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Technical and Productivity Efficiency of Agriculture Inputs in Pineapple (*Ananas Comosus Sp.*) Production: A Case Study in Muar, Johor, Malaysia

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Abstract
Pineapple production has contributed about 0.24% towards the Malaysian gross domestic product (GDP). However, the average current national pineapple production value which is 30 Mt/ha still considered as low productivity since it is much lower compared to the national target of 40 Mt/ha. The low national pineapple productivity might be caused by the inefficient inputs' usage which is still below the economies of scale. The objectives of this research were to analyse the technical and productivity efficiency of agricultural inputs and to assess the relationship between the different rates of agricultural inputs with pineapple production. The data was collected from 97 respondents in Muar State, Johor, Malaysia. The data were analysed using the technical efficiency (TE) formula, focusing on significant technical efficiency in utilizing agricultural inputs to improve pineapple production. Besides that, correlation and multiple regression analyses were used in assessing the significant relationship between agriculture inputs and pineapple production. As a result, from technical efficiency analysis, it was found that the herbicides and pesticides technical efficiency is the highest among all three agricultural inputs used and has a significant technical effect on pineapple production. The regression analysis also suggested that the pesticides and herbicides inputs as the most dominant inputs affecting the pineapple production. Thus, it was recommended that the related organization come out with guidelines and policies for controlling the inputs for the production, especially focusing on pesticides and herbicides to improve the national pineapple production.
Keywords: Pineapple, Technical Efficiency, Productivity, Dominant, Pesticides/Herbicides, Smallholder

Introduction

Pineapple is one of the most promising fruits in Malaysia, with high demand in both the local and international markets. 70% of the pineapple produced is consumed as fresh fruit in the country oforigin, out of total production of 100%. It is originated in warm climates in the Americas, with Thailand, Brazil, the Philippines, India, and China serving as the primary producers (Suhaimi *et* al., 2021). Many smallholders in Malaysia rely on pineapple for income generation because of its high nutritional value and delicate flavour. The main pineapple varieties in Malaysia are: 'Moris', 'N36', 'Sarawak', 'Gandul', 'Yankee', 'Josapine', 'Maspine', and most recently 'MD2' (Lasekan and Hussein, 2018). Lower productivity of pineapple production as compared to national target production can be related to the inefficient usage

of agricultural inputs in improving pineapple production. Example of agriculture inputs related to pineapple production includes labour, fertilizer pesticides and fungicides. Thus, this study focused on studying the agricultural inputs relationship with pineapple production. The objectives of this research were to analyse the technical and productivity efficiency of agricultural inputs and to assess the relationship between the different rates of agricultural inputs with pineapple production. Based on the results obtained from this study, it would contribute towards economic knowledge and as a guide for pineapple producers in obtaining the optimum profitability for pineapple production in Malaysia.

Research Methodology

The location of the study is Muar a district in Johor. Johor state was determined to have the most prominent pineapple fruit cultivation area with approximately 15,263 ha. Agricultural land accessibility, favourable soil conditions, and an appropriate environment are all factors that contribute to the production of high-quality fruit in Johor (Suhaimi *et* al., 2021). Using the convenience sampling method, the sample size of 97was chosen out of the 128 total populations of pineapple smallholders in Muar. Subsequently, a sample size is determined based on (Krejcie & Morgan, 1970). The questionnaire can be utilized to measure socio-demographic variables, productivity, technical efficiency, and factors affecting production. In addition, to gather information from smallholder pineapple farmers, structured survey questionnaires were supplemented with questions administered using standardized questions with a fixed scheme which is an objective type of question, which specifies the exact wording and order of the questions to gather information from the participants. Social Science Statistical Package (SPSS) version 21 is the primary instrument employed in this investigation. In this study, many forms of data analysis were used, including technical efficiency formulas, descriptive analysis, and correlation analysis. The significance level of this study was determined by the p-value of 0.05.

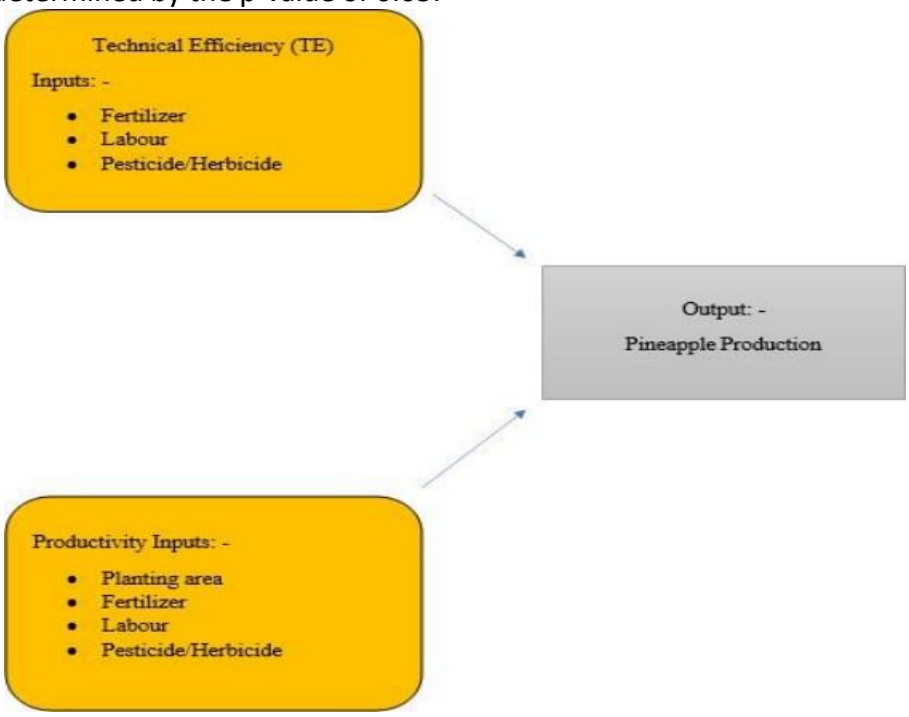

Figure 1. Research Conceptual Framework

Results and Discussion

Descriptive statistic for demographic information

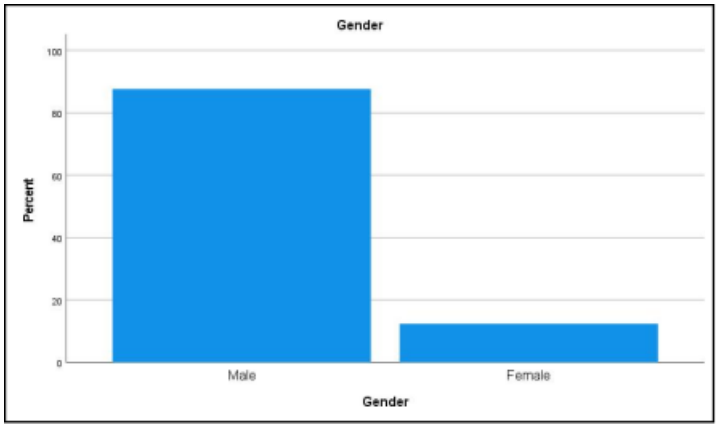

Figure 2 (a) Demographic information based on gender.

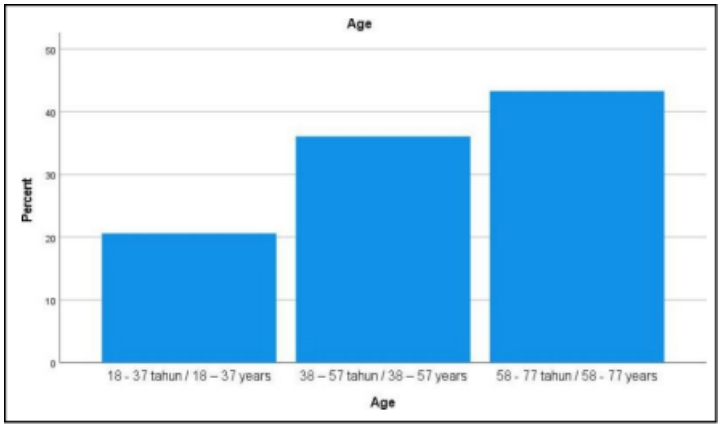

Figure 2 (b) Demographic information based on age.

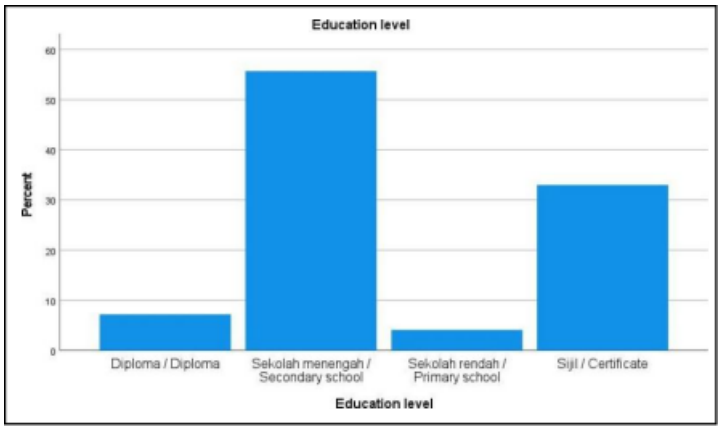

Figure 2 (c) Demographic information based on education level.

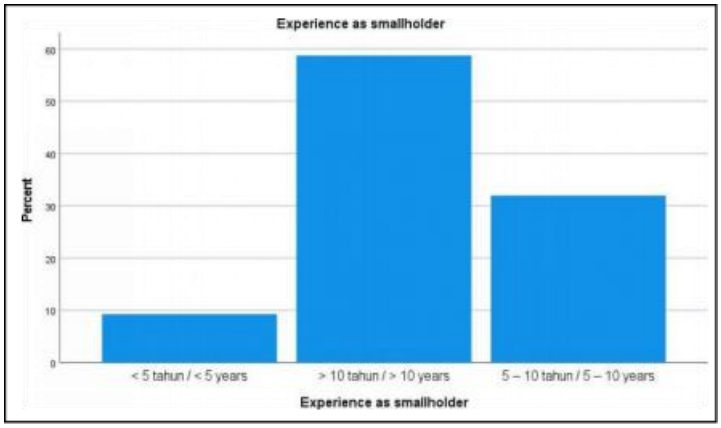

Figure 2 (d) Demographic information based on experience level.

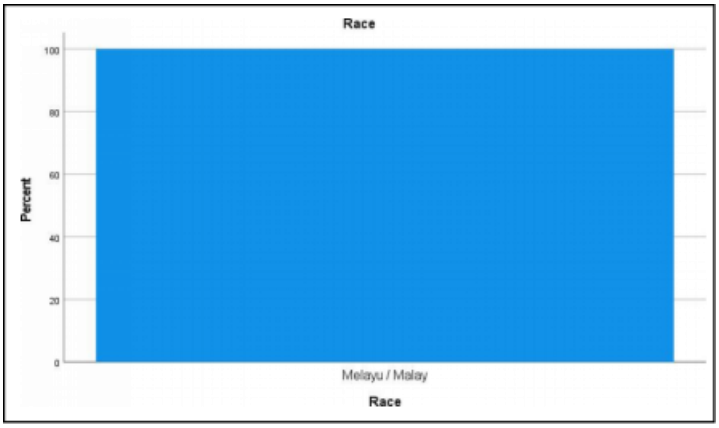

Figure 2 (e) Demographic information based on race of respondents.

Figure 2 above shows the results of the descriptive analysis of the demographics of respondents. Most of the smallholders in Muar, which was about 42 respondents (43.3%) the aged 58 years old to 77 years old. Most of the respondents of pineapple production in Muar were males which comprises 87.6% while the remaining 12.4% are females. Malays have dominated the population as it comprises about 100% of the population with 97 respondents. Besides, most of the smallholders possessed secondary education which accounted for 55.7% (54). The remaining 4.1% of pineapple smallholders completed primary education and about 40.2% of the respondents attending tertiary education or university level. About 9.3 % of the smallholders had less than 5 years' experience or involvement in activities related to the pineapple industry. About 58.8% of smallholders have the experience of more than 10 years, and the average percentage was 32 % for those who have 5 to 10 years of experience.

Technical and Productivity Efficiency
Technical Efficiency of Inputs

$$\text{Technical Efficiency of Inputs} = \frac{Pineapple\ production\ (pcs)}{Amount\ of\ Inputs}$$

Table 1
Technical Efficiency of Inputs Related

Input	Technical Efficiency (TE) value
Fertilizers	38403 /3320 =11
Labour	81800/929.4 = 88
Pesticides and Herbicides	30356/109.2 = 280

Based on Figure 3, the pineapple production is 38,403 per hectare and the usage of fertilizer for 97 smallholders is 3320kg. Hence, the small holder's technical efficiency for fertilizer is 11. This means 1kg of fertilizer can produce 11 pineapple production. Since the fertilizer ratio is greater than 1, it shows that the inputs have a significant technical effect towards pineapple production. The amount quantity of fertilizer being used gives a response to the pineapple production. The quantity of fertilizer applied was directly related to the output of pineapple (Balogun *et* al., 2018). The reason isthat agronomic evidence has shown that pineapple yields are responsive to fertilizer application.

The pineapple production is 81,800 and the total labour working hours in a month for 8 workers and working hours per day is 4 hours and a half, thetotal is 929.4 hours. The smallholder's technical efficiency for labour is 88. This means 1-hour work of labour can produce 88 pineapple production. Since the agriculture input is greater than 1 it shows the inputs have a significant technical effect towards the pineapple production. Hence, work in the farm will be more organized and labourers will be able to achieve the quantity needed to achieve efficiency. This statement is supported by Balogun *et* al (2018), labour that gives a significant technical effect towards pineapple production is efficiently managed along with other inputs to avoid redundancy and diminishing return to labour. The pineapple production is 30,536 and the usage of pesticides and herbicides is 109.2 litres. The smallholder's technical efficiency for pesticide and herbicide is 280. This means 1 litre of pesticide and herbicide can produce 280 pineapple production. Since the agriculture input is greater than 1 it shows the inputs have a significant technical effect towards pineapple production. The finding of the technical efficiency levels among the smallholders in the pineapple production indicates that most of the smallholders are givensignificant technical efficiency in utilizing the agriculture inputs to ensure that they would be able to enhance the pineapple production for the next season. Lastly, the smallholders could still improve their production of pineapple with fewer existing inputs if they were more technically efficient.

Correlation Analysis

Table 2

Correlation table

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

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

		The area Of pineapple crop	Types of pineapple variety	Fertilizer	Herbicide/ pesticide	Labour
Pineapple production	Pearson Correlation	0.498	-0.168	0.287	0.614	0.544
	Significant (2 tailed)	< 0.001	0.099	0.004	< 0.001	< 0.001
	N	97	97	97	97	97

The correlation between the area of pineapple crop and pineapple production is 0.498. This result shows a moderate relationship between the area of pineapple crop and pineapple production. That means more outputs could be produced with an increase in the quantity of land and efficient use of land resources (Etwire*, et* al., 2013). In the types of pineapple variety, the correlation with pineapple production was -0.168 and it shows the low negative relationship between them. The correlation between fertilizer and pineapple production is 0.287. It shows a low relationship between fertilizer and pineapple production. The correlation between herbicide/pesticide and pineapple production is 0.614. The correlation between labour and pineapple production is 0.544. This means herbicide/pesticide and labour show a strong relationship between them and pineapple production. The significant level for the area of the pineapple crop is less than 0.001, the significant level for the fertilizer at 0.004, the significant level for the herbicide/pesticide at less than 0.001, and the significant level for the labour at less than 0.001. Since the p-value is less than 0.05, there is a significant relationship between the area of pineapple crop, fertilizer, herbicide/ pesticide, and labour towards pineapple production. The significant value is 0.099and the p-value must be less than 0.05. This shows that there is no significant relationship between the types of pineapple variety and pineapple production. According to Liu *et* al (2021), in the long term, the use of fertilizer will increase yield production and improve soil nutrientenvironmental conditions. According to Colbach and Cordeau (2018), reducing herbicides will harm crop production and Jawale *et* al (2017) stated that plant pesticides increase crop yield in agriculture by protecting plants. When the productivity of labour increases, pineapple production will increase. This statement is supported by Jackson (2017) which said that when the rates of labour productivity increase, then the production of output increases.

Multiple Regression Analysis

Table 3

Model Summary Table

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.744[a]	.553	.534	.703	.685

a. Predictors: (Constant), The area of pineapple crop, Fertilizer, Herbicide/Pesticide, Labour

b. Dependent Variable: Pineapple production

The result shows that the value of R is 0.744 which is the correlation between the independent variable and dependent variable. The R Square was 0.553 which means there are only 55% o f pineapple production was explained by independent variables. Meanwhile, another 45% was being explained by another factor that is not included in this study. The adjusted R Square is 0.534.

Table 4

ANOVA Table

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	56.392	4	14.098	28.490	<.001[b]
	Residual	45.526	92	.495		
	Total	101.918	96			

a. Dependent Variable: Pineapple production

b. Predictors: (Constant), The area of pineapple crop, Fertilizer, Herbicide/Pesticide, Labour

The table above displayed an ANOVA table with four independent variables which are the area of pineapple crop, fertilizer, herbicide/ pesticide and labour and one dependent variable which is pineapple production. The F value of 28.49 is significant, with a p-value is less than 0.001. These prove that the study is significant.

Table 5
Coefficients Table

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.122	.210		-.581	.562
	Labour	.050	.052	.092	.965	.337
	HerbicidePesticide	.146	.026	.506	5.525	<.001
	Fertilizerrr	.002	.010	.019	.233	.817
	The area of pineapple crop	.253	.058	.374	4.331	<.001

a. Dependent Variable: Pineapple production

Analysis showed that independent variables of the area of pineapple crop, fertilizer, herbicide/ pesticide, and labour toward the pineapple production through the positive value of Beta. Hence, the significant value was measured by p-value which is smaller than 0.05 is significant. The constant value is - 0.122, which means that if the area of pineapple crop, fertilizer, herbicide/ pesticide, and labour are constant or equal to zero (0), pineapple production will equal -0.122.

Labour has a coefficient regression of 0.092. It means if labour increases by 1unit (scale), pineapple production will increase by 0.092 units (scale) with the assumption that other independent variables are constant. Herbicide/Pesticide has a coefficient regression of 0.506. It means if herbicide/pesticide increases by 1 unit (scale), pineapple production will increase by 0.506 units (scale) with the assumption that another independent variable is constant. Fertilizer has a coefficient regression of 0.019. It means if fertilizer increases by 1 unit (scale), pineapple production will increase by 0.019 units (scale) with the assumption that other independent variables are constant. The area of the pineapple crop has a coefficient regression of 0.374. It means if the area of pineapple crop increases by 1 unit (scale), pineapple production will increase by 0.374 units (scale) with the assumption that other independent variables are constant. The p-value for herbicide/pesticide and the area of pineapple crop is less than 0.001 and it is significant since the p-value is more than 0.05. The p-value for labour is 0.337and for fertilizer is 0.348 and it is not significant since the p-value is more than 0.05. Based on Table 5, it also can be concluded that herbicide/pesticide is the most dominant factor in this study. This is because each unit of change to herbicide/pesticide will have a high impact on the pineapple production compared to other factors mentioned in this study. In regression analysis, the two factors that are significant are the area of pineapple crop and herbicide/pesticide, while the other two factors, fertilizer and labour are not significant.

Conclusion

The production of pineapple had been fluctuating since 2013 until 2016. The highest production of pineapple in Malaysia is in Johor which produced 329,954.15 Mt pineapple. This study has utilized the sample through random sampling of 97 sample sizes in Muar. The present study has brought into focus, various issues related to socio-economic status, production of pineapple and technical efficiency among smallholders. Among the issues of this study are instability of the price due to current economic conditions such as demand and supply as well as socio-economic conditions of smallholders and variations in farming practices. Meanwhile, the overuse of input, low education, and training as well as poor

farming practices will affect the technical efficiency and productivity of the smallholders. Therefore,targeting the improvement of inefficient smallholders is important to enhance productivity and technical efficiency under existing technology. The empirical results revealed that the technical efficiency for fertilizer is 11, the technical efficiency for labour is 88 and the technical efficiency for pesticide/herbicide is 280. The technical efficiency of agricultural inputs is greater than 1 which shows that each input has a significant technical effect towards the pineapple production. Furthermore, the significant level for the area of pineapple crop is less than 0.001, The significant level for fertilizer at 0.004, the significant level for herbicide/pesticide at less than 0.001 and the significant for labour level at less than 0.001 and the p value for these four agriculture inputs is less than 0.05. Thus, there is a significant relationship between the area of pineapple crop, fertilizer, herbicide/pesticide and labour towards pineapple production. Meanwhile, the significant value for the pineapple variety is 0.099 and the p-value must be less than 0.05. This shows that there is no significant relationship between the types of pineapple variety and pineapple production. The last findings from multiple regression analysis have shown that herbicide/pesticide is the most dominant factor in this study. This is because each unit of change to herbicide/pesticide will have a high impact on the pineapple production compared to other factors mentioned in this study. Thus, it can be concluded that the pesticides and herbicides were the most dominant factor affecting the pineapple production. Also, in terms of technical efficiency, the return per investment of each pesticide and herbicide input was the highest. As a recommendation, it was suggested that the related agencies for pineapple production can use these research outputs as the baseline data for the generation of policies or guidelines related to improving the national productivity of pineapple.

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