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Study on Handing Process and Quality Degradation of Oil Palm Fresh Fruit Bunches (FFB)

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Abstract. The main objective of this study is to determine the relationship between quality of oil palm fresh fruit bunches (FFB) and handling processes. The study employs exploratory and descriptive design, with quantitative approach and purposive sampling using self-administered questionnaires, were obtained from 30 smallholder respondents from the Southern Region, Peninsular Malaysia. The study reveals that there was a convincing relationship between quality of oil palm fresh fruit bunches (FFB) and handling processes. The main handling process factors influencing quality of oil palm fresh fruit bunches (FFB) were harvesting activity and handling at the plantation area. As a result, it can be deduced that the handling process factors variable explains 82.80% of the variance that reflects the quality of oil palm fresh fruit bunches (FFB). The overall findings reveal that the handling process factors do play a significant role in the quality of oil palm fresh fruit bunches (FFB).

Keywords: Oil palm fresh fruit bunches, handling processes

1. Introduction

The palm oil industry is one of the key economic drivers of the agricultural sector in developing countries such as Malaysia and Indonesia. Both countries have been competing with each other to increase their productivity and improve their yield. Palm oil brings people together, due to its flourishing and profitable business. The smallholders took this opportunity to join this business. According to the Malaysian Palm Oil Board (MPOB), as at December 2015 the number of smallholders have grown almost 47% to 177,046 from 120,437 in 2007; as at January this year, smallholders have exceeded 180,000. Malaysia is a big player in palm oil and it is the fourth largest...
contributor to the national economy. Malaysia’s palm oil industry currently accounts for RM53 billion in GNI [13]. Khoo and Chandramohan [7] mentioned palm oil is the second largest oils and fats produced after soybean oil, accounting for 23.6 million tonnes or 20% of the world oils and fats production since 2001. There are two value chains that Malaysia’s palm oil spans which is upstream and downstream plantation. Having limited land to expand oil palm plantations, the industry needs to enhance upstream plantation to sustain growth in this sector. The interest in oil palm cultivation in Malaysia remains strong despite issues of land scarcity and limited human capital (Intan Farhana Zainul, [6]). As land is scarce, palm oil and development is working hard to greatly increase the yield without having to use more land. Thus, the introduction of the National Key Economic Area (NKEA) has the potential to contribute a quantifiable amount of economic growth to the Malaysian economy and hence help Malaysia achieve high income by 2020.

2. Background of the Study

2.1 Quality of Oil Palm Fresh Fruit Bunches (FFB)

Quality of oil palm fresh fruit bunches (FFB) is measured by low free fatty acids (FFA) and high oil extraction rate (OER). The smallholders are making efforts to produce high quality oil palm FFB by enhancing the proper way of handling the oil palm FFB so that the oil palm FFB would not be damaged or bruised while the handling process takes place. Moreover, the quality of oil palm FFB also could be differentiated by observing young, ripe, and overripe fruits. The Palm Oil Mill Administrator [18] stated that a ripe fruit bunch is a bunch that has fruit that are reddish orange in colour and has some fruit that have been detached. If the fruits are young, it will contribute none or zero oil component. Bunches with long stalks and very young bunches will undoubtedly reduce the extraction rate (Abdul & Tan [1]). However if the fruits are overripe and ripe these will contribute to high OER where the fruits contain a lot of oil component. The research Abdul and Tan [1] found that in achieving high rates of extraction, bunches have to be in the state of optimal ripeness. Therefore the fruits should be graded correctly by an individual appointed by the company and must have undergone grading training courses. The purpose of grading is to ensure that oil palm FFB is harvested and collected according to the standard of ripeness. Besides that, the aim of this oil palm FFB manual grading is to improve the quality and quantity of crude palm oil and kernel production in Malaysia. The Palm Oil Mill Administrator [18] also stated that the purpose of oil palm FFB grading is to determine the quality of oil palm FFB received and thus helps to determine the purchase price. Whenever the quality of oil palm FFB is high, the smallholders would receive a worthy price according to premium price and premium quality. This will also ensure that the suppliers and millers obtain a fair deal from their transactions.

2.2 Harvesting Activity

The important process in oil palm plantation is to harvest oil palm fresh fruit bunches at the optimum ripeness for maximum oil yields as the content of a fruit bunch is a function of its degree of ripeness. The extraction rate obtained by the factory is greatly affected by oil palm fruit ripeness standards since the oil content of fruit increases rapidly. Bunch colour begins to change from black to reddish-orange until full ripeness is achieved. The most usual method of defining the ripeness standard is by reference to the number of loose or detached fruits, with ten loose fruits on the ground being a commonly-used standard. Oil palm mature has specified a standard that mature bunches must have at least one detached loose fruitlet on the ground at the base of the palm before the bunch is harvested. According to Geoffrey [4], fruits may be damaged in the process of pruning palm fronds to expose the bunch base to facilitate bunch cutting. This shows that if the harvester harvests the fruit roughly it will damage the oil palm FFB. Malaysian Standard 1784 [11] stated that oil palm FFB should be harvested according to acceptable industry ripeness standards. This indicates that grading is important in the harvesting
process in order to distinguish which fruits are ripe to be harvested by the harvester. It was also clearly stated that all loose fruits should be collected without contamination by ground debris and stones.

Furthermore, in the harvesting process it is important that the harvester collect all the loose fruit because loose fruits contain more oil component as compared to bunches. Whenever the harvester collects the loose fruits without it being contaminated by soil debris and stones, it will increase the extraction rate. There should also be zero tolerance for unripe bunches as unripe bunches do not have any oil component. Harvesting correctly is crucial and exerts considerable influence on both oil extraction rates and the final crude palm oil (CPO) quality. If smallholders harvest poor quality bunches, it will lead to high FFA and low OER.

2.3 Handling at Plantation Area

Material handling is the general term for moving materials within an organization. Every time those materials are moved around operations it will use materials handling. The aim is for efficient movements with short journeys, using proper equipment with little damage and delay. Material handling is concerned with the movement of goods within that space. One of the definitions adopted by the Materials Handling [12] is that materials handling is the art and science involving the moving, packing, and storing of substances in any form. The quality chain regarding handling starts from the harvesting process. After the harvester have harvested the oil palm FFB, they should handle the oil palm FFB with care because it could easily become bruised and damaged if it is not handled properly. Minimal post-harvest handling and damage to oil palm FFB is important to maintain an acceptable FFA content in the crude palm oil. During the handling process at the plantation area, it is vital for the harvester to collect all the loose fruits that fall from the oil palm. The oil palm mature specified that the complete collection of loose fruits is important because they contain up to 48% oil while bunches contain approximately 22% oil. In addition, the equipment used during the handling process in the plantation area is also important. As we know, handling consists of moving the material from one place to another, thus, equipment such as chisel, sickle, small axe, and wheelbarrow are needed while handling the oil palm FFB at the plantation area. Harvester efficiency will reduce when poor quality wheelbarrows are used for harvesting and infield collection. Other than that, all ripe bunches and all loose fruits must be harvested, stacked neatly at the ramp or roadside to be collected and delivered to the intermediate collection center which is the fruit dealer. All oil palm FFB and loose fruits collected from the palm base should be delivered to the collection points with minimal damage, delay and contamination, as per the Malaysian Standard 1784 [11].

2.4 Handling at Intermediate Collection Center

At the intermediate collection center, it is important to minimize fruit damage because it will then be transported to the mill where the oil palm FFB will be sterilized and processed to produce a good quality of crude palm oil. For example, at the ramp during loading and unloading of the oil palm FFB where it will be graded to distinguish between the good and damaged fruits so as to maintain the quality of the crude palm oil. Malaysian Standard 1784 [11] stated that oil palm FFB should not be shoveled into vehicles from the intermediate ramp floor to minimize bruising. This indicates that the bruises on the fruit will contribute to fruit damage and hence will increase the FFA. When the FFA is increased, the extraction rate will consequently decrease. Geoffrey [4] mentioned that research has shown that if the fruit is bruised, the FFA in the damaged part of the fruit increases rapidly to 60 percent in an hour. In other words, the oil palm FFB should be transported to the mill within 24 hours after being harvested. If transport of the oil palm FFB to the mill was delayed, it will affect the oil palm FFB quality which will cause infections. As per Abdul and Tan [1], the delay in transferring harvested bunches especially the overripe ones, allows these bunches to be infected by microorganisms thereby resulting in rotting fruits. A study made by Abdul and Tan [1] identified that the state of deterioration has been attributed mainly to handling and transportation of oil palm FFB to
the mill and also the condition of the oil palm FFB at the collecting platform and ramp. This shows that the oil palm FFB is prone to damages and bruises which then will affect the quality of the oil palm FFB during the handling process and transportation of oil palm FFB whether at the collecting center or ramp.

2.5 Oil Palm FFB Protection during Transportation

The vehicles must be in clean condition in order to preserve the quality of the oil palm FFB so that the oil palm FFB will not be contaminated by the residues left on the vehicles. Based on MPOB [10], the compartments should be dedicated to oil palm FFB, free from previous load residues, and free from odors of previous loads. The driver of each transport should check the vehicle before each consignment is loaded into the compartment. Furthermore, the vehicles have to keep the oil palm FFB covered at all times while the transportation of oil palm FFB is in progress. This is to ensure that the oil palm FFB is prevented from being exposed to rainwater or bird droppings. If the oil palm FFB gets wet, the water will penetrate into the fruits and thus will affect the quality whereas if the fruits were exposed to bird droppings, it will lead to contamination. MPOB [11] also states that the penetration of rainwater and splash water should be prevented during transport. Besides that, the vehicles should be free from carrying any hazardous cargo to avoid any damages during the transportation. Hazardous cargo such as materials that are radioactive, flammable, explosive, corrosive, toxic and many more is not allowed on the vehicles because it could affect the quality of the oil palm FFB. According to Malaysian Standard 1784 [11], the vehicles transporting oil palm FFB shall be registered and licensed and secured and should not carry other hazardous cargo e.g. chemicals. When the vehicles arrive at the intermediate collection center, it must be weighted at the ramp and then recorded on the proper documentation so that they could keep track of the oil palm FFB to prevent loss and pilferage during the conveyance as this is to retain the quality of the oil palm FFB. As per MPOB (2008), in the case of delivery to third parties, all consignment of oil palm FFB for transport to the purchaser must be accompanied by proper documents which must meet the minimum regulatory requirements set by the MPOB.

The palm oil industry is the fourth largest contributor to the Malaysian Gross National Income (GNI) (NKEA, [9]). Thus, referring to the Prime Minister’s program which is NKEA, the EPP2 aims to increase the national oil palm FFB yield from 21 tonnes per hectare to 26.2 tonnes per hectare by 2020 (MPOB, [13]). In order to increase the yield the oil palm FFB producers need to supply good quality oil palm FFB to the market and to do this, it involves the handling process of the oil palm FFB. As quality of goods is very important to meet consumer demand, it is crucial to take into account how the raw materials are handled. Material handling is important to ensure movement of goods is in a right quantity and in good quality. Tuan Hj. Shamsudin Selamat the Chairman of the Intermediary Collection Center did mention that “Generally, Malaysia has a similar type and condition of land and weather. Unfortunately, the oil palm FFB quality is not similar. This reflects the situation of something wrong somewhere”. From that statement there may be several problems concerning quality of oil palm FFB.

The problems that might be faced by the company which affect oil palm FFB quality regarding their handling process are:

i) Harvesting activity

In order to harvest the oil palm FFB, the harvesters have to prune the fronds. The oil palm FFB will be harvested by the harvester and they need good skills to have a better understanding of how to harvest the oil palm FFB, identify the oil palm FFB correctly whether overripe, ripe, or unripe so that they harvest the oil palm FFB that is in the state of optimal ripeness.

ii) Handling at plantation area

This refers to the handling process of raw materials from the plantation area to ramp where the oil palm FFB will be placed and assembled before being carried to the collection premise.
iii) Handling at intermediate collection center
   When the raw materials reach the collection premise, there will be another handling process
   that took place. The weight of the oil palm FFB will be measured and recorded and then the
   oil palm FFB will be placed and assembled before being transported out to the mill.

iv) Oil palm FFB protection during transportation
   This refers to steps taken for protection during the transportation of oil palm FFB from the
   plantation area to the mill. How the drivers preserve the freshness of oil palm FFB when
   transporting it to other locations. Example of vehicles used during the transportation is a small
   lorry that has capacity of 1 tonnes and a big lorry that has capacity of 30 tonnes.

The main objective of this study is to determine the relationship between quality of oil palm fresh
fruit bunches (FFB) and handling processes.

3. Methodology
   Figure 1 shows the framework of the research.

   ![Research Framework](image)

   Figure 1: Research Framework on the relationship between Quality of oil palm FFB and Handling
   Process

   The study employs exploratory and descriptive design, with quantitative approach and purposive
   sampling using self-administrated questionnaires. The sample size was chosen among smallholders in
   the Southern Region, Peninsular Malaysia. Lansford B. R & Lansford T. R [8] suggested that the
   minimum number of sample size could be 28. The instrument used in the questionnaires was adopted
   from Zainon et. al., [19, 20, 21, 22, and 23].

4. Results and Discussion
   Table 1: Respondents’ Demographic Profile

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>25</td>
<td>83.8</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td>Area of Plantation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 acre</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-2 acre</td>
<td>22</td>
<td>73.7</td>
</tr>
<tr>
<td>&gt; 2 acre</td>
<td>8</td>
<td>26.3</td>
</tr>
<tr>
<td>Age of Oil Palm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 3 years old</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3-10 years old</td>
<td>21</td>
<td>73.3</td>
</tr>
<tr>
<td>&gt; 10 years old</td>
<td>9</td>
<td>26.7</td>
</tr>
</tbody>
</table>
Table 2: Reliability Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>No of item</th>
<th>p or (α)</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of oil palm fresh fruit bunches (DV)</td>
<td>3</td>
<td>0.884</td>
<td>3.778</td>
<td>0.813</td>
</tr>
<tr>
<td>Harvesting activity (IV₁)</td>
<td>5</td>
<td>0.844</td>
<td>3.213</td>
<td>0.934</td>
</tr>
<tr>
<td>Handling at plantation area (IV₂)</td>
<td>5</td>
<td>0.848</td>
<td>3.527</td>
<td>0.744</td>
</tr>
<tr>
<td>Handling at intermediary collection centre (IV₃)</td>
<td>5</td>
<td>0.873</td>
<td>3.720</td>
<td>0.798</td>
</tr>
<tr>
<td>Oil palm fresh fruit bunches protection during transportation (IV₄)</td>
<td>5</td>
<td>0.853</td>
<td>3.727</td>
<td>0.723</td>
</tr>
</tbody>
</table>

Note: M – mean, SD – Standard Deviation

Table 3: Pearson Correlation Matrix

<table>
<thead>
<tr>
<th>Variable</th>
<th>DV</th>
<th>IV₁</th>
<th>IV₂</th>
<th>IV₃</th>
<th>IV₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>DV</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV₁</td>
<td>0.827**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV₂</td>
<td>0.808**</td>
<td>0.709**</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV₃</td>
<td>0.521**</td>
<td>0.574**</td>
<td>0.604**</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>IV₄</td>
<td>0.434**</td>
<td>0.304</td>
<td>0.672**</td>
<td>0.690**</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Note: ** Correlation is significant at the 0.01 level (two-tailed)
* Correlation is significant at the 0.05 level (two-tailed)

Table 4: Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.910*a</td>
<td>0.828</td>
<td>0.800</td>
<td>0.36368</td>
</tr>
</tbody>
</table>

Table 5: ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum Square</th>
<th>Df</th>
<th>Mean Square</th>
<th>F-test</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>15.879</td>
<td>4</td>
<td>3.970</td>
<td>30.013</td>
<td>0.000b</td>
</tr>
<tr>
<td>Residual</td>
<td>3.307</td>
<td>25</td>
<td>0.132</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19.185</td>
<td>29</td>
<td>0.132</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: ** Correlation is significant at the 0.01 level (two-tailed)
a. Dependent Variable: Quality of Oil Palm FFB (DV)
b. Predictors (constant): IV₁, IV₂, IV₃, IV₄
This study was conducted in the southern region of Peninsular Malaysia. Based on the respondent profile, 83.8% of the respondents are male and the remaining 16.7% are female. They are considered as small farmers since 73.7% or 22 of the respondents have 1 to 2 acres of palm oil plantation and only 8 respondents (26.3%) have more than 2 acres of palm oil plantation. All of them harvest their palm oil fruits twice a month, as shown in table 1. All variables are having a good α value for Cronbach alpha (α) test. According to Tabachick [17], an alpha (α) value above 0.8 and less than 0.9 are considered good. The quality of oil palm FFB having the highest α value at $p = .884$ followed by handling at intermediary collection center with $p = 0.873$ and harvesting activity having the lowest α at $p = 0.844$, as shown in table 2. Pearson correlation analysis has found that all independent variables correlate significantly with the dependent variable as shown in table 3. The results show that, all independent variables in this study correlates significantly with the dependent variable which is the quality of the fresh fruit bunch. Nevertheless, according to Guildford Rule of Thumb, among the independent variables the harvesting activity has the highest correlation with $p = 0.827$. This result confirmed that the harvesting activity is the most important process in ensuring the quality of the oil palm fruits. The harvester has to have enough knowledge in determining the level of optimum ripeness to gain maximum oil extraction and final crude palm oil quality. Harvesting premature fruits will lead to low quality of output and wasting of resources in the production. Handling at the plantation area is found to be the second important factor in determining its quality. Results show in table 3, that handling at the plantation area correlate significantly with $p = 0.808$. Where handling at intermediary collection center and protection during transportation are also significant at $p = 0.521$ and $p = 0.434$ respectively. Having the optimum oil palm FFB alone does not ensure the quality if it is not properly handled before the oil palm FFB reaches the extraction process. The time taken to the processing center, the equipment used in handling the oil palm FFB and probably the infrastructure (i.e. transportation and road condition) may reduce the fruits damages and thus contribute to the quality of the oil palm FFB. As a result, harvesting activity, handling at plantation area, handling at intermediate collection center, and oil palm FFB protection during transportation as independent variables with significance can explains 82.80% (R square) of the variance that reflects the quality of oil palm fresh fruit bunches (FFB) as dependent variable as shown in table 4. The pilot test study model was a fit model according to ANOVA table 5, with the significant value $p <0.05$.

5. Conclusion

In order to maintain the oil palm FFB quality, harvesting activity should be given priority especially in selecting which fruit bunch is ready for harvest. Other than that, handling process and fruit protection after harvesting also need to be considered to ensure the quality of oil palm FFB. By having good quality oil palm FFB, it will help increases the production of the crude oil palm per ton as land scarcity is our main issue in expanding the industry. The limitation of the study employs exploratory and descriptive design, with quantitative approach and purposive sampling using self-administrated questionnaires, were obtained from 30 smallholder respondents from the Southern Region, Peninsular Malaysia. The recommendation of the study for the future researcher is to conduct an actual sampling based on the actual population of smallholders in Malaysia and to employ this pilot study test model.

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References


