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Modelling The Effects of Weather Parameters and Types of Fertilizer on Oil Palm's Fresh Fruit Bunches (FFB) Productivity and Oil Qualities in Malaysia: Case Study of Merlimau Jasin Melaka

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Abstract

Oil palm industry already in Malaysia for almost 105 years since 1917. However the FFB yield and OER performance still below that the national target that is 35:25 (FFB yield: OER).This research is intended to examine the nature of the relationship between FFB yield, OER and the elements involve (types and rates of fertilizer, rainfall, wind speed and temperature). As well as to discover the most powerful factor in influencing the FFB and OER performance. All the secondary data have been collected from oil palm estate in Merlimau Jasin District. Analysis that being used are descriptive and inferential analysis (Pearson correlation and regression). The study reveal FFB yield has a positive relationship with Bio-Organik Fertlizer BOF (r=0.819) and Bulk Blending fertilizer BBF (r=0.631). In contra, the OER has a negative relationship with the rainfall(r=-0.335), meaning that, the higher rainfall occur, the lower quality OER will be produce. Not like BOF and BBF, only wind speed from weather parameters gives a large adverse effect by reducing the FFB productivity, it is a different result compared to the previous study in 2021 by Ahmed Abu Bakar et al. The author mentions all the weathers element were not influencing the FFB yield. For OER, it is a new finding because three (rainfall, temperature, and wind speed) out of four from weather parameters give a negative impact.

Keywords: Weather Parameters, Yield, OER (Oil Extraction Rate), Fertilizer, Temperature, Wind Speed, Rainfall, Fresh Fruit Bunches (FFB) and Productivity.

Introduction

Since 1917 until 2022, it already 105 years Malaysia involve commercially in palm oil industry. By year and decade, the country become more experienced by developing a lot of research and improving their management practices either in estate or mill. No wonder, this sector play a significant role in boosting the national economy. Nevertheless, 2022 will be a year for Malaysia facing a massive challenged like declining FFB yield and OER quality due to climate

change, rising Potash fertilizer cost for almost 93 percent (CGS-CIMB, 2022). Therefore, Best Management Practices (BMP) is required to be implemented to achieve high FFB yield. Fertilization plays vital role in plantation management to determine the state of FFB yield. Although many countries respond to subsidizing fertilizer, economists have been sceptical that farmers still use their money for fertilizer expenses (Duflo et al., 2008). Both issues need to be tackled to avoid the drop of FFB yield. When it comes climate change like el Nino, La Nina, it will cause a decreasing bunch and oil yield up to 20%. The dry season will impact the sex ratio and reduce the number of Fresh Fruit Bunches (Gunawan et al., 2021). When the rainfall pattern changes, especially long drought periods will give oil palm plantations difficulties in a long-term manner. The production of this plant decreases by 10% for every reduction of 100 mm of water due to reduced rainfall. But the information and study on weather elements and types of fertilizer are still low especially their effects on OER. For this reason, this research is important to investigate the weather parameters, BOF and BBF in affecting the FFB and OER.

Hence, the objectives of this study are:

1) To study the relationship among the FFB yield, OER, types of fertilizer and weathers elements.
2) To identify the dominant factors that affecting the FFB yield and OER quality.

Materials and Methods

Table 1**:** Technique Analysis Table

Objective	**Types of Data**	**Measurement Unit**	**Analysis**
1. To study the relationship among the FFB yield, OER, types of fertilizer and rainfall.	Types of fertilizer Rainfall Wind speed Temperature	Mt/ha mm Km/h Celsius	1.Pearson R Correlation Value (Obj.1)
2. To identify the dominant factors that affecting the FFB yield and OER quality.	OER FFB yield	percentage Mt/ha	2.Regression (Obj.2)

Table 1 give a clear picture about the types of data that been collected and to make sure it aligned with the objectives. Meaning that, all the objectives will be answer by conducting the analysis. Meanwhile, the conceptual framework is the guidance of the study by the correct theories which can make the study will be on track (Dickson, A. 2018). The theories need to be matched with the study so that it will lead to a focus on the purpose of the study. When the purpose of the study has been a focus, the objective of the study will be achieved. The conceptual framework in this study is built on theoretical views and previous empirical research on correlation between factors (types of fertilizer, rainfall, temperature, windspeed) and productivity (FFB yield and OER). The relationship between variables used in this study can be seen in Figure 1. The study conducted at oil palm estate situated at Merlimau Jasin Melaka. Data that being analyzed are 3 years data (secondary data), collected from the Merlimau estate.

Statistical Analysis

All the secondary data that gathered would be interpreted in Social Science Statistical Package (SPSS) 22nd edition. The data is analyzed the proportion and calculated the data of FFB, OER,

Rainfall, temperature, windspeed and types of fertilizer.

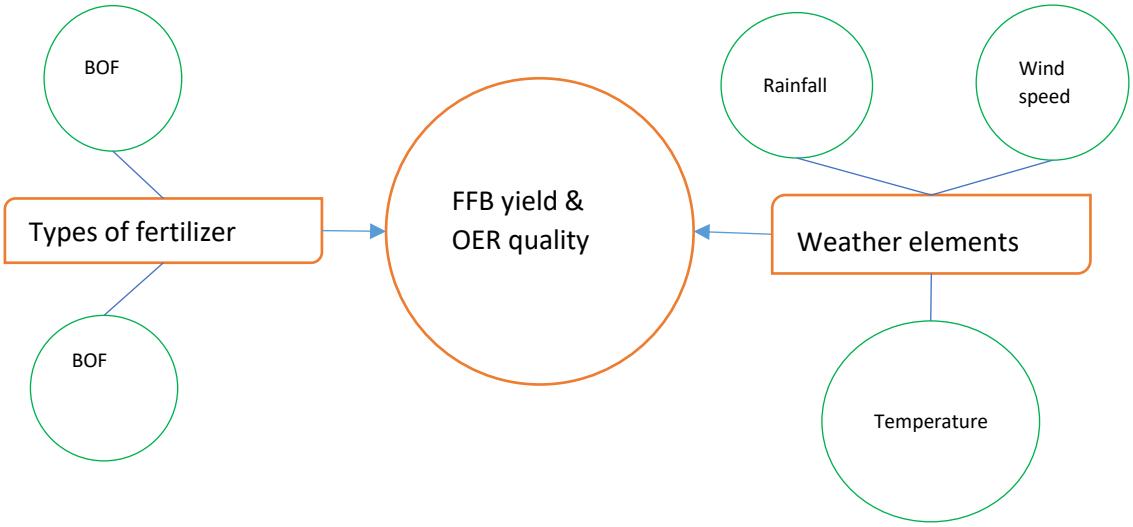

Figure 1: Conceptual framework

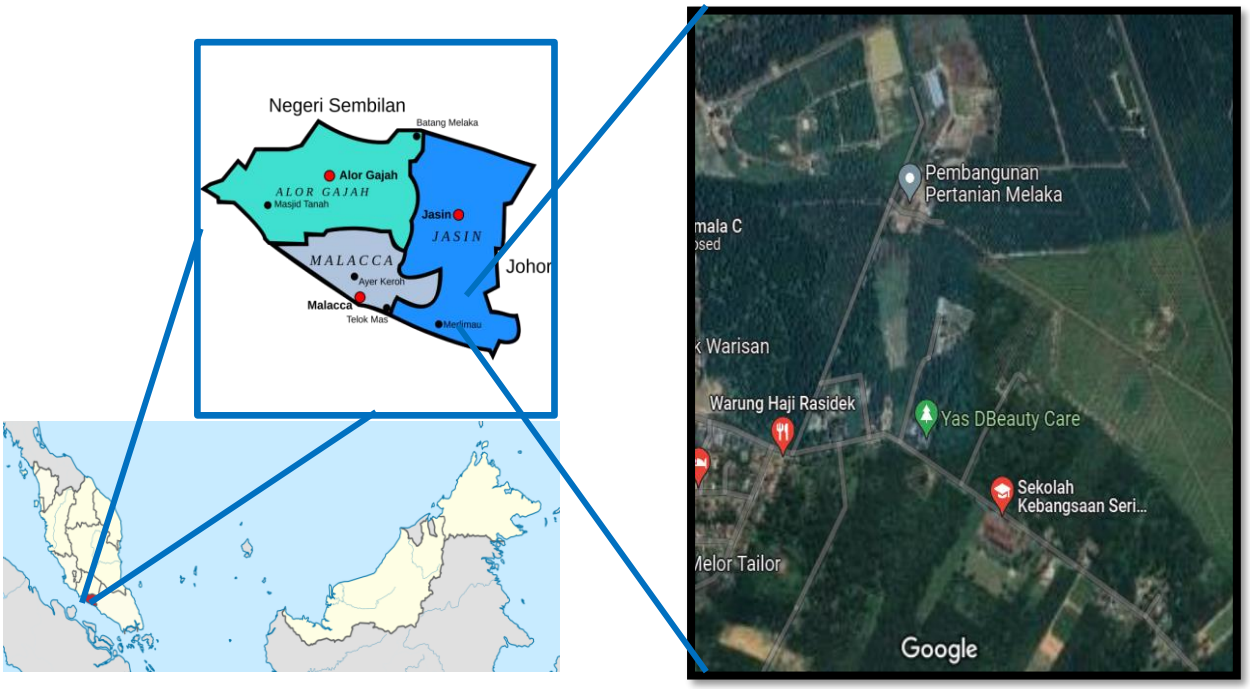

Figure 2: Location of the Merlimau estate.

Results and Discussion

Relationship between Factors Contributed to FFB yield and OER quality

Table 2: Correlations matrix among variables

Variables		Rainfall	Temperature	Windspeed	BOF	BBF	OER
Temperature	Pearson Correlation	-.263					
	Sig. (2-tailed)	.121					
	N	36					
Wind speed	Pearson Correlation	**-.504****	.161				
	Sig. (2-tailed)	**.002**	.349				
	N	36	36				
BOF	Pearson Correlation	.103	-.301	.045			
	Sig. (2-tailed)	.549	.075	.792			
	N	36	36	36			
BB	Pearson Correlation	-.045	.135	-.110	**-.780****		
	Sig. (2-tailed)	.792	.432	.522	**.000**		
	N	36	36	36	36		
OER	Pearson Correlation	**-.330***	-.282	-.169	.000	.000	
	Sig. (2-tailed)	**.049**	.096	.324	1.000	1.000	
	N	36	36	36	36	36	
FFB yield	Pearson Correlation	.007	.239	-.303	**.631****	**.819****	.097
	Sig. (2-tailed)	.967	.161	.073	**.000**	**.000**	.574
	N	36	36	36	36	36	36

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 2 shows the correlation matrix among the variables that is significant. It explained that each of the variables are response to each other, even though it is not significant. The Pearson Correlation Analysis was used to identify the relationship between the independent variables (rainfall, temperature, windspeed, types of fertilizer (BOF and BBF)) that affect the dependent variable (FFB yield and OER). The correlation value is as presented in Table 3 below: -

Table 3: Correlation value Interpreted according to Hinkle, Wiersma and Jurs (1988)

Correlation Value	Relationship Strength
± 0.90 - 1.00	Very Strong
± 0.70 – 0.90	Strong
± 0.50 – 0.70	Averagely Strong
± 0.30 – 0.50	Weak
± 0.01 – 0.30	Very Weak
0	No relationship

Table 4: Analysis of a Correlation among variables for FFB yield

	FFB yield			
Factors	**Significant *(p)***	**Correlation value *(r)***	**Relationship strength**	**Ranking**
Rainfall	0.967	0.007	No relationship	5
Temperature	0.239	0.239	Very weak (Not significant)	4
Wind speed	0.073	-0.303	Weak (Not significant)	3
BOF	0.000	0.631	Averagely Strong (Significant)	2
BBF	0.000	0.819	Averagely Strong (Significant)	1

Based on the findings in table 4, it was found that BBF (r=0.819) and BOF (r=0.631) showed a averagely strong correlation value compared to other factors. Meanwhile, windspeed (r=-0.303) and temperature (r=0.239)) fell under ranking 3 and 4. It is appeared that the rainfall doesn't correlate with the FFB yield. Based on the result of this study, the usage of BOF and BBF in the estate increasing the FFB yield. But the windspeed need to be monitor due to the higher the speed, the lower FFB output will be produce.

Table 5: Analysis of a Correlation among variables for OER

	OER quality			
Factors	**Significant *(p)***	**Correlation value *(r)***	**Relationship strength**	**Ranking**
Rainfall	**0.049**	**-0.330**	**Weak (Significant)**	1
Temperature	0.096	0.239	Very weak (Not Significant)	3
Wind speed	0.324	-0.303	Weak (Not significant)	2
BOF	1.000	0.000	NA	
BBF	1.000	0.000	NA	

The table above (Table 5) explained that the rainfall (r=-0.330), windspeed (r=-0.303) and temperature (r=0.239) have a relationship even it was weak. BOF and BBF shows that there is no relationship between these 2 types of fertilizer on OER quality.

Regression
Coefficient of Determination
Table 6: Model of summary for FFB yield

Model	R	R^2	Adjusted R^2	Effect size
1	0.819[a]	0.670	0.661	Large (Cohen, 1988)
2	0846[b]	0.720	0.699	Large (Cohen, 1988)

a. Predictors: (Constant), BBF
b. Predictors: (Constant), BBF, Windspeed (kph)

R^2 value is said to be strong when in explaining the variation of the independent variables on the dependent variable the value is between 0 (zero) and 1 (one). According to Table 6, the Coefficient of determination (R^2) was 0.67 for model 1; meaning that BBF alone explain its effect on FFB yield equal to 67%.For model 2 the R^2 was 0.72,it mean that,72% were from BBF and windspeed were explain it effect on FFB. While the rest of the elements are not affecting the FFB output.

Table 7: Model of summary for OER

Model	R	R^2	Adjusted R^2	Effect size
1	.330[a]	.110	.083	Small (Cohen, 1988)
2	.510[b]	.260	.215	Medium (Cohen, 1988)
3	.629[c]	.400	.340	Large (Cohen, 1988)

a.Predictors: (Constant), rainfall (mm)
b.Predictors: (Constant), rainfall (mm), windspeed(kph)
c.Predictors: (Constant), rainfall (mm), windspeed(kph), temperature(celcius)

In table 7,it appear 3 model, with model 1:rainfall (R=0.11) already explained 10 percent from this study,and with a combination of rainfall, windspeed and temperature in model 3 (R=0.40), these 3 elements already represent 40 percent affecting the OER. It mean that. These elements have a large effect on OER quality. While the rest 60 percent are the factors that still not been conducted in this research.

Multiple Linear Regressions analysis
Table 8: Results of multiple regression analysis for FFB yield

Unstandardized coefficients			Standardized coefficients			Collinearity Statistics	
Model	B	Standard error	β	*t*	significant	Tolerance	VIF
BBF	0203	0.024	0.795	8.52	0.000	0.988	1.012
Windspeed	-0.090	0.039	-0.215	-2.30	0.028	0.988	1.012

Next is table 8, multiple regression analysis was applied to see which factor impact FFB yield. Regression analysis aids to measure the relative strength of independent variable on dependent variable. Due to two predictors are correlated, multicollinearity must be diagnosed using tolerance and Variance inflation factors (VIF). Values of VIF that exceed 10 and tolerance below 0.25 are regarded as multicollinearity. It is discovered the regression model is fit. All direct relationship between variables and FFB yield were examined using

multiple regression analysis to ascertain the extent to which they explain that the variance in FFB yield. Two variables significantly impact the FFB production with BBF(Beta=0.795) providing the powerful impact and followed by temperature (Beta=-0.215). This indicate that if the rate of BBF increases, then FFB output will also increase. Meaning that, for every 3.6 mt /ha BBF been put in the field, FFB predicted increase about 0.73mt/ha. Meanwhile, if the windspeed increasing, the FFB production will be decrease. Meaning to say, for every 2.18kph, the crop will be expected to decline.

Table 9: Results of multiple regression analysis for OER

Unstandardized coefficients			Standardized coefficients			Collinearity Statistics	
Model	B	Standard error	β	*t*	significant	Tolerance	VIF
Rainfall	-0.003	0.001	-.650	-3.994	.000	-.650	-3.994
Windspeed	-0.070	0.026	-.435	-2.734	.010	-.435	-2.734
Temperature	-0.219	0.081	-.383	-2.686	.011	-.383	-2.686

Table 9 explaining that the rainfall (Beta=-0.650) is the dominance factors affecting the OER. Then followed by windspeed (Beta=-0.435) and temperature (Beta=-0.650). Its explain that for every 84.41 mm rainfall drop, it is expected the OER percentage will be decline for about 0.23 percent. Second powerful factor affecting the OER is windspeed. For every28.5 kph hit the Merlimau estate, the OER will be drop almost 0.15 percent. Followed by temperature, meaning that,when it reach 28.3C^{o} the OER expected to decline almost 0.14 percent.

Conclusion

The weather conditions (rainfall, temperature, wind speed) and types of fertilizers in impacting FFB and OER output quality has been examined satisfactorily. By using BOF and BBF in field, the FFB yield increasing, however only BBF give a better result and large effect on the fruit production, therefore the estate should consider applying another types or brand to replace the BOF or find another alternative like MOP (Muriate of Potash), Yara Mila Fertilizer, MPOB F2 and Ajib CRF. Not like BOF and BBF, only wind speed from meteorological factors produces a major detrimental influence by reducing the FFB productivity, it is a different result compared to the earlier study in 2021 by Ahmed Abu Bakar et al. The author mentions all the weathers components were not influencing the FFB yield. For OER, it is a new finding because three (rainfall, temperature, and wind speed) out of four from meteorological parameters produce a negative influence. Conclusively, the findings will support the oil palm industry especially the estate management in fighting climate change in this following year by offer a new variety that can bare stand the weather challenge. For types of fertilisers, the management level can plan which types of fertilizers that suit or alternative to the existing fertilizer, indicating that the oil palm yield and OER quality still can be maintained and improvised.

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