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The assessment of input factors and technical efficiency of rice in IADA Seberang Perak, Kerian and Barat Laut Selangor

(Penilaian faktor input dan kecekapan teknikal padi di IADA Seberang Perak, Kerian dan Barat Laut Selangor)

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Keywords: technical efficiency, input factors, inbred variety

Abstract

Additional input factors in rice production phase is one of the key factors contributing to increase in yield. However, nowadays, the increase in the additional input factors such as area, labour, fertilisers, pesticides and seeds did not seem to significantly increase rice yields. The IADA Seberang Perak, Kerian and Northwest Selangor areas are among three of the eight major granaries in Malaysia. The increase in yields in these three areas had a great impact on the country's rice production and contributed to the sustainability and sufficiency of local food. In addition to input factors, socioeconomic factors are also important issues in explaining dimensions that contribute to improve the yield in rice production. Therefore, this study was conducted to explain and study these factors as well as to determine the performance of the respective Technical Efficiency (TE) of the selected granaries. The data of the study was collected through face to face interviews using structured questionnaires. Random sampling was applied to the proportionate size of farmers' population for each of the three granaries. A total of 180 responses have been successfully attained as 60 respondents represented granaries respectively. The study found that the additional internalisation of input factors did not give much significant impact to the yield increment (decreasing return to scale). Therefore, other alternatives need to be implemented in securing or at least maintaining the output production of rice cultivation in the granaries.

Introduction

The major agricultural focal point in the Eleventh Malaysia Plan (RMK-11) was focusing on the increase in productivity, farmer's skill and enhancing support and delivery services. The intensification of paddy production in Malaysia is strongly related to the efficiency and productivity level alongside technological advancement (Parichatnon et al. 2017). Various incentives and subsidies have been granted by the government to growers in order to increase the productivity as well as the income. The largest government spending on the input subsidy has efficiently reduced the production cost for farmers (Rajamoorthy and Munusamy 2015).

In general, the total parcel area for paddy in Malaysia in 2015 was 678,954 ha. Fifty seven percent of the area is drawn from 8 paddy fields with a total area of 387,020 ha. Rice production in 2015 was

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2.7 million tonnes with an average yield of 4.0 t/ha. Seventy four percent of the total rice production is derived from the country's 8 major producing areas with 1.9 million tonnes of paddy converted into 1.7 million tonnes of rice. The paddy area is divided into the northern, western and eastern zones. In this study, the focus will be on three granaries located in the northern and central parts of the Integrated Agricultural Development Area (IADA) Seberang Perak, IADA Kerian and IADA Barat Laut Selangor.

Background

The arable land especially for rice cultivation, has been decreasing over the years to give way to the development of basic infrastructure such as roads, houses and others. However, at IADA Seberang Perak, it was reported that there was an increasing trend in the parcel over the years despite a slight increase in the area (*Figure 1*). It is estimated that about 0.55% of the increase in cultivated area can be seen in Seberang Perak in 2018 compared to 2014.

Compared to the increase in cultivation over the years in this granary, the average increase did not appear to be in line with the trend. Based on *Figure 2*, there was an average decrease in paddy production between 5 and 15% from 2014 to 2017 before recording an increase of 31% or approximately >1 tonne in 2018 compared to the previous year. The decline in revenue until 2017 may have been attributed to factors such as reduced input and technical efficiency.

Meanwhile in IADA Kerian, the parcel area in 2018 was 41,822 ha, down slightly by 0.18% (76 ha) compared to the previous year. However, this decline was not significant compared to the decline in 2016, which demonstrated a decrease of 156 ha or 0.37% compared to 2015. Smaller fluctuations in number and percentage were common due to technical planting issues during that particular year (*Figure 3*).

There was an insignificant decrease in the output of the average yield in IADA Kerian. Generally, the granary has been operating without facing issues such as decline in cultivation areas. From 2014 to 2017, the average paddy production at IADA Kerian showed no significant increase. However, in 2018 there was a relatively significant increase in average yield of 15.2% compared to the previous year. *Figure 4* shows that the average yield surpassed 5 tonnes in 2018 while it remained between 4.4 and 4.6 tonnes for the previous 4 years. It is possible that the use of modern technologies in the rice cultivation phase at IADA Kerian affected the increase in yield.

During the three years from 2014 to 2016, paddy cultivation at IADA Barat Laut Selangor increased its cultivation area from 37,800 to 38,100 ha. Extensive and widespread declines in 2017 were nearly 1,500 ha before returning to 38,142 ha of cultivated areas in 2018. This may have been due to a severe disease or pest attack

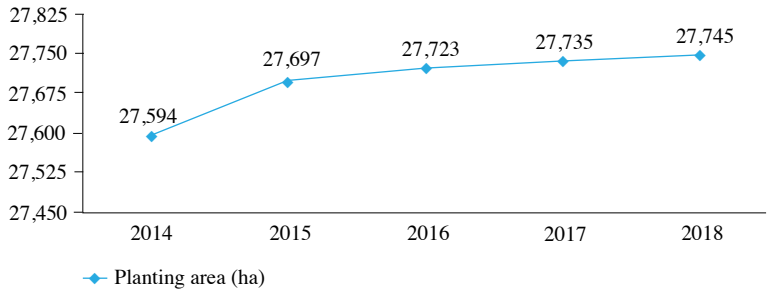

Figure 1. Planting area for silver rice (2014 – 2018)

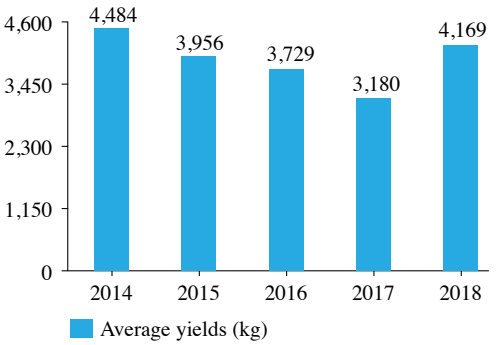

Figure 2. Average yields of FELCRA for silver rice planting (2014 – 2018)

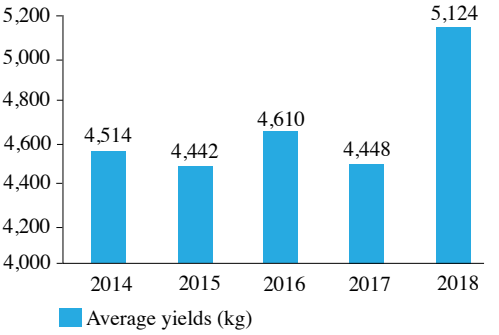

Figure 4. Average yield of IADA Kerian rice cultivation (2014 – 2018)

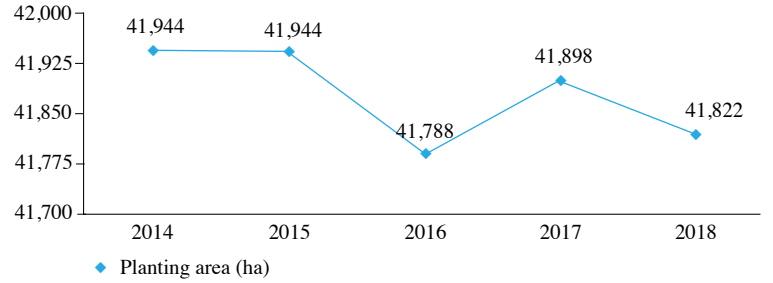

Figure 3. Planting area for IADA Kerian cultivation of rice (2014 – 2018)

during the 2 growing seasons during that year which resulted in a significantly sharp decline in the cultivated area of IADA Northwest Selangor (*Figure 5*).

In accordance with the decline of paddy cultivation area in 2017, average paddy production during the same year also saw a significant decrease of more than 1 t/ha. In addition to the severe attack by pests and diseases, other factors that may be involved include environmental uncertainty that prevailed. However, the above factors are not empirically proven and require further study. Hence, average yields in IADA Barat Laut Selangor returned to pre-2018 levels with an average yield of 6.5 t/ha (*Figure 6*).

An assessment of the inputs used in rice production and the relationship between inputs used and the yield in the rice crop sector is important. The general objective of this study is to construct an economic assessment of inbred rice in the area and also to investigate the impact of input on the selected granaries rice production.

Methodology

This study was conducted on 180 farmers in three areas, namely, IADA Seberang Perak, IADA Kerian and IADA Barat Laut Selangor. Respondents were selected using simple random and random sampling methods by area, region and zone. The selection of respondents was built based on high, medium and low-income categories as well as the use of service providers in cultivation phases. A focus group discussion was organised in each of the selected areas to identify the parameters in order to develop the questionnaire for employed farmers. This group consisted of farmers, service providers and expansion officials. Information and data collected include date of cultivation, soil type, rice varieties, service provider categories and practices of paddy cultivation in each selected area.

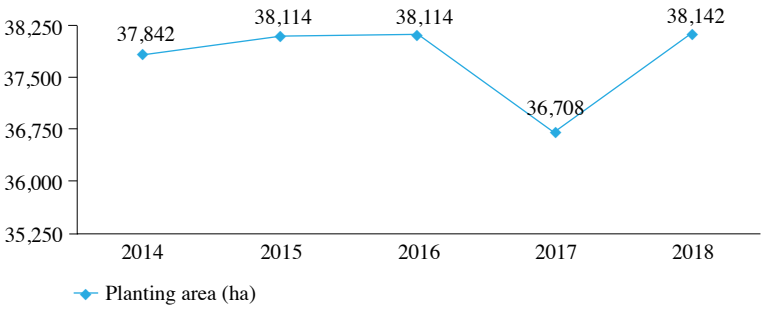

Figure 5. Planting area for IADA rice fields Northwest of Selangor (2014 – 2018)

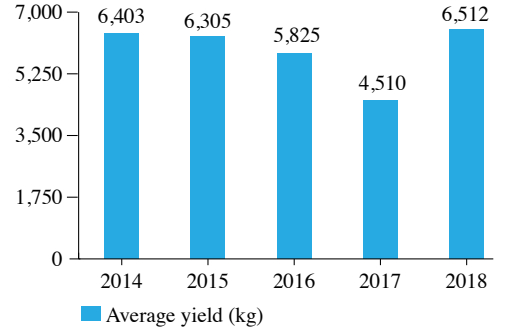

Figure 6. Average yield of IADA Northwestern Selangor rice cultivation (2014 – 2018)

The questionnaire was developed based on the findings of the focus group discussion. Information and data collected through the questionnaire forms included repertoire profiles, field characteristics, rice cultivation practices, technologies used, production costs, yields and factors that influence productivity. Prior to the field survey, a pilot study was undertaken to test the developed questionnaire. The survey was carried out by enumerators assigned to the selected area towards the farmers and service providers for the two planting seasons, namely, off-season of 2018 and the main season of 2018/2019. The face-to-face surveys were carried out by the cooperative agencies of IADA Seberang Perak, Kerian and Barat Laut Selangor staffs appointed according to the area.

The data were analysed using descriptive methods to get a broad overview of respondents' profiles and fields. The technical efficiency analysis was performed using the Cobb-Douglas production function method using the FRONTIER 4.1. A multivariate regression analysis was also performed to identify factors influencing the yield of each granary.

Technical efficiency and elasticity

The combination of inputs in rice production will generate the optimal level of output for each field (Enwerem and Ohajianya 2013). Generally, inputs involved include seeds, fertilisers, pesticides, labour, capital and land. All of these factors of production are considered to be variable inputs, where an increase in one input will result in an increase in output at a reduced rate and eventually, a negative effect will occur if the input continues to increase. Technical efficiency (TE) analysis was performed to measure the most efficient use of resources in the granary areas of IADA Seberang Perak, IADA Kerian and IADA Barat Laut of Selangor. The TE levels of each farmer was categorised by grading as in the previous study of productivity by Raziah et al. (2010). *Table 1* shows the efficiency level based on the percentage of efficiency scale.

The estimated coefficients of the Cobb-Douglas function were used to calculate the elasticity (ε) value of the whole area. The calculation of these elasticity values was to determine the category of return of each field according to three categories (Serin and Radam 2009) as shown below:

- The increasing return to scale that is when the value is $\varepsilon > 1$
- The constant return to scale is $\varepsilon = 1$
- Decreasing return to scale of $\varepsilon < 1$

Table 1. Technical competence level (TE) scale

Percentage of efficiency	Level of efficiency
Less than 25%	Very low
25 – 50%	Low
50 – 75%	Moderate
More than 75%	High

Source: Raziah et al. (2010)

Results and discussion

Profiles of the respondents

Data analysis was conducted on 180 respondents in IADA Seberang Perak (60), IADA Kerian (60) and IADA Barat Laut Selangor (60). A total of 29.9% of the respondents were in the age group of 45 – 54. Of the respondents in IADA Kerian and IADA Barat Laut Selangor, it was found that 1.7% were women and 100% were Malays while all respondents in IADA Seberang Perak were men. The majority (64%) of the respondents finished their secondary education (SPM) while only 1.3% and 1.7% had a degree representing Kerian and Barat Laut Selangor respectively.

It was observed that the majority (59%) of respondents in all granaries had 4 – 6 family members and dependents of 4 – 6 people (48.2%). A total of 85% of the respondents were engaged as paddy farmers as the main occupation while the rest were involved in the government sector (5.6%), businessmen (5%) and 2.8% engaged in other commodities. Some of them participated in other occupations besides farming such as trading. For instance, one might be a grower and a seller in the market, and/or as paddy and other crop growers and also trade and carry out other jobs.

The majority of respondents (63.3%) had less than 29 years of experience in paddy cultivation. However, there were a relatively large number of farmers with over 30 years of experience (36.7%). As regards to family participation, it was found that 94.4% of the respondents were facilitated by family members with less than 3 people per farmer.

Factors and technical efficiency of the granary

The Cobb-Douglas production function is a specific function, which is widely used to describe the technological relationship between two or more inputs (mainly physical and labour capital) and the amount of output that can be produced. This study uses this function to measure the significance of inputs such as the area of rice cultivation, the number of seeds used, the quantity of labour and the quantity of fertilisers and pesticides concerning the yield of each granary, namely, IADA Seberang Perak, IADA Kerian and IADA Barat Laut Selangor.

IADA Seberang Perak

The independent variables in the regression analysis conducted on yields at IADA Seberang Perak comprised important inputs such as area, seeds, labour, fertilisers and pesticides. The regression model was significant with a F value = 32.920 and all variables included in the regression model represented 21.2% (Adjusted R^2 = 0.212). There were another 79.8% potential factors in improving the yield specifically at IADA Seberang Perak. There was only one significant input variable which was the paddy-field area (β-coefficient = – 0.467). Negative coefficient values indicated a contrary finding to the expected results. If there is an increase in one unit of paddy-field area in this granary, the yield will show a decrease as much as 0.467 tonnes. Various possibilities could contribute to this factor such as the field management structure and the environmental dimensions which will require further study (*Table 2*).

The TE at IADA Seberang Perak was at a moderate level of 70% with an elasticity of ε = 0.869. The value of ε of less than one (1) indicated that the cultivation of rice in Seberang Perak was in decreasing return to scale. In other words, for every 1% increase in input to this granary, there will be less than 1% increase in revenue. This finding is

in line with the results shown in the Cobb-Douglas production function regression analysis.

Regression analysis was also conducted to identify the socioeconomic factors that could potentially influence the yield at IADA Seberang Perak. Based on the findings in *Table 3*, the number of dependent family members (β-coefficient = 0.387) was significantly positive at 5% on the increase in paddy yield. Rice farmers will have to strive to cultivate more in order to serve a great number of dependents. Experience in rice cultivation (β-coefficient = 0.503) was also significantly positive at 10% indicating that the experienced farmer would benefit the great impact on the yield.

IADA Kerian

The independent variables in the regression analysis of the Cobb-Douglas production function were also performed on the yield at IADA Kerian. The regression model was significant at 1% with a value of F = 65.25 and the overall variables included in the regression model accounted for 73% (Adjusted $R^2 = 0.212$) of the total factors that could influence the yields. Only 27%

Table 2. Input factor and TE at IADA Seberang Perak

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	8.523	0.072		117.727	0.000***
Area	–0.372	0.065	–0.467	–5.738	0.000***
Seeds	–.014a	–0.17	0.865	–0.016	0.995
Labour	.094a	1.15	0.253	0.106	0.981
Fertiliser	–.108a	–1.297	0.197	–0.119	0.952
Pesticide	.017a	0.205	0.838	0.019	0.999
F value		32.920***			
R^2 value		0.218			
Adjusted R^2 value		0.212			
*Technical Efficiency (TE)		70			
Elasticity		0.869			

Note: *TE calculations are average for both seasons
*Significant at 10%, **Significant at 5% and ***Significant at 1%

Table 3. Socioeconomic factors at IADA Seberang Perak

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	2689.314	1075.246		2.501	0.020**
Age	–17.765	27.028	–0.177	–0.657	0.518
Dependent family members	208.43	96.981	0.387	2.149	0.042**
Experience	42.394	21.528	0.503	1.969	.0610*
Main occupation	562.155	605.359	0.216	0.929	0.363
Other occupations	–30.434	106.683	–0.063	–0.285	0.778
a. Dependent variable: Yield					

Note: *Significant at 10% and **Significant at 5%

of other factors may have the potential to improve the yield at IADA Kerian. The results in *Table 4* indicated two significant input variables at 5% and 1%, namely, labour (β-coefficient = 0.166) and pesticides (β-coefficient = 0.290). Positive coefficient values indicated that there will be an increase in paddy yield in the event of a unit increase in both inputs. A unit increase in the use of labour in any related cultivation phase would indicate an increase in yield of 0.166 tonnes. Likewise, a unit increase in pesticides used may increase about 0.290 tonnes of rice production.

Technical efficiency at IADA Kerian was 72% which is at a moderate level with an elasticity of ε = 0.997. This value (ε <1) indicated the decreasing return to scale for paddy cultivation at Kerian granary. In other words, for every 1% increase in input, it was

Table 4. Input factor and TE at IADA Kerian

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	3.676	2.562		1.435	0.154
Area	0.366	0.382	0.320	0.957	0.341
Seeds	0.121	0.349	0.107	0.347	0.729
Labour	0.168	0.082	0.166	2.056	0.042**
Fertilizer	0.033	0.088	0.037	0.376	0.708
Pesticide	0.321	0.113	0.290	2.846	0.005***
F value		65.25***			
R^2 value		0.741			
Adjusted R^2 value		0.730			
*Technical Efficiency (TE)		72			
Elasticity		0.997			

Note: *TE calculations were average for both seasons
*Significant at 10%, **Significant at 5% and ***Significant at 1%

Table 5. Socioeconomic factors at IADA Kerian

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	–14496.528	17738.89		–0.817	0.419
Age	179.851	277.639	0.116	0.648	0.521
Education	6865.131	2857.717	0.386	2.402	0.021**
Number of family members	–2093.563	1566.983	–0.267	–1.336	0.189
Dependent family members	2641.524	1959.201	0.259	1.348	0.186
Main occupation	–3478.247	1955.155	–0.305	–1.779	0.083*
Other occupations	–597.408	1255.415	–0.083	–0.476	0.637
Experience	518.219	260.598	0.358	1.989	0.054*
a. Dependent variable: Yield					

Note: *Significant at 10% and **Significant at 5%

found that there was less than 1% increase in revenue. However, when the value of elasticity approaches 1, it indicated only a small number of yield decreasing return to scale.

There are 3 socioeconomic factors that could have potentially influenced the production at IADA Kerian. The education level of farmers (β-coefficient = 0.386) was positively significant at 5% on the increase in paddy yield. With a higher level of education, there is a greater potential for production to increase. Experience (β-coefficient = 0.358) which was significantly positive at 10% indicated that more experience resulted in greater impact on the yield development. One of the important socioeconomic factors was the main occupation. Possession of this factor (β-coefficient = –0.305) negatively affected the yield (*Table 5*).

IADA Barat Laut Selangor

The independent variables in the Cobb-Douglas production function regression analysis conducted on yields at IADA Barat Laut Selangor included a number of significant inputs in rice cultivation. The regression model was significant at 5% with a F value of = 5.978 and the total input variables included in the regression model represented 40% (Adjusted $R^2 = 0.40$). There were another 60% potential factors in enhancing paddy yield especially at IADA Barat Laut Selangor. There was only one significant input variable at 5% i.e. labour (β-coefficient = 0.220). This finding showed that a unit increase in labour, regardless of any relevant cultivation phase, showed an increase of 0.220 tonnes of yield. Other inputs such as paddy-field area, quantity of seeds, fertilizers and pesticides were not significant (*Table 6*).

Technical efficiency at IADA Barat Laut Selangor was 86%, the highest level compared to IADA Seberang Perak and Kerian, with an elasticity of ε = 0.996. However, if the value of ε is less than one, it indicated decreasing return to scale. In other words, for every 1% increase in input, there was less than 1% increase in revenue. The same situation in all three granaries showed that increase in inputs did not improve results in the same ratio. However, there was at least a slight increase in productivity by labour increase based on findings in the previous regression analysis.

A regression analysis was also conducted to identify socioeconomic factors that could potentially influence the yield

Table 6. Input factor and TE at IADA Barat Laut Selangor

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	7.674	0.312		24.630	0.000***
Labour	0.102	0.042	0.220	2.445	0.016**
Area	–.019a	–0.215	0.831	–0.020	0.993
Seeds	.034a	0.189	0.851	0.018	0.250
Fertilizer	–.111a	–1.234	0.220	–0.114	1.000
Pesticide	.059a	0.620	0.537	0.057	0.916
F value		5.978**			
R^2 value		0.49			
Adjusted R^2 value		0.40			
Technical Efficiency (TE)		86			
Elasticity		0.99588			

Note: *TE calculations were average for both seasons
*Significant at 10%, **Significant at 5% and ***Significant at 1%

Table 7. Socioeconomic factors at IADA Barat Laut Selangor

Coefficients					
Model	Unstandardised coefficients		Standardised coefficients	t value	Significance
	B	Std. Error	Beta		
(Constant)	4922.567	1313.783		3.747	0.001***
Age	–19.422	18.966	–0.328	–1.024	0.319
Sex	–329.727	724.972	–0.087	–0.455	0.654
Number of family members	–132.398	62.914	–0.428	–2.104	0.049**
Number of dependents	–72.166	58.246	–0.259	–1.239	0.23
Experience	33.363	20.486	0.539	1.629	0.12
Education level	924.333	436.676	0.405	2.117	0.048**
Other occupations	–114.507	74.767	–0.299	–1.532	0.142
a. Dependent variable: Yield					

Note: *Significant at 10%, **Significant at 5% and ***Significant at 1%

at IADA Barat Laut Selangor. According to *Table 7*, the number of dependents in a family (β-coefficient = –0.428) was significantly negative at 5% over paddy yield. This indicated that there was a decline in yield with an increase in the number of family members. This scenario may occur with different social structures from one granary to another. Whereas, the education level (β-coefficient = 0.405) was significantly positive at 5% over rice yield which meant that the higher education level of individuals may potentially improve the rice production.

Conclusion

The policy formulation that affects the sustainability in rice production in these granaries is very much needed. The education level significantly affected the variability in yield achievement for Kerian and Barat Laut Selangor farmers. In addition, experience factor was also one of the vital dimensions that influenced the yield performance, specifically for Seberang Perak and Kerian farmers. Some of the things that needs to be improved in line with the findings of this study include the trainings held by related agencies which has to be augmented either in quality of the contents or the number of exercises for younger farmers to gain experiences. Other than that, the modernisation of the cultivation activities is undeniably vital which requires relevant exposition of new information uptake through education levels among the farmers.

Furthermore, the increase of major inputs in rice production with TE of less than 1 ($\varepsilon < 1$) does not promise the potential of increasing returns to scale. Although the study found that the increase of certain inputs such as labour, pesticides and area significantly affected the increase of yield per hectare, the overall trade- off value was found to be worthless with the collective increase of these input units. Therefore, alternative interventions especially in modernisation of rice production with the use of technologies (Pestereva 2014) such as precision farming should be considered to be adopted in order to provide more favourable returns and greater output.

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Abstrak

Pertambahan input dalam fasa pengeluaran padi merupakan antara faktor utama dalam peningkatan hasil. Namun begitu, pertambahan input-input seperti keluasan, buruh, baja, racun dan benih untuk meningkatkan hasil padi di jelapang padi pada masa kini tidak menunjukkan perbezaan yang begitu ketara. Jelapang padi di IADA Seberang Perak, Kerian dan Barat Laut Selangor adalah antara tiga daripada lapan jelapang utama yang ada di Malaysia. Peningkatan hasil di ketiga-tiga jelapang ini sangat memberi impak kepada pengeluaran padi negara dan menyumbang kepada jaminan kelestarian serta kecukupan makanan lokal. Di samping faktor input, faktor-faktor sosioekonomi juga merupakan isu penting dalam menerangkan dimensi yang menyumbang kepada peningkatan hasil. Oleh yang demikian, kajian ini dijalankan untuk menerangkan dan mengkaji faktor-faktor tersebut di samping menentukan prestasi Technical Efficiency (TE) jelapang-jelapang yang terlibat. Data kajian telah dikumpulkan melalui temuduga bersemuka dengan soal selidik berstruktur. Pensampelan secara rawak digunakan untuk saiz penduduk petani yang seimbang untuk setiap tiga butir-butir tanah. Sejumlah 180 jawapan telah berjaya dicapai yang mana 60 responden masing-masing mewakili setiap jelapang. Kajian mendapati bahawa pengambilan tambahan faktor input tidak memberi kesan yang signifikan kepada kenaikan hasil (penurunan pulangan ke skala). Oleh itu, alternatif lain perlu dilaksanakan dalam memastikan atau sekurang-kurangnya mengekalkan pengeluaran dan penanaman padi di jelapang-jelapang tersebut.