in this sample.

4. Conclusions

According to this study, finance plays a significant role in the implementation of GAP among independent oil palm smallholders in Malaysia. This is closely related to the fact that, among all oil palm growers, this group has the least access to finance to change their plantation practices. The big estates normally have sufficient funding to implement good plantation practices such as GAP, while the organised smallholders normally receive training and access to funding through the agencies responsible for them. Thus, to ensure the successful implementation of good practices such as GAP in plantations operated by independent smallholders, governments, probably through agencies such as MPOB and DOA, could provide financial aid in the form of grants or loans to interested and trained groups of smallholders.

Beyond confirming the central role of finance, this study also contributes empirically to the limited literature on GAP implementation among independent oil palm smallholders in Malaysia. By focusing on a relatively well-developed state such as Selangor, the analysis shows that even where basic education and physical infrastructure are comparatively favourable, a sizeable share of smallholders still report only moderate levels of GAP implementation. The regression results, which highlight finance as the only statistically significant predictor once age, labour, time and knowledge are controlled for, suggest that awareness and basic knowledge alone are insufficient; smallholders also require the financial capacity to invest in inputs and labour to translate GAP messages into practice.

These findings complement recent policy discussions on myGAP and MSPO by providing farm-level evidence on the conditions under which independent smallholders can adopt recommended practices. They underline the importance of coupling technical extension on GAP with accessible, appropriately designed financial support instruments, such as soft loans, grants, or cost-sharing schemes, targeted at independent smallholders who are willing to adopt recommended practices but lack capital. Such support can help close the implementation gap and, in turn, enhance the productivity, resilience and sustainability performance of independent smallholder oil palm in Malaysia. These findings are consistent with broader regional evidence that independent smallholders' ability to invest in farm improvements and to comply with sustainability standards depends strongly on their financial resilience and access to cost-reduction mechanisms (Hendrawan *et al.*, 2024; Irawan *et al.*, 2024), which reinforces the central role of finance observed in this study.

This study has several limitations that should be acknowledged. First, the sample is confined to independent smallholders in Selangor and was obtained using a structured survey of 120 respondents; therefore, the findings may not be fully generalisable to independent smallholders in other Malaysian states with different institutional or biophysical conditions. Second, the cross-sectional research design and reliance on self-reported information on GAP practices mean that causal inferences cannot be drawn, and some responses may be affected by recall or social desirability bias. Third, while the study includes key farmer-level factors

such as age, perceived finance, labour, time and knowledge, it does not explicitly cover other potentially important determinants of GAP implementation, including land tenure security, exposure to private buyers or mills, the strength of farmer organisations or detailed farm-level profitability. Future research could address these limitations by combining farm-level surveys with field observations of GAP compliance, panel data on smallholder performance, and a broader set of explanatory variables that capture institutional and market drivers.

Author Contributions: Fazlin Ali led the overall research design, supervised the fieldwork, and drafted the initial version of the manuscript. Aleisha Julia Deme Anak Julin contributed to the coordination and implementation of field data collection. Nur Syuhada Binti Othaman Alek assisted in developing the questionnaire and preparing the original project report on which this manuscript is based. Kelly Wong Kai Seng contributed to the development and validation of the research instrument. Abdul Rahman Saili supported formal statistical analysis and interpretation of the data. Zanurul Huzaima Zainudin conducted additional data analysis and substantially revised and refined the manuscript for journal submission. Omer Thabit support.

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References

- Ab Rahman, A. K., Abdullah, R., Mohd Shariff, F., & Simeh, M. A. (2008). The Malaysian palm oil supply chain: The role of the independent smallholders. *Oil Palm Industry Economic Journal*, 8(2), 17–27. <http://palmoilis.mpob.gov.my/publications/OPIEJ/opiejv8n2-ayat.pdf>
- Bakhtary, H., Haupt, F., Luttrell, C., Landholm, D., & Jelsma, I. (2021). *Promoting sustainable oil palm production by independent smallholders in Indonesia: Perspectives from non-state actors* [Briefing paper]. Climate Focus & Meridian Institute. <https://climatefocus.com/publications/promoting-sustainable-oil-palm-production-independent-smallholders-indonesia/>
- Bok, C. H., Lim, C. H., Ngan, S. L., How, B. S., Ng, W. P. Q., & Lam, H. L. (2022). Life cycle assessment and life cycle costing analysis for uncertified and Malaysia sustainable palm oil (MSPO)-certified independent smallholders. *Journal of Cleaner Production*, 379, Article 134646. <https://doi.org/10.1016/j.jclepro.2022.134646>
- Che Omar, S., Abu Rahim, M. A. R., Nik Sharifulden, N. S. A., Teoh, A. N., Chooi, J. Q., & Lai, C. X. (2024). *Understanding the landscape of agrifood smallholders in Malaysia: Climate risks, sustainable standards, and gender gap*. Khazanah Research Institute. <https://krinstitute.org/Publications-@-Understanding-the-Landscape-of-Agrifood-Smallholders-in-Malaysia-Climate-Risks,-Sustainable-Standards,-and-Gender-Gap.aspx>
- De Vos, R. E., Suwarno, A., Slingerland, M., van der Meer, P. J., & Lucey, J. M. (2023). Pre-certification conditions of independent oil palm smallholders in Indonesia: Assessing prospects for RSPO certification. *Land Use Policy*, 130, Article 106660. <https://doi.org/10.1016/j.landusepol.2023.106660>
- Department of Standards Malaysia. (2016). *Good Agricultural Practice (GAP) – Crop commodities* (Second revision) (MS 1784:2016).
- Donough, C. R., Witt, C., & Fairhurst, T. H. (2009). Yield intensification in oil palm plantations through best management practice. *Better Crops*, 93(1), 12–14. <http://www.ipni.net/publication/bettercrops.nsf>

- Fairhurst, T. H., & McLaughlin, D. (2009). *Sustainable oil palm development on degraded land in Kalimantan, Indonesia*. World Wildlife Fund. https://assets.worldwildlife.org/publications/353/files/original/Sustainable_Oil_Palm_Development_on_Degraded_Land_in_Kalimantan_Indonesia.pdf
- Food and Agriculture Organization of the United Nations. (2003). *Development of a framework for good agricultural practices* (COAG/2003/6). FAO Corporate Document Repository. <https://www.fao.org/3/y8704e/y8704e.htm>
- Hendrawan, D., Chrisendo, D., & Musshoff, O. (2024). Strengthening oil palm smallholder farmers' resilience to future industrial challenges. *Scientific Reports*, 14, Article 12105. <https://doi.org/10.1038/s41598-024-62426-z>
- Irawan, S., Pasaribu, K., Busch, J., Dwiastuti, A., Martanila, H., Retnani, D., Fajri, D. M., & Hukom, V. (2024). Cost reduction for upscaling voluntary sustainability standards: The case of independent oil palm smallholders in Central Kalimantan, Indonesia. *Frontiers in Forests and Global Change*, 7, Article 1418782. <https://doi.org/10.3389/ffgc.2024.1418782>
- Ismail, A., Simeh, M. A., & Noor, M. M. (2003). The production cost of oil palm fresh fruit bunches: The case of independent smallholders in Johor. *Oil Palm Industry Economic Journal*, 3(1), 1–7. <http://palmoilis.mpob.gov.my/publications/OPIEJ/opiejv3n1-ismail.pdf>
- Kannan, P., Mansor, N. H., Rahman, N. K., Tan, S. P., & Mazlan, S. M. (2021). A review on Malaysian Sustainable Palm Oil certification process among independent oil palm smallholders. *Journal of Oil Palm Research*, 33(1), 171–180. <https://doi.org/10.21894/jopr.2020.0056>
- Kharel, M., Dahal, B. M., & Raut, N. (2022). Good agriculture practices for safe food and sustainable agriculture in Nepal: A review. *Journal of Agriculture and Food Research*, 10, Article 100447. <https://doi.org/10.1016/j.jafr.2022.100447>
- Malaysian Palm Oil Board. (2023). *Malaysian oil palm statistics 2022* (42nd ed.). MPOB Economics and Industry Development Division.
- Malaysian Palm Oil Board. (2025). *Overview of the Malaysian oil palm industry in 2024*. MPOB Research Hub. <https://mpob.gov.my/>
- Mansor, N. H., Che Jaafar, N., Johari, M. A., Kannan, P., & Tan, S. P. (2021). Acceptance of Good Agricultural Practices (GAP) among independent oil palm smallholders in Malaysia. *International Journal of Modern Trends in Social Sciences*, 4(16), 1–12. <https://doi.org/10.35631/IJMTSS.416001>
- Mansor, N. H., Dahari, N., Omar, I., & Omar, W. (2016). MPOB GAP certification: A step towards smallholders' sustainable palm oil production. In *Proceedings of Persidangan Kebangsaan Pekebun Kecil Sawit 2016* (pp. 169–183). Malaysian Palm Oil Board.
- Maspan, R., & Halimoon, N. (2024). Adoption of Malaysia Good Agricultural Practices (MyGAP) by crop producers in Peninsular Malaysia. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4743722>
- Mohd Suib, N. A. B., Mohd Salleh, N. H., Shukor, M. S., Chamhuri, N., Shahimi, S., Mohamed Salleh, K., & Hashim, K. (2023). The influence of Good Agricultural Practice (GAP) on the productivity and well-being of Malaysian Sustainable Palm Oil (MSPO)-certified independent smallholders in Malaysia. *Agriculture*, 13(5), Article 990. <https://doi.org/10.3390/agriculture13050990>

- Nagiah, C., & Azmi, R. (2012). A review of smallholder oil palm production: Challenges and opportunities for enhancing sustainability—A Malaysian perspective. *Journal of Oil Palm & the Environment*, 3, 114–120. <https://doi.org/10.5366/jope.2012.12>
- Othman, N. (2006, November 20–24). *Malaysia's experiences in training of farmers on good agricultural practices* [Conference presentation]. FAO/AFMA/FAMA Regional Workshop on Marketing Training in the Agricultural Supply Chain, Kuala Lumpur, Malaysia.
- Petri, H., Hendrawan, D., Bähr, T., Musshoff, O., Wollni, M., Asnawi, R., & Faust, H. (2024). Replanting challenges among Indonesian oil palm smallholders: A narrative review. *Environment, Development and Sustainability*, 26(8), 19351–19367. <https://doi.org/10.1007/s10668-023-03527-z>
- Poisot, A.-S., Speedy, A., & Kueneman, E. (2007). *Good Agricultural Practices – a working concept: Background paper for the FAO Internal Workshop on Good Agricultural Practices* (FAO GAP Working Paper Series No. 5). Food and Agriculture Organization of the United Nations. <https://www.fao.org/3/ag854e/ag854e00.htm>
- Proforest. (2025). *Options to broaden smallholder inclusivity in legal and deforestation-free palm oil supply chains in Malaysia* [Policy brief]. European Forest Institute. <https://www.proforest.net/publications/>
- Sareen, S. (2016). *A scheme and training manual on good agricultural practices (GAP) for fruits and vegetables: Volume 1. The scheme – standard and implementation infrastructure*. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific. <https://www.fao.org/3/i5453e/i5453e.pdf>
- Sekaran, U., & Bougie, R. (2010). *Research methods for business: A skill-building approach* (5th ed.). Wiley.
- Sheil, D., Casson, A., Meijaard, E., van Noordwijk, M., Gaskell, J., Sunderland-Groves, J., Wertz, K., & Kanninen, M. (2009). *The impacts and opportunities of oil palm in Southeast Asia: What do we know and what do we need to know?* (Occasional Paper No. 51). Center for International Forestry Research. <https://doi.org/10.17528/cifor/002792>
- U.S. Department of Agriculture, Foreign Agricultural Service. (2024). *Indonesia: Palm oil production, yield, and harvested area, 2023/24* [Data set]. Crop Explorer. <https://cloud.apps.fas.usda.gov/cropeplorer/>
- Vermeulen, S., & Goad, N. (2006). *Towards better practice in smallholder palm oil production* (Natural Resource Issues No. 5). International Institute for Environment and Development. <https://pubs.iied.org/14515iied>
- Wahid, M. B. (2009, March 23). *Sustainable palm oil developments in Malaysia* [Conference presentation]. Palm Oil – The Sustainable 21st Century Oil: Food, Fuels & Chemicals, The Royal Society, London, United Kingdom.

