THE EFFECTS OF CROP INTEGRATION ON FERTILIZER COST AND OIL PALM YIELD

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Abstract

Oil palm crop integration is an effective practice to be applied by oil palm growers in their plantation. The objectives of the study were to determine the effects of crop integration on the cost of fertilizer and to identify the effect of crop integration to the yield of oil palm. The study was carried out at Felda Kota Gelanggi 1, Felda Kota Gelanggi 2, Felda Kota Gelanggi 3, and Felda Kota Gelanggi 4, Pahang. The questionnaire consists of 35 questions that are related to crop integration of oil palm, which are distributed among the respondents. Accordingly, statistical tests that were conducted had included Pearson correlation, Bivariate Correlation, Partial Correlation and Wilcoxon Signed Rank Test. The results indicated that there were differences on the cost of fertilizer before and after crop integration where the P-value is 0.029, and the strength of the correlation is 0.562. They also showed the differences in the amount of oil palm yield where the P-value is 0.006 and that there was a significance results between the oil palm yields before and after crop integration. This study is important to encourage the settlers to apply crop integration and to help them to increase the income and reduce the farm cost. Therefore, the settlers are encouraged to apply crop integration on their oil palm due to the positive results that has been shown.

Keyword: Cost, Crop Integration, Oil Palm, Yield

Introduction

The oil palm tree or *Elaeis guineensis* has originated from West Africa where it grows in the wild which is then developed into an agricultural crop (Zainal, 2010). The Malaysian Palm Oil Council (MPOC, 2012) has reported that oil palm has been introduced in Malaysia by the British in the early 1870's as an ornamental plant. In 1917, the first commercial planting took place in Tennamaran Estate in Selangor, laying the foundations for the vast oil palm plantations and the palm oil industry in Malaysia. The oil palm was commercially exploited as an oil crop only from 1911 when the first oil palm estate was established (MPOB, 2011). Today, Malaysia is the second largest oil palm producers in the world after being overtaken by Indonesia in 2006.

Integration is a system that involves the planting of permanent crop with other cash crop plant or livestock in the oil palm estate (Zulkifli et al., 2010). Integration can be done when two or more crops are grown together, and each integration must have adequate space to maximise cooperation and minimise competition between the crops. Integration of oil palm with other crops such as rubber, teak, and Sentang has been investigated by many researchers as reported by Lee et al. (2005). For integration of oil palm, usually the areas of one to three

years old of oil palms, still have wide empty spaces among the rows of oil palms; this is similar for the areas of four to five years old oil palms (Corley & Tinker, 2003). The wide empty spaces among the rows of oil palms have resulted in ineffective or inefficient utilisation of environmental resources, such as land, growing space, sunlight, and carbon dioxide (Eka et al., 2012). Therefore, integration is effective for oil palm plantation. Plant integration provides many benefits to oil palm producers. Among the benefits of integration are integration includes providing higher income per unit area than sole cropping, it acts as an insurance against failure of crop in an abnormal year, maintains soil fertility as the nutrient uptake is made from both layers, reduces oil runoff, increases the productivity of the estate, conserves the soil structures, reduces the development and maintenance cost, increases the oil palm production and reduces risk (Zulkifli et al., 2010).

Integration in oil palm plantation refers to the implementation of a system in farming that involves planting crops, raising livestock or other agricultural activities in oil palm plantations. For the young crop (less than three years), the growth of palm fronds and roots is still limited, thus this enables a high percentage of sunlight to reach the earth; this situation allows a variety of crops to be grown in the area between the lines and palm trees. As the crop mature, large palm fronds could limit the penetration of light and this makes the surrounding area unsuitable for planting trees, however, the various types of weeds that grow under the oil palm tree are suitable as feedstuffs for livestock (Basri et al., 2010).

According to Lam et al. (2008), the integration system has benefited settlers especially in saving labour cost of up to 50% per hectare per year, reduced weeding cost by 30-50%, increase oil palm fresh bunch by 6-30%, lower usage of chemical fertilizers and improvement of soil structure through the addition of organic matter to the soil. Plant integration provides many benefits to oil palm producers. Among the benefits of integration include providing higher income per unit area than sole cropping, it acts as an insurance against failure of crop in abnormal year, integration maintains soil fertility as the nutrient uptake is made from both layers, reduces soil runoff, increases the productivity of estate, conserves the soil structures, reduces the development and maintenance cost, increases the oil palm production and reduces risk (Zulkifli et al, 2010).

Moreover, integration activities in oil palm plantations are included in the high-income strategy of the Malaysian Palm Oil Board (MPOB) in order to achieve its mission to strengthen the country's oil industry. Besides, the production of some products through the integration system is in line with the government's strategies to reduce the cost of importing food. According to Zulkifli et al. (2010), the studies on crops such as banana, pineapple, groundnut, and soybean have shown that these crops have high potential to be integrated in the oil palm plantation. Integration helps the oil palm producers increase their production. However, the settlers refuse to implement the crop integration with oil palm due to the concern that the cost of fertilizer changes and the crop may affect their oil palm yield. On the contrary, crop integration is expected to reduce the cost of fertilizer and increase the yield of oil palm. Thus, this study aims to determine the effects of crop integration on the cost of fertilizer and yield of oil palm, and to identify the relationship between the cost of fertilizer and the yield of oil palm. This study solely focuses on the Felda Kota Gelanggi 1- 4 settlers who are practising crop integration at their oil palm field.

Materials and Methods

The population in this study was chosen from the number of populations of FELDA settlers who applied crop integration in their oil palm plantation. The data was obtained from the manager of FELDA Kota Gelanggi 1- 4. The total population was 15 settlers. Sample is a representative portion of a population (Salkind, 2012). According to Salkind (2012), 10% of the size of the population could be considered as a sample size. However, the minimum

number that is required is 30 samples and not more than 500 samples for each research (Cavana et al., 2001). Thus, in this study, the number of the sample size is the number of the total population, which is 15. The pilot tests were done before the actual questionnaire was distributed. The data of this study were collected through the questionnaire that was distributed to the selected settlers. The questionnaire had included a cover letter that explained the reasons of the study; the importance of a cover letter was to establish a sense of authority and to convey the importance of the project.

Result and Discussion

Table 1 shows the summary of measurement, scale, and statistic. The data that had been gathered from the questionnaire were analysed using the Statistical Packages for Social Science (SPSS). According to Cavana et al. (2001) SPSS is a specialised statistical package for the analysis of numerical data. By using the SPSS, the data is analysed in terms of mean, median, standard deviation and inferential statistics. For this study, SPSS was used to carry out the significance and correlation between the variables, whereas Microsoft Excel was the software that had been used to gather the data; its function was to perform calculations, analyse information and visualise data in spreadsheets. In this study, Microsoft Excel was used to illustrate the demographic in a graph form.

Table 1 Summary of measurement, scale and statistic

	Item	Measurement	Scale	Statistic
1.	Demographic	Gender, Age, Marital status, Generation status, Race, Education level	Interval	Descriptive statistic
2.	Objective 1: to determine the effects of crop integration on the cost of fertilizer	Percent of change in fertilizer usage, Cost of fertilizer before & after integration	Interval	Pearson Correlation & Partial Correlation
3.	Objective 2: to identify the effects of crop integration on the yield of oil palm	Tonnes of oil palm production before & after oil palm integration	Interval	Wilcoxon Signed Rank Test

Descriptive statistics

Table 2 demonstrates the descriptive analysis of the total respondents. All 15 respondents involved in the study were male, where the age range of 8 respondents (53.3%) were from 60 to 70 years, 5 respondents (33.3%) within the age range of 50 to 60 years, and 2 respondents (13.3%) in the age range of 70 and above. In addition, all the respondents (100%) were married and 13 of the respondents were first generation Felda settlers while the other two (13.3%) were the second generation of Felda settlers, which could be the sons of the first-generation settlers. All respondents (100%) in the study were Malay and had completed their study up to standard six, i.e., the primary school only.

Table 2 Descriptive analysis

No	Measurement	Frequency	Percent
1	**Gender**		
	Male	15	100
	Female	0	0
2	**Age of respondent**		
	50-60	5	33
	60-70	8	53.3
	70 and above	2	13.3
3	**Marital Status**		
	Married	15	100
	Single	0	0
4	**Generation Status**		
	First generation	13	86.7
	Second generation	2	13.3
5	**Race**		
	Malay	15	100
	Non-Malay	0	0
5	**Education Level**		
	Standard 6 Primary School	15	100

The effect of crop integration on the cost of fertilizer

Table 3 shows the correlation between the cost of fertilizer before integration and the cost of fertilizer after integration, the result shows a significant value where the p-value is 0.029. The strength of the linear relationship between the cost of fertilizer before integration and the cost fertilizer after integration is a strong positive which is 0.562. According to Davis (2011), the range of correlation coefficient between 0.50-0.69 shows that the strength of the Linear relationship is strong.

Table 3 The correlation analysis between cost of fertilizer before and after integration

		Cost fertilizer before integration	Cost fertilizer after integration
Cost fertilizer before integration	Pearson Correlation	1	.562*
	Sig. (2-tailed)		.029
	N	15	15
Cost fertilizer after integration	Pearson Correlation	.562*	1
	Sig. (2-tailed)	.029	
	N	15	15

Meanwhile, **Table 4** shows significant results in the percentage of change in the usage of fertilizer with cost fertilizer before integration and after integration where the p-value is 0.027. The correlation between percentage that change in the use of fertilizer with cost fertilizer before integration and cost fertilizer after integration is a strong positive linear relationship which is 0.589. According to Zhang et al. (2010), the one year old oil palms that have been intercropped with soybeans and groundnuts have the advantage for an additional supply of nitrogen (N) from the soybeans and groundnuts which are from the legume family, and thus have the ability to obtain free nitrogen from the air through a mutualism symbiotic

with Rhizobium. Thus, the crop integration will help to reduce the number of nitrogen fertilizer that is to be applied to the oil palm crop.

Table 4 The correlation between percentage of change in cost of fertilizer before and after integration

Control Variables			Cost fertilizer before integration	Cost fertilizer after integration
Percent that change in use of fertilizer	Cost fertilizer before integration	Correlation	1.000	.589
		Significance (2-tailed)	.	.027
		df	0	12
	Cost fertilizer after integration	Correlation	.589	1.000
		Significance (2-tailed)	.027	.
		df	12	0

The effect of crop integration on the yield of oil palm

Table 5 shows a significant result in the number of the tonnes of oil palm that is produced before and after the integration with the p-value of 0.006 which is higher than a monocrop plantation. According to Ooi (2008) the fresh fruit bunch (FFB) yield was extremely low at between 6 and 8 tonnes per hectare per year in a monoculture plot as compared to the crop integration plot with an average between 15.9 and 20.3 tonnes per hectare per year. This is because the seed source or planting material, good agricultural practices such as crop integration together with the proper amount of fertilizer are factors that ensure the optimum yield of oil palm.

Table 5 Wilcoxon Signed Rank Test between tonnes of oil palm before and after integration

	Tonnes_after - Tonnes_before
Z	-2.725[a]
Sig. (2-tailed)	.006

The constraints faced by settlers on oil palm crop integration

Table 6 shows the most constraint that were faced by the settlers during crop integration is theft was 93%. 47% of the respondents stated that they faced damages from wild animals and other pests such as monkey, rodents and pigs on their crop, while 40% of the respondents faced the problem of input cost, and 20% of the respondents stated that the unpredictable weather was their main constraint. The other 13% of the respondents had stated problems such as fluctuation in market price, insect damages and storage problems as their constraints.

Table 6 The constraints faced by settlers during crop integration

No.	Constraints	Frequency	%
1	Input cost	6	40
2	Damages by wild animals & pests	7	47
3	Weather & environment	3	20
4	Theft	14	93
5	Others	2	13

Conclusion

As a conclusion, the study indicates that the effects of crop integration have a significant difference between the cost of fertilizer and the yield of oil palm. From the result, crop integration has been proven to have an effect on the oil palm where the cost of fertilizer gives both positive as well as negative changes; the amount of yield of FFB also changes after the integration. Besides, the settlers also gain an additional income from the crop integration which simultaneously can increase the productivity in oil palm plantation. However, before any crop integration is implemented, the oil palm settlers must first identify their planting techniques in order to ensure that the crop integration could be implemented.

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Conflict of interests

Author declares no conflict of interest.

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