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A Systematic Literature Review of Factors Affecting the Yield of Fresh Fruit Bunch and Oil Extraction Rate among Smallholders in Malaysia

Nurhuda Mohamad Hamidi, Prof. Madya. Ts. Dr. Abdul Rahman Saili, Ts. Syahrizan Syahlan

Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA (UiTM), 77300 Merlimau, Melaka, Malaysia

Email: rizan@uitm.edu.my , hudahamidi97@gmail.com, arsaili@uitm.edu.my

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Abstract

Despite the widely acknowledged significance of smallholders within the agricultural sector in Malaysia, a notable gap persists in the ratio of Fresh Fruit Bunches (FFB) to Oil Extraction Rate (OER) between major estate businesses and smallholders' production. This study presents an analysis of the factors which influence the yield of FFB and OER among smallholders in Malaysia. A total of twenty different research articles were analyzed as part of the review with the objective to compile a comprehensive list of results and conclusions. Based on the research outcomes, it has been determined that the main trends covering methods, crop management, site selection, and labor hold significant importance. It has been identified that poor agricultural practice is the primary factor in determining the quantity of FFB and OER that is produced by smallholders. The findings reveal that the research took place mainly in the states of Pahang, Perak, Sabah, and Johor. Hence, it can be inferred that there is a shortage of research related to the evaluation of factors influencing the yield of FFB and OER among smallholders in the regions of Melaka, Negeri Sembilan, and Sarawak. Sarawak exhibits a somewhat lower level of research activity in comparison to the other two states. Related to the subject, it is recommended that further investigation be conducted in other regions, with a specific focus on expanding the oil palm supply chain for Malaysia, with the objective of achieving the targeted 23% rate of OER as outlined in the National Key Economic Area (NKEA).

Keywords: Fresh Fruit Bunch, Oil Extraction Rate, Smallholders, Yield.

Introduction

In humid tropics, oil palm cultivation is known to be one of the most profitable land uses. More than 21 million hectares have been planted across the tropics (Jean et al., 2019). Generally, oil palm is thought of as an industrialized crop. However, it is regarded as a useful

crop by smallholders (Barcelos et al., 2015). The quality of an oil palm can be seen through oil extraction rates (OER) and the ripeness of fresh fruit bunches (FFB) can affect the OER. Although large-scale industrial plantations provide most worldwide oil palm supplies, independent smallholder farms are becoming increasingly profitable and are already dominating output in some of the future's main producing countries (Jean et al., 2019). Countries like Malaysia and Indonesia see expanding oil palm production as an opportunity to create jobs, improve livelihoods, and reduce poverty rates, especially in rural regions (Etuah et al., 2020). Therefore, the factors affecting productivity must be understood to assist other states in Malaysia in increasing their output as well, as no research has been conducted on this subject. Additionally, this study contributes to Malaysia's objective of obtaining a 23 percent rate of OER in the National Key Economic Area (NKEA) plan. According to Hassan et al. (2020), the fourth Entry Point Project (EPP) within the palm oil National Key Economic Area (NKEA) aims to boost oil extraction rates (OER) to 23% by 2020. However, the national OER has shown a significant drop over the years as a result of the uneven quality of fresh fruit bunches (FFB) provided to mills. Thus, to address this issue, it is necessary to study the factors affecting oil palm productivity among smallholders. This is because they contribute significantly to the Malaysian agriculture business and hence require assistance. Through this research, factors, strengths, and weaknesses may be assessed and examined, ultimately assisting our country in attaining its aim of achieving a 23% rate of OER in the National Key Economic Area (NKEA). Thus, economically, this will benefit Malaysia as a country, as oil palm output is identified as one of its critical assets. Following a comprehensive review and screening of published papers and journal articles from a variety of sources, it was discovered that there is a diverse range of journals that have published research articles regarding ~~on~~ the OER and FFB yield in oil palm plantations. The majority of these papers, however, emphasized how it affects oil palm globally and how it affects owners of oil palm plantations, rather than how it affects smallholders of oil palm plantations in Malaysia particularly. Thus, studies concentrating on smallholders of oil palm are scarce among the sources consulted.

The Necessity of Conducting a Systematic Review

According to (Shaffril et al., 2019), the systematic review has various advantages compared to other types of reviews. A systematic review can be reinforced by implementing a transparent article retrieval method, expanding the scope of the study, and establishing more meaningful objectives that can help control research bias. Apart from that, this also serves as a motivator for the researcher to generate higher-quality evidence with more important findings. Considering its advantages, this research focuses on finding primary factor that affects the yield of FFB and OER among smallholders in Malaysia. Thus, articles that are related to factors affecting the FFB or OER, in the context of smallholders in Malaysia are analyzed and discussed. The Systematic Literature Review (SLR), is the method used for this research. According to Mengist et al (2020), SLR is a method that enables the collection of relevant information on a specific topic that meets predefined eligibility criteria and provides an answer to the research questions set. A systematic review of the literature is also a process that entails identifying, evaluating, and interpreting all available research related to a specific research question, topic area, or circumstance of interest. A systematic review is a method of doing a literature review that follows a set of procedures to ensure that adequate transparency is achieved during the process of examining a large body of work. It proposes that four processes are necessary to demonstrate the relevance of this research: planning, sample, analysis, and reporting (Ghani et al., 2019).

Prisma Method

This section explains the strategy for finding the publications on factors impacting OER and FFB yield among smallholders. The PRISMA method was used in this study, to analyse research publications from various sources (e.g., Science Direct, Scopus, and Google Scholar Research Gate) to undergo a systematic evaluation, eligibility and exclusion criteria. The review process includes steps such as identification, screening, eligibility, and data abstraction and analysis.

Preferred Reporting Items for Systematic Reviews (PRISMA) is a widely accepted method for conducting systematic reviews of the literature. In general, publication standards must provide authors with relevant information that enables them to evaluate and study the quality and rigour of a review. Additionally, PRISMA places a premium on the review report that examines randomised trials, which can be used as a template for other forms of systematic reviews. Furthermore, PRISMA analyses a large body of scientific literature over a stipulated time frame, allowing for an accurate search of phrases related to a researcher's objective (Mohamed Shaffril et al., 2019).

Numerous databases were used to identify the sources which include a total of 103 research articles. The criteria are further checked by deleting duplicate articles, resulting in a total of 95 articles. Following title screening, the papers were further reduced to 65 and then to 46 following the abstract screening. This quantity contains papers describing the techniques and management systems in place throughout the oil palm harvesting sector. Figure 1 depicts the flow of the article screening process. Non-indexed journals are also utilized as a source of information for literature published in journals that are not indexed by major bibliographic databases such as SCOPUS, Google Scholar, and Science Direct. Non-indexed journals were not used as primary sources in this study, but rather as a means of supplementing the original data from indexed papers.

The first search approach for SLR is to create a search string by identifying the keywords. This is the most critical stage since the database will select which documents to fetch based on the keywords. Four key trends were selected for this review which includes practices, crop management, land selection and labour. Next is the identification of sources of information. The investigation began with a search of the literature for the terms "oil extraction rate," "fresh fruit bunch," "factors impacting yield," "factors affecting oil extraction rate," and "factors affecting fresh fruit bunch." The title of each document was used to determine the manuscript's preliminary relevance. If the title indicated that the article's content included issues impacting OER or FFB, we collected the article's complete reference, including author, year, title, and abstract, for further review. This is accomplished through the usage of several databases such as Google Scholar, Research Gate, SCOPUS, and Science Direct, four regularly accessed databases by researchers from a variety of disciplines. Since technology advancements affect harvesting methods for oil palm, the review period for period technology advancements was limited to 2010–2021 (articles published within the last decade), allowing the study to be built on contemporary literature regarding information retrieval and synthesis in the digital age.

This stage is critical in identifying all relevant studies on the issue of factors impacting FFB and OER yields among smallholders. Moreover, this stage also contains several levels. The

first level of screening entails searching through any article journals using the Web of Science search engine by entering "factors impacting yield" and "factors affecting OER," yielding only two results. Through the use of the search engines Science Direct, Google Scholar, and Research Gate, and the inclusion of keywords such as "oil extraction rate", "fresh fruit bunch", "factors affecting yield", "factors affecting oil extraction rate", and "factors affecting fresh fruit bunch", a total of 103 articles were gathered. Then, the second level in the screening stage took place which involves reviewing all journal articles and selecting those that are relevant to the issue, 30 are rejected since their contents cannot be used in this work. The remaining 65 papers are then subjected to the third level of screening, during which the journals' eligibility is determined. After the third step of screening was completed, 25 candidates were eliminated from the next round of screening. After the third filtering stage, only 40 journal articles remain for inclusion in this study report.

For the third stage, termed eligibility, a total of 88 pieces were written. The titles, abstracts, and primary contents of all papers were extensively checked to ensure that they met the inclusion criteria and were suitable for use in the current study to accomplish the research objectives. As a result, a total of 70 articles were removed because they lacked empirical data and were determined as did not specifically address fishermen adaption techniques or Asian countries and territories. Finally, a total of 20 publications were retained for analysis.

Journal indexation shows quality. Indexed journals are considered more scientifically reliable than non-indexed ones. Many article databases hold millions of journals with different ratings thus, this study analyzed the indexes of the journals cited within the paper utilizing indexation service providers to ensure that only relevant journals were used. Indexing helps the publication achieve its main goal of accessibility. Accessibility will increase a journal's reputation as a reliable source of high-quality information in its field. Researchers will start their study process by searching well-known databases. Inclusion in a well-known database for a topic will increase a journal's audience.

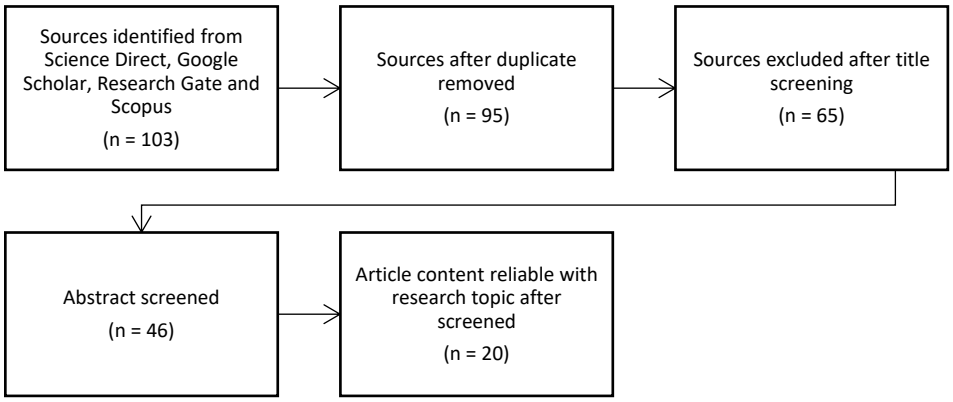

Figure 1: Systematic Literature Review Articles Screening Process

Findings and Results

Independent smallholders are unlikely to benefit directly from direct connections to nearby factories. Additionally, they rely on traders to purchase and carry their FFB to the mill and have no assurances about the price they will receive for their crops. This review identified four major topics and ten sub-themes about factors affecting the production of FFB and OER among smallholder farmers (See Table 1). Practices, crop management, land selection, and labor are the primary themes. The sub-theme of poor practices is described in the major theme of practices. Crop management as a whole has four sub-themes: mechanization, crop specification, costs, and tree age. Meanwhile, the primary issue of land selection is subdivided into three sub-themes: soil type, climatic change, and abiotic stress. The main theme of labor is subdivided into two sub-themes: the knowledge of farmers and low-skilled labor. The number of journals classified by sub-theme is depicted in Figure 2.

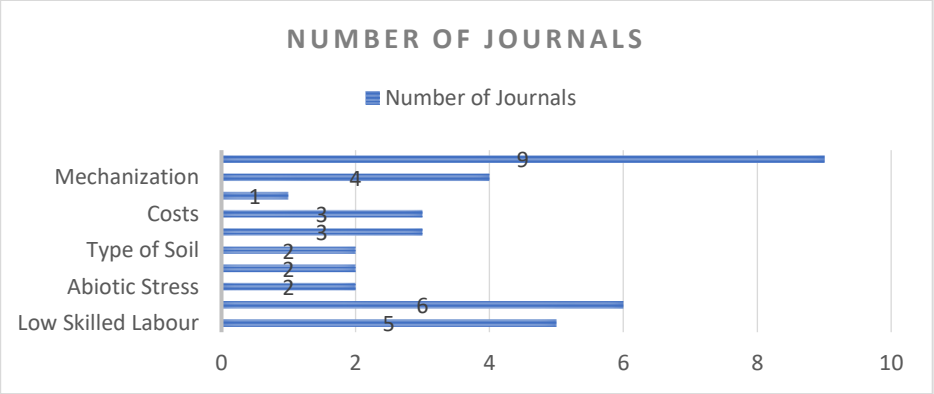

Figure 2: Graph Representation of Number of Articles discussing on Factors Affecting Yield of FFB and OER among smallholders

Table 1
The Findings

Authors	Practices	Crop Management				Land Selection			Labor	
	PP	M	CS	C	AT	TS	CC	AS	K	LSL
Khatun et al., 2017	✓									
Nagiah & Azmi, 2012	✓									
Murphy, 2014						✓	✓	✓		
Jalani et al., 2002	✓				✓					✓
Senawi et al., 2019				✓					✓	
Tan et al., 2019	✓				✓	✓		✓	✓	
Mior et al., 2016									✓	
Azman et al., 2018	✓								✓	
Ahmad et al., 2020				✓						
Chang et al., 2003	✓	✓					✓			
Musa et al., 2021										✓
Crowley, 2020										✓
Ismail et al., 2003	✓		✓	✓	✓					
Mohd Ishak et al., 2020									✓	✓
Lazim et al., 2020		✓								
Mustaffa, 2020		✓								
Ahmad Parveez et al., 2021	✓								✓	
Abazue et al., 2015										✓
Norhajijah et al., 2021		✓								
Kushairi, 2017	✓									

Practices	Crop Management	Land Selection	Labor
PP = Poor Practices	M = Mechanization CS = Crop specification C = Costs AT = Age of trees	TS = Type of soil CC = Climate change AS = Abiotic stress	K = Knowledge LSL = Low skilled labor

Poor Practices

Poor practices refer to farm practices that do not produce a sustainable production or profit. These practices include planting a crop with low-quality seeds or seedlings, failing to replant when the crop reaches its peak and enters its trough stage of life, applying too much or too little fertilizer (Tan et al., 2019), and harvesting unripe FFB (Chang et al., 2003). Additionally, bad practices include imprecise data management procedures, which affect the entire operation of the plantation, indicating that smallholders in Malaysia are known to be less productive among other producers (Nagiah & Azmi, 2012). The yields of huge estates and smallholders differ greatly. Small-scale processors, for example, had a 13% lower oil extraction rate than large-scale processors, showing a gradual decline in productivity (Rhebergen et al., 2018). Poor management practices, particularly insufficient crop recovery and improper agronomic management, were the primary contributors to such yield discrepancies (Ahmad Parveez et al., 2021).

It has been recognized that issues such as unproductive palms, lack of effective agricultural methods, uneconomic landholding area, and incompetent smallholders contribute to poor smallholder FFB yields. The majority of these smallholders also earn less money due to the poor yield and quality of oil palm (Kushairi, 2017). Ineffective and insufficient adoption of efficient estate management procedures will result in substandard output. A significant example is the lack of control over harvesting criteria, which results in the cutting of several unripe and under-ripe bunches, resulting in low OER (Jalani et al., 2002). Incorrect spacing during planting can cause overcrowding, leading to resource competition and a decrease in potential production. Inadequate fertilization practices, such as under-application or uneven nutrient ratios, can lead to nutrient deficiencies or toxicities, ultimately affecting tree health and output. Inefficient pest and disease control can lead to significant yield losses by damaging the palm's leaves, fruits, and vascular system, making production more challenging. To ensure the sustainability of Malaysia's oil palm sector among the smallholders, they must shift their mentality and embrace the challenge of revolutionizing farm management. This statement was also supported by (Ismail et al., 2003).

Mechanization

Most of the people that work on oil palm plantations are local natives who live in communities around the plantations (Syazwani et al., 2015). To aid employees in palm oil plantations, machines have been designed and equipped in farm operation to ensure tasks may can be completed in the most effective manner possible. Thus, today's advances in farm mechanization serve as new technological innovations that are deemed optimal for contemporary agricultural standards (Norhajijah et al., 2021). However, there are still many farmers who lack acceptance and are unprepared for technological growth. The initial capital investment required for purchasing machinery such as harvesters, tractors, and processing equipment can be substantial. This is particularly accurate for small-scale growers with restricted financial means. Maintaining and repairing mechanical equipment requires ongoing expenses and the expertise of technical personnel, which increases the complexity and costs of operations. Furthermore, the utilization of equipment necessitates skilled individuals, emphasizing the importance of workforce training and expertise in enhancing mechanized procedures to maximize oil palm production potential.

As a result, they choose to disregard the use of technology in favor of their customary preferences. These farmers continue to harvest the oil palm using manual devices such as the chisel and sickle. They rejected and refused technology aid for a variety of reasons, including a lack of training and expertise, fear of attempting anything new, and a preference for the traditional technique. This rejection undoubtedly have a detrimental influence on Malaysia's agriculture industry's growth, particularly on overall yield productivity (Lazim et al., 2020b) as conventional and manual techniques impose an unreasonable amount of time on the processing and harvesting of FFB, hence reducing the FFB's yield. This was also mentioned by (Chang et al., 2003) that not upgrading to machines is one of the major factors that affect the OER of oil palm. Small-scale farmers must modernize and improve their operations to raise their living conditions, increase agricultural production, and promote industrial development (Mustaffa, 2020b).

Crop Specification

Oil palm is a tree that is known to have no branches, can reach a height of 20 to 30 meters and has a useful life of 25 to 30 years (Barcelos et al., 2015). The majority of the roots are found in the top 15 cm of the tree's soil, with a primary palm concentration and a secondary palm concentration between 1.5 and 2 meters from the base (Verheye, 2010). The crop's specification in terms of height, crown diameter, and leaf area has a significant impact on yield and activity in the oil palm sector.

Oil palm trees can reach a height of 30 meters, making it difficult to inspect and harvest the fruit at this height, especially when using manual tools. This results in the oil palm fruit being left unharvested due to its level of difficulty and vulnerability to spoilage. Thus, as a result of fruit spoiling, oil palm plantations suffered a significant loss of output when the fruits fell to the earth's surface, causing fruit damage and significantly reducing the fruit's oil rate. Apart from that, the height of the trees makes it difficult to inspect the fruit bunches for pests and pathogens or to figure out the maturity level of the FFB. Considering the plantation locations, the average palm stand was larger in smallholder plantations, but also more variable. Disrupted and imbalanced growth of plant development indicates incorrect palm point lining, which results in conflicts among the inter-palm and decreased light absorption by the palm leaf canopy, whereas low-density palm stands frequently indicate a failure to remove unproductive palms or fill gaps in the palm stand during the immature process (Rhebergen et al., 2018).

Costs

The increase in fertilizer and pesticides prices resulting from the collapse of the national currency has aggravated the suffering of oil palm smallholders during the decline in commodities prices. Thus, with this recurring issue, smallholders' difficulty in increasing the yield of FFB and quality of OER increases when input costs such as fertilizers and pesticides rise. This also results in farmers failing to apply fertilizer on time, which also affects the yield of FFB and the quality of the OER (Ahmad et al., 2020). This was also mentioned by Ismail et al., 2003 as cited in Senawi et al., (2019) that the primary issue confronting smallholders is high production costs, which have driven them to use low-quality input materials to save money. This has resulted in low productivity and poor quality of FFB, resulting in low-quality palm oil production.

In order to counter this major issue that is affecting the yield of FFB and OER, Smallholders must understand how to keep track of their agricultural management activities, including monthly yield, production expenditures such as fertilizer purchases, harvesting labor costs, and FFB transportation costs. In other words, smallholders must keep an eye on their production costs because a majority of smallholder farmers in Malaysia do not maintain adequate records of their farming activities, making it difficult to determine their true expenditures and revenues.

Age of Trees

The quality and rate of an oil palm plantation are heavily dependent on the OER rate, which varies according to the maturity age of the oil palm trees. According to Hazir et al., (2012), OER may be calculated using both the FFB yield and the age of the oil palm tree. This indicates that the age of the oil palm trees, particularly during their maturity phase, has a significant impact on their OER value, emphasizing the importance of efficient plantation to ensure a high OER rate develops during the phases that can be obtained. Ismail et al. (2003) argued that smallholders had a lower cost of FFB production than estates. This was influenced by the fact that both companies had a diverse cost structure based on their distinct manufacturing backgrounds. For example, smallholder plantations frequently employ family labor and several do not even fertilize their oil palm trees, which significantly reduces production costs in terms of labor wages and input costs. However, this has an effect on OER and oil palm yield because of labor shortages, lengthy working hours, and also the oil palm trees' unproductiveness due to insufficient fertilizer application.

Additionally, research indicates that the average age of oil palm trees on independent smallholdings is between 20 and 30 years. Palms are already exhibiting a declining age profile within their age range, implying a depleting amount of total production yield. Thus, to address this issue, a strategy for systematic replanting must be developed. According to Ismail et al. (2003) the average age of oil palm trees on smallholder plantations is 20 years. At the end of this age bracket, the palms have already begun to deteriorate. The presence of a large number of ancient oil palm trees owned by smallholders indicates a poor replanting rate. The low rate of replanting has resulted in the current high percentage of elderly palms, particularly those above the age of 20 years. High and elderly trees complicate the harvesting procedure, resulting in decreased output in the oil palm farm (Tan et al., 2019). Hence, to increase the opportunity of our oil palm industry, the oil palm trees are needed to be replanted (Jalani et al., 2002). Thus, the quality and development of FFB were shown to be 99.0 percent dependent on plant age, and previous research indicates that the distribution of FFB yields is also dependent on farm size, treetop age, and smallholder plantation upkeep. The palm oil age is also known to have a negative effect on the OER rate. Therefore, considering the palm oil age together with well-managed plantations, can result in enhanced fruit production (Salmiyati et al., 2014).

Type of Soil

Aspects other than biology that influence the effectiveness and production of oil palms include environmental factors such as soil types, crop management strategies, and the success of these strategies, all of which have a direct impact on how much palm oil is produced at the national or regional level (Murphy, 2014). Oil palms are one of the crops that are known for their capacity to germinate and lives in low PH soils. The physical qualities of

the soil, particularly its humidity, are more critical than the amount of nutrients that can be fixed through fertilizer application (Verheye, 2010). In general, soils used to grow oil palms are deficient in fertility, and as a result, mineral fertilizers are typically required to maintain a healthy soil nutritional status conducive to oil palm growth and productivity. In order to optimize pH levels for improved nutrient availability and microbial activity, acidic soil conditions may necessitate remediation via liming. Conversely, low fertility soils demand additional fertilization to meet the nutritional demands of oil palms. Nutrients such as nitrogen (N), phosphorus (P), potassium (K), and magnesium are required in large quantities by oil palm (Mg) (Tan et al., 2019). In general, fertilizer requirements can be assessed during the immature stage of a new plantation using soil analysis, followed by foliar analysis to assure continued nutrient provision, which has a significant effect on yield due to the enhanced development of fruits caused by fertilizer application, primarily potassium. Thus, nationally and regionally, the amount of palm oil produced is influenced by a variety of non-biological factors, which include the climate and soil type (Murphy, 2016).

Climate Change

The optimal temperature range for oil palm cultivation is between 27 and 28°C daily, with a monthly mean of between 30-32° C and 21-24° C monthly. According to some studies, the tree's development ceased below 18° C. Thus, this temperature change can interfere with crop development that will reduce agricultural productivity, thereby lowering the quality of the final output (Verheye, 2010). Studies conducted in Malaysia (Paterson, 2018) and also in West Africa (Okoro et al., 2017) demonstrate how yields of FFB and OER are affected by climate change. As mentioned by Chang et al. (2003), differences in climate, season, and geography are one of the major factors that affect the OER of an oil palm. Murphy (2014) also stated that at the national or regional level, the amount of palm oil produced is influenced by a variety of non-biological factors, including climate, soil type, and the effectiveness of crop management systems. Malaysia is notorious for its three to four months of torrential rain and hot tropical climate. Due to the fluctuating temperature, the quantity and quality of CPO are affected, interfering with the process of fruit maturation, therefore decreasing the coming months' production. As the fruit matures, the yield of FFB declines with time. Thus, in Malaysia, climate change can be viewed as affecting oil palm yields, particularly among smallholder plantations, which often have smaller plot sizes of cultivated land (Paterson, 2018).

Abiotic Stress

Abiotic stress is the primary environmental constraint on the yields of the majority of crops. Abiotic stress is an uncontrollable issue; hence, both large estates and smallholder plantations are significantly impacted. Moreover, environmental factors have a significant impact on oil palm productivity. When drought occurs for a period of two to four months, there is a possibility of major yield fluctuations. Fresh fruit output may also be reduced by 20%-30% under protracted drought. Additionally, a combination of 50 mm water depravity and a 1°C increase in temperature reduces productivity by an average of 2.15 tonnes per year, or approximately 40% of the usual yield (Zhou et al., 2020). Abiotic stressors such as haze have a detrimental effect on Malaysia and Indonesia, lowering the amount of fruit produced and improving the quality of oil palm fruits after harvest, which is critical for the industry's economic viability. On the other hand, flooding occurrences can result in oxygen deprivation, root suffocation, and nutrient leaching, which can exacerbate the negative impacts on palm

health and productivity. Extreme temperature changes, whether they are extremely high or low, have the potential to disrupt metabolic processes, hinder the growth of reproductive organs, and damage the quality and set of fruit plants. This is related to the natural functioning of biological activities, particularly photosynthesis, which is harmed when stress conditions exist (Zhou et al., 2020).

Knowledge

The agriculture industry is becoming more knowledge-intensive (Tan et al., 2019). Farmers benefit from the most recent knowledge since it allows them to be more effective in managing their farms, therefore, enhancing their livelihood. Information such as new technology in agronomic approaches to boost yields, for example, has frequently failed to reach smallholders (Hasnida et al., 2014). Meanwhile, adopting and manipulating expertise in fertilizer management can help smallholders boost the production of their oil palm plantations on their farms. Research has shown that smallholders producing FFB at a rate of 21-30 tons per hectare per year possessed an advanced understanding of fertilizer management. However, smallholders producing FFB at a rate of fewer than 10 tons per hectare per year or 11-20 tons per hectare per year showed a moderate understanding of fertilizer management (Tan et al., 2019).

Smallholders is are particularly vulnerable due to a lack of understanding about farm maintenance, which resulted in decreased output, receiving lack financial support, and deprived of information on market access prices (Senawi et al., 2019). Therefore, knowledge in knowing the requirement of optimum fertilizer application to have information on oil palm nutrient deficiency is crucial in capitalizing the palm oil productivity (Ahmad Parveez et al., 2021).

Mior et al (2016), concluded that, more impactful knowledge-based initiatives are needed to instill a greater understanding of pesticides among palm oil workers. It is because, people may become less cautious and expose themselves to more problems in the future due to lack of education. This is supported by Ishak et al. (2020) that the primary factors determining production are attitude, knowledge, and capabilities. Thus, it is critical to do research and have knowledge on the current labor situation of independent oil palm smallholders to completely comprehend their struggle and devise the best strategy for resolving labor-related issues (Azman et al., 2018).

Low Skilled Labor

A skill is the ability to complete a task with predetermined consequences within a specified amount of time, effort, or both. Skills can be classified as area-general or area-specific. For instance, in the field of employment, general skills such as time management, cooperation and leadership, and self-enthusiasm are valuable, whereas job-specific talents are only useful for a certain position (Ishak et al., 2020). The low productivity in oil palm plantations is a result of a labor shortage. At the moment, there are still tiny plantations that rely mainly on immigrant laborers' who are primarily uneducated and lack expertise due to their brief employment. This results in a poor rate of productivity, which also results in low harvesting standards and a low OER (Jalani et al., 2002). Extension programs must be improved for smallholders to improve their knowledge and skills in managing workers and the plantation as a whole. Additionally, research indicates that while re-skilling employees may

increase costs, having a predominantly skilled migrant labor force on commercial plantations is still desirable (Murphy, 2009). This is because, if smallholders in Malaysia keep hiring unskilled foreign workers, after a few years, those unskilled turn into skilled foreign workers. Therefore, they will eventually leave Malaysia with the skills they have and the cycle rotates all over again (Musa et al., 2021). Moreover, Crowley (2020) stated that the first implication of hiring foreign labor is that Malaysian plantations are looking to replace workers with prior agricultural experience with workers who have no prior agricultural experience.

The current discussion over agricultural production is largely focused on land productivity and rarely considers labor productivity. It is uncertain which constraint on smallholder development is more severe: land or labor. Additionally, the land-labor ratio and the seasonality of labor demand determine whether land or labor is the 'binding restriction.' When farmers employ more intense production methods, such as intensification, produce per unit area increases due to low land-labor ratio and reduced transient overlap between the two activities. In comparison, output increases through area expansion are frequently more likely to occur at times of high land-labor ratios and intense labor rivalry, while maintaining or reducing input levels per unit area, such as intensification. Thus, improving or enhancing the skills of smallholders can definitely increase their production of FFB and maintaining the quality of OER, at the same time increasing their standard of living (Abazue & Alam, 2015).

Conclusion

Considering the four main themes deduced from the systematic review, there is one main theme that can be seen to have the biggest effect on the yield of fresh fruit bunch and oil extraction rate among the smallholders in Malaysia. This study has discovered that the factor of poor practices was mentioned in nine research articles included in the review. This signifies that the factor of poor practices was the main factor affecting the yield of fresh fruit bunch and oil extraction rate among the smallholders in Malaysia. The least affecting factor was determined as crop specification, listed under crop management theme. Only one research article mentioned how the specifications of an oil palm tree can affect the factor of yield. From the results, it can be interpreted that improving practices in the oil palm sector for the Malaysian smallholders can also improve their yield. However, when poor practices are used, their productivity will decrease as it gives a huge effect on the direct yield of FFB and the quality of OER. As for crop specification, it can be interpreted that it does not give much effect to the yield of FFB and OER because yielding from a high tree can be solved with new mechanisms and advanced machine.

Malaysia’s government plays a crucial part in establishing policies, laws, and efforts to promote sustainability in the palm oil sector. One notable initiative involves Malaysia's active participation as a founding member of the Roundtable on Sustainable Palm Oil (RSPO), advocating for palm oil producers to adhere to sustainable practices and facilitating their certification. This commitment is reinforced by governmental incentives and support to encourage palm oil producers in obtaining RSPO certification (Begum et al., 2019). Furthermore, Malaysia prioritizes research and development efforts through the Malaysian Palm Oil Board (MPOB) to improve oil palm productivity and sustainability. This includes research endeavors focused on developing high-yielding palm oil varieties, implementing effective pest and disease management protocols, and promoting sustainable production

practices throughout the industry. Such initiatives underscore Malaysia's concerted efforts to balance economic interests with environmental conservation in its palm oil sector.

This systematic review has retrieved relevant studies from the literature and discussed a few factors affecting the yield of FFB and OER among smallholders in oil palm plantations in Malaysia. To begin, oil palm agriculture has spread over the world and is frequently developed in large-scale production. Thus, Malaysia has a significant impact on global production as one of the most productive oil palm producers, alongside Indonesia. This review has summarized, from the literature, the factors affecting FFB yields and OER among smallholders which include poor management practices, mechanization adoption and application, crop specification, costs, tree age, soil type, climatic change, abiotic stress, smallholder knowledge, and low skilled labor. Moreover, this review has found that the primary factor affecting FFB and OER yields among smallholders across the country is poor management practices. This is shown in nine publications included in the review that discussed about bad management practices. Meanwhile, mechanization was discussed in four studies, crop specification was discussed in one study, costs were discussed in three studies, age of trees was discussed in three studies, type of soil was discussed in two studies crop specification, abiotic stress, and knowledge were discussed in six studies respectively, and low skilled labor was discussed in five studies.

Malaysia holds a prominent global position as the second-largest oil palm producer (Senawi et al., 2019). The key aspect of this research is its contribution towards Malaysia's goal of achieving a 23% Oil Extraction Rate (OER) in the National Key Economic Area (NKEA). As elucidated by Hassan et al. (2020), the fourth Entry Point Project (EPP) under the palm oil National Key Economic Area (NKEA) aims to achieve this target by 2020. However, the national OER has not witnessed significant improvements over time, primarily due to the inconsistent quality of fresh fruit bunches (FFB) supplied to the mills. Given that smallholders' contributions account for approximately 40% of the total oil palm production (Abazue et al., 2019), it becomes crucial for them to enhance their productivity. Given their substantial role in the Malaysian agricultural industry, smallholders require assistance in enhancing their productivity. This research will facilitate the evaluation and study of factors, strengths, and weaknesses, ultimately aiding in achieving the country's goal of attaining a 23% rate of OER in the NKEA. Economically, these endeavours will also prove beneficial to Malaysia, as oil palm yield is an essential asset contributing to the country's prosperity.

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