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THE ANALYSIS OF TECHNICAL EFFICIENCY OF PADDY PRODUCTION IN IADA KETARA: NEW TECHNOLOGY PACKAGE

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Abstract: *Rice, a fundamental staple crop not only in Malaysia but worldwide, has faced a challenge in Malaysia where the actual paddy production has lagged behind its potential. Recently, Universiti Putra Malaysia (UPM) introduced a technological package for paddy production called PadiU Putra, with the aim of enhancing both the quantity and quality of paddy output. Therefore, the objective of this study is to assess the impact of the PadiU Putra technology package on the technical efficiency of paddy production in IADA KETARA, Terengganu, Malaysia.To analyze the technical efficiency of paddy yield, an output-oriented Data Envelopment Analysis (DEA) approach was employed. This analysis was based on a cross-sectional survey and face-to-face interviews with 121 paddy farmers, who were selected using stratified random sampling in 2019. The study's results revealed that the implementation of the PadiU Putra technology package led to a notable 23 percent increase in the technical efficiency of paddy production when compared to non-PadiU Putra technology practices in the study area. Overall, these findings underscore the successful role of the PadiU Putra technology package in boosting paddy production within the study area.*

Keywords: *Output-oriented DEA; Technical Efficiency; Paddy production; New Technology*

Introduction

The central focus has consistently revolved around food security as a strategy to shield the nation from potential crises. The establishment of the National Food Security Policy and the Agrofood Policy (2011–2020) was aimed at bolstering the country's rice reserves. These policies were set in motion to accomplish a dual objective: ensuring food security and boosting the income of paddy farmers. In 2021, the agricultural sector played a significant role in Malaysia's Gross Domestic Product (GDP). The production of paddy increased 3.07 %, from 2,356 thousand tonnes in 2020 to 2,429 thousand tonnes of production in 2021, with a total cultivated area spanning hectares 647,859 (Department of Agriculture, 2022). This rise in paddy production accounted for 72.85% of the self-sufficient level (SSL) of rice production in Malaysia. The cultivation of paddy holds immense importance, especially in rural areas, serving

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as a primary source of employment and income for local communities, while also contributing to Malaysia's efforts to reduce its dependence on rice imports (Fauzi and AB. Wahab, 2013).

In Malaysia, rice granaries are distributed across Peninsular Malaysia, Sabah and Sarawak: Muda Agricultural Development Authority (MADA), Kemubu Agricultural Development Authority (KADA), North Terengganu Integrated Agriculture Development (IADA KETARA), IADA BARAT LAUT SELANGOR, IADA KERIAN, IADA SEBERANG PERAK, IADA PULAU PINANG, IADA KEMASIN, IADA PEKAN, IADA ROMPIN, IADA KOTA BELUD and IADA BATANG LUPAR. The average yield produced from IADA KETARA granary area is 5,000 kg/ha from 2016 to 2021 (see Figure 1).

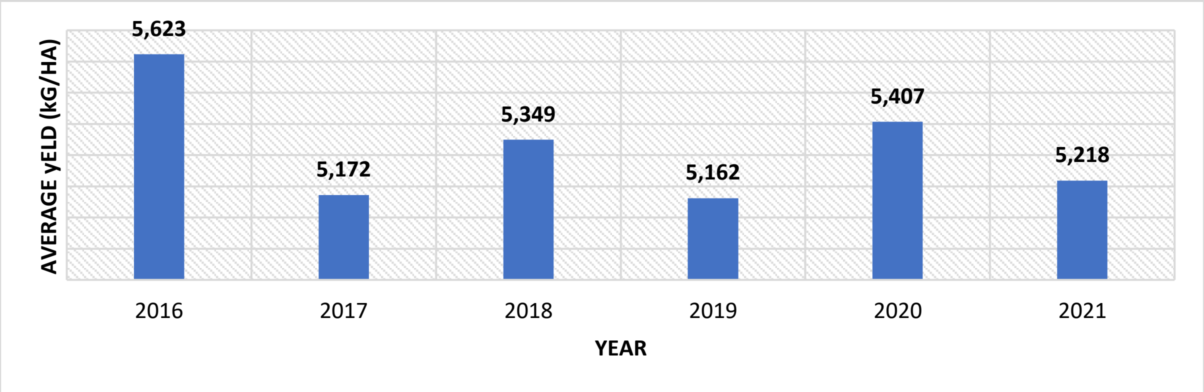

Figure 1: Average yield paddy production in IADA KETARA
Sources: Department of Agriculture, 2022

In line with Malaysia's national food security policy, PADIBERAS Nasional Bhd (Bernas) operates as the ultimate buyer, acquiring paddy from farmers at a Guaranteed Minimum Price (GMP) of RM1200 per tonne. Paddy farmers are also eligible to receive support in the form of RM200 per hectare for pesticide purchases, 240 kg/ha of compound fertilizer, 80 kg/ha of urea fertilizer per hectare, and 100 kg/ha of organic fertilizer for their rice cultivation efforts (Harun, 2017). Additionally, there is a subsidy of RM240 per hectare provided for ploughing. Despite these input subsidies, the rising costs of inputs have added to the financial burden of farmers, impacting the profitability of those engaged in rice farming.

To enhance their income, farmers need to focus on increasing productivity through the introduction of new technologies, the adoption of existing technological advancements, and the efficient utilization of available resources. In the realm of paddy production, technology and innovation are pivotal in optimizing input utilization and elevating yields. Nonetheless, the level of technology adoption in Malaysian paddy production remains somewhat moderate, with a noticeable gap between high-performing and low-performing farmers in terms of their technological practices (Nor Amna et al., 2016). The adoption of technology within the agricultural industry is deemed crucial and indispensable. Technology is not only used to support farmers but also to enhance productivity, improve the livelihoods of farmers, and overall advance the agricultural sector (Das et al., 2016).

Government always strives to transform the traditional agriculture to modern agriculture through the agricultural development programs. MARDI is a government agency responsible for research and development activities related to the agricultural sector in Malaysia. In the case

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of the paddy industry, Green Revolution is one of the most important programmes for the growth of the sector. Green Revolution is the basis of reform of paddy cultivation mechanization, package in the use of high production paddy varieties with biochemical inputs such as fertilizers, herbicides, and others that supported by infrastructure facilities (Fauzi and AB. Wahab, 2013). During the climax of Green Revolution in 1970, the self-sufficiency level (SSL) of rice in Malaysia is about 90% due to the new high yield paddy varieties introduced; Ria, Malinja and Mahsuri that help in the paddy production increment.

Breeding of modern varieties has played an important role in paddy production and increasing the income of farmers. Rice varietal improvement work began in Malaysia around 1915 with the selection of localized traditional varieties and this was followed by pure line selection work. Countrywide adaptability trials were initiated in 1961 to select widely adaptable varieties. Between 1970-2018, 49 rice varieties were released in Malaysia. Breeding for short-term double cropping varieties began with the introduction of the Cuttack hybrids from which Malinja and Mahsuri were developed. Since yield increase was considered the most important requirement then, IR8 from IRRI was release as Ria to introduce the concept of very high yields associated with the stiff strawed, dwarf plant type. The current concept in rice breeding allows for development of adaptable varieties for general use and location-specific varieties for areas with specific requirements like drought, submergence, and acid sulphate tolerance. In fact, due to change in consumer demand and taste, high yield-inbred and hybrid, good resistance to pest and disease, eating quality, phenotype and embarked on niche market or commercialization were among the aspects considered in breeding advancement. The recent release of MRs' family was to cater all those aspects and MR220 CL2 was popular variety cultivated by farmers (MARDI, 2019).

In addition to government agencies, the university also plays a part in carrying out research and development activities. For example, as a university with a relatively popular agricultural faculty, Universiti Putra Malaysia (UPM) also conducts a range of studies related to rice production technology. The replacement period of new rice varieties has declined over time and the current replacement period is around 10 years with lower adoption rates of newly released rice varieties. Development of high yielding, and pest and disease resistant rice variety is a prerequisite for attaining increase in production and generating high income for farmers as well as to achieve national self-sufficiency level. UPM through LRGS program has developed blast resistant rice variety with high yielding potentiality to be release for commercial cultivation.

In 2017, UPM released PadiU Putra technology package, which includes foliar enhancer (Putra UGrow), biofertiliser (Putra Bio-1), new rice varieties (Putra Siri-1), activated humid acid (Putra AHA), pest and disease control, precision agriculture (Putra Persis) and pest and disease prediction. Experimental studies have been performed in selected granary area, namely (Integrated Agricultural Development Authority) IADA KETARA, Terengganu. The main objective of each technology introduced is to increase the yield of rice through efficient combination of inputs used. In Economics, technical efficiency approach commonly employed to measure the ability of a farm to either produce the maximum possible output from a given bundle of inputs with a given technology, or to produce a given level of output from the minimum number of inputs for a given technology.

Therefore, the objective of this study is to evaluate the effects of this technology package on technical efficiency in paddy production. Furthermore, this research will identify the factors that influence the technical efficiency of paddy production in the IADA KETARA, Terengganu.

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Literature Review

The technical efficiency of paddy farming has drawn more attention from researchers and scholars recently. Many studies have been conducted to investigate different aspects of efficiency in the paddy farming sector for many different countries, for example, Battese and Coelli (1995) studied technical efficiency on paddy farmers from Indian village from Aurepalle by using panel data; Dhungana et al. (2004) investigate economic inefficiency of Nepalese paddy farms. Xiao and Li (2011) measured technical efficiency of paddy production in China; Kiatpathomchai et al. (2008) estimated technical efficiency of southern Thailand's rice farms by using input oriented; Huang et al. (2002) examined cost efficiency of rice farming in Taiwan; Nassiri and Singh (2009) studied energy use efficiency for paddy production in Punjab by using data envelopment analysis; Nassiri and Singh (2010) studied energy use efficiency for paddy production in Punjab, India by using parametric and non-parametric approach; the economic efficiency on paddy farms in Northwest Selangor was estimated by Radam and Latif (1996). Thiruchelvam (2005) examined the efficiency of rice production in the districts of Anuradhapura and Polonnaruwa in Sri Langka; Tadesse and Krishnamoorthy (1997) investigate technical efficiency analysis on paddy farms in Tamil Nadu state, India.

Abedullah and Khalid (2007) employed the stochastic frontier approach to examine the technical efficiency of rice production in Punjab, Pakistan. Their findings indicated that farmers in the study area exhibited a high level of efficiency, with an efficiency score of 91 percent. This suggests that there was limited room for improvement in resource utilization efficiency. Additionally, Abedullah and Khalid (2007) revealed that education and mechanization had a positive and statistically significant impact on the technical efficiency score, whereas age was found to have a negative and significant effect. In another study conducted by Idiong (2007) in the Cross River State of Nigeria, farm-level technical efficiency in small-scale swamp rice production was estimated using the stochastic frontier approach. The results showed an average technical efficiency score of 77 percent, implying a greater potential for enhancing resource-use efficiency. Idiong (2007) also identified that years of schooling, membership in associations, and access to credit were significant factors influencing technical efficiency.

Bamiro and Janet (2012) applied the stochastic frontier approach to assess the technical efficiency of swamp rice and upland rice production in Osun State, Nigeria. They reported an average technical efficiency of 56% for swamp rice production and 91% for upland rice production, indicating room for efficiency improvement in swamp rice production. The study further revealed that the volume of credit had a negative impact on the technical efficiency of upland rice, and it found that females exhibited higher efficiency levels compared to males in swamp rice production. Lastly, Kadiri et al. (2014) uncovered that paddy rice production in the Niger Delta Region of Nigeria was technically inefficient.

The study further indicated that marital status, educational level, and farm size were major determinants of rice production in the study area.Recent studies have considered the technical efficiency of paddy production worldwide (Nguyen et al. 2020; Afrin et al. 2017; Anang et al. 2016; and Xiao and Li 2011). Nguyen et al. (2020) studied the weather shocks, credit, and production efficiency of rice farmers in Vietnam and found that access to credit plays a significant role in alleviating the negative impact of weather shocks on rice production. Anang et al. (2016) examined the microcredit and technical efficiency of smallholder rice farmers in Northern Ghana. Findings show that credit-participating households are technically more efficient (63%) than non-participants (61.7%). Kumar et al. (2020) indicate that the adoption of new varieties of paddy in India varies significantly within and between regions; further, the

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adoption of new varieties is affected by a number of socioeconomic and demographic factors; the authors also find that the adoption of new varieties increases yield significantly. Inputs like human labor, mechanical labor, fertilizer, irrigation and insecticide were found to determine the yield in paddy cultivation across India (Bhoi et al., 2021)

Impact of technology introduced can be seen in term of economic, social, and environmental. The use of technology will also reduce the cost of production, reduce the time taken for a job to be done, increase the yield and make the farm more efficient (Mohd Syafiq, 2009). With the use of modern technology in paddy cultivation, farmers can increase the efficiency and reduce the dependency on workers (Nor Amna et al., 2016). For an example, in Taiwan, there is a positive impact for farmers that use drone technology for paddy sector such as in pesticide and fertilizer spray, that reduce the pesticides utilization about 25%, labor cost can be reduced to 30% and yield increment of 10% (Rohaniza, 2019). Malaysian farmers should be encouraged by the government through the agriculture extension to adapt with the modern technology. Even though the labor needed will be decreased when they use technology but with the adoption of technology, young people will be attracted to involve in agricultural sector especially in paddy cultivation. This will bring to the expansion in this sector and can also reduce the unemployment in Malaysia.

In India, Das et al. (2017) study about the comparison between conventional system, System Rice Intensification (SRI) and Modified System Rice Intensification (MSRI) in term of productivity, employment, and income. The crop production technology which is SRI was introduced in Meghalaya, India. With the adoption of this technology (technique for paddy cultivation), there is a possibility that it can reduce the yield loss due to climate change and ensure better farmers' livelihood (Das et al., 2017). SRI is getting popular in many countries including India because it has many advantages which are saving of water and seed, high yield and less dependence on chemicals but SRI needs some modification to suit the local conditions, so MSRI introduced (Das et al., 2017). The water-use efficiency (WUE) and water productivity (WP) increased substantially with MSRI practice compared to Farmers' Practice (FP) (Das et al., 2017). Besides, the SRI needs significantly lower number of seed than with conventional methods, which gives farmers enough economic incentives to adopt this method (Das et al., 2017). Soil fertility also improved due to adoption of MSRI in rice and growing of leguminous pea in sequence. The adoptions of MSRI in rice with or without cultivation of pea as a succeeding crop substantially improved the soil fertility (Das et al., 2017).

The increases in grain yields under MSRI are because of the effects of cultivation practice modification. For example, the seedlings age for transplanting per hill, the spacing, the water management and the weed management. The spacing of rice grown in MSRI is wider and it can develop better root system. It can explore larger areas to absorb the nutrients from soil and easily access the sun for photosynthesis process. For weed management, they use cono-weeder that can gives advantages to the paddy which are the soil got aerated and it also helps in decomposing the weed biomass within the soil to transform into organic manure. Therefore, the roots and the paddy itself grew healthier and have higher yield (Das et al., 2017). Even there was about 10% increase in cost of cultivation for MSRI, the adoption of MSRI enhanced the gross and net return by 39% and 61% respectively, compared to FP. The higher gross and net returns fetched by MSRI practices may be due to lower total variable cost and higher yield compared to FP (Das et al., 2017).

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In this research, the researchers use experimental site description method. A proper training was given to the farmer for promoting this new technology of rice cultivation and field demonstrations were conducted (Das et al., 2017). Then, they use water-use efficiency (WUE) formula to know the ratio of crop yield (usually economic yield) to water used (Das et al., 2017). Then, they use water productivity (WP) to define the relationship between amount of crop produced and the amount of water involved in crop production, expressed as crop production (yield) per unit volume of water consume (Das et al., 2017). To measure yield, they use rice equivalent yield (REY). For the gross return, it was estimated by multiplying the economic yield with their respective minimum support price (MSP) as per Government of India (for rice) and with their prevailing market price (for pea). The difference between gross return and cost of cultivation was taken as net return. The benefit: cost ratio (B:C ratio) was computed by dividing gross return with cost of cultivation. Significant improvement in crop and WP, employment, and income of the farmers have been achieved due to adoption of MSRI compared to the FP. Thus, MSRI is recommended for enhancing rice productivity, sustaining soil fertility and income of farmers in the studied hill ecosystem of India and elsewhere in the world with similar agro-climatic conditions (Das et al., 2017).

Resfa et al. (2019) conducted a study on SALIBU technology, an innovative approach in rice farming. This technology involves modifying rice ratooning, where the rice plant regrows after its stem is cut. In contrast to conventional practices that require replanting after each harvest, SALIBU technology allows farmers to sow and transplant once, enabling repeated harvests (Resfa et al., 2019). This method not only differs from traditional practices but also offers several advantages, including a reduction in the time needed for paddy cultivation, decreased water and seed usage, and minimized labor requirements. With SALIBU technology, many activities such as land preparation, sowing, and transplanting are streamlined, resulting in efficient resource utilization, lower production costs, and a more environmentally friendly approach (Resfa et al., 2019). Additionally, due to the shortened cultivation period, SALIBU technology facilitates the potential for more than two annual harvests and an increase in paddy production (Resfa et al., 2019).

The researchers conducted field experiments to gather data in their study. In the initial experiment, they collected data on productive tillers, the number of grains per panicle, and overall productivity based on various treatments. Subsequently, they focused on implementing this technology across three distinct agro-ecosystems, namely highland, moderate, and lowland areas, to assess its impact on paddy growth (Resfa et al., 2019).There are three arguments that state the reason for the SALIBU technology is more efficient rather than the conventional technology. SALIBU technology uses more efficient resources especially seeds and labor. Secondly, the productivity is higher than the main crop. The last one, since the paddy in SALIBU technology can be harvested repeatedly, it can increase the cropping intensity annually that can boost the land productivity (Resfa et al., 2019). So, it can be concluded that using this SALIBU technology is profitable, shown by these indicators which are the productivity is higher, the production cost is lower and the return on labor per day exceeds the conventional system (Resfa et al., 2019).

Different for Shahrina et al. (2014) that study about the fertilizer technology. The researchers make a study about the openness of the farmers on accepting newly introduced technology of fertilizer and their awareness about new fertilizer technology. Government targets to increase the national (SSL) and wants to reduce the dependency of the farmers on subsidies for paddy farming. So, the need for innovation in the fertilizer technology increases (Shahrina et al.,

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2014). Fertilizer is important for the paddy growth in Malaysia because to make sure the fertility of the soil and to provide enough nutrients. Besides, the paddy plant varieties are responsive towards the fertilizer (Shahrina et al., 2014).

In the fertilizer industry, they introduced new development of fertilizer which is the controlled release technique that make the nutrients to be released according to the plant's need for its growth. So, it could be benefited to the farmers because they will only fertilize their plant for only one time application (Shahrina et al., 2014). Besides, there is also another development which is 'Precision Farming' that uses 7R approach that include The Right Place, the Right Fertilizer, and The Right Timing. This is really depending on a country's economic capability and its human resources (Shahrina et al., 2014). The inefficiency of fertilizer utilization may cause low yield of paddy due to many reasons such as the nutrient released untimely and the amount of the nutrient contained in the fertilizer (Shahrina et al., 2014). In the research, the researchers adopted a quantitative research design where they use questionnaire for the data collection. The first section of the questionnaire is the demographic indicators which were basically to understand the respondents and background of the respondents which is statistically necessary. The other three dimensions include Knowledge and Information which involved 11 indicators, followed by the Management and Innovation dimension consisting of 4 indicators, the Level of Acceptance of New Product with 9 indicators while the last dimension of the questionnaire was structured for the farmers to list their observation about the innovation of new farming technologies particularly fertilizer.

Ginting (2019) studied on the best rice variety in production among the varieties studied that integrated with the used of liquid organic fertilizer. For the best interaction between variety and liquid organic fertilizer, the researchers used randomized block design with two treatment factors: Liquid Organic Treatment Factor consists of 4 treatment levels which are Mo = without liquid organic fertilizer, M1 = 3 cc/liter of water, M2 = 6 cc/liter of water and M3 = 9 cc/l of water. Then, Variety Treatment Factors consist of 3 types of rice paddy varieties which are V1 = Ciherang, V2 = Inpari 30 and V3 = Inpari 32 (Ginting, 2019). The research data was processed using Variance Analysis method (Fisher's test) and the Duncan Multiple Ranga Test (DMRT) mean difference test at a 5% real test level. If farmers want to increase the paddy production, they should choose the best interaction between paddy variety and liquid organic fertilizer. It is suggested to choose the Inpari 32 varieties and using liquid organic fertilizer TOP G2 6 cc/litre of water (Ginting, 2019).

Rosnani Harun (2015) make a comparison of paddy production technology practices and the technology practices competitiveness level in Malaysia with world chosen countries' best practice. This research also wants to see the potential technology that can be accepted and more efficient with environment in Malaysia. In this research, data has been analysed by descriptive method. Besides, the researcher also analysed data using qualitative method by listing the technology and paddy production technology practice among farmers in Australia, Vietnam and Malaysia. The finding shows that there are many technologies adapted in Australia (highest paddy productivity in the world) and Vietnam (highest productivity in South East Asia). These two countries use many kinds of technology in their paddy cultivation such as in the paddy variety, planting method, land preparation, water management, and harvesting. Among those technologies, there are several potential technologies that can be accepted in Malaysia which are Electromagnetic soil Mapping (EM38), Computerized Whole Farm Design Laser Land forming, and GPS (Global Positioning Systems) and Precision Farming.

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Studies conducted by Kumar et al (2020), Khade (2020) and Sehal et al., (2021) indicate that the new technology increase the paddy yields in India. Kumar et al., (2020) estimate the impact of the adoption of new paddy variation yield. The study also finds a significant positive impact on paddy yield of the adoption of new varieties, which underlines the importance of new varieties for food security and farmers' livelihoods. Khade (2020) compares the paddy yield among low, moderate and higher groups of technology adopters. He discovered that the higher the level of technology adoption, the higher the yield. In addition, Sehal (2021) analyse cost and returns in Paddy (Basmati) in integrated pest management (IPM) and integrated nutrient management (INM), (IPM-INM) farms versus Conventional Practices Management (CPM) in Haryana.The cultivation of paddy was found to be profitable with the adoption of IPM-INM technology due to cost saving in plant protection measures on one hand and an increase in yield on the other. Therefore, use of IPM-INM technology needs to be expanded among all the paddy growers.

This section discusses the findings of TE using Data Envelopment Analysis (DEA), Output Oriented Approach. Estimation for DEA is carried out using DEAP program version 2.1. The study applies the maximizing output method under the CRS and VRS assumptions.

Table 1: Summary statistics of input and output in paddy production

IADA KETARA (n=121)								
	PadiU Putra				Non-PadiU Putra			
Variables	**Mean**	**SD.**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**
Rice yield (tons/ha)	6.51	2.00	0.83	12.50	5.06	1.51	0.89	8.33
Land (ha)	0.73	0.40	0.40	2.80	2.17	1.26	0.40	6.00
Seed (kg/ha)	112.18	30.57	50.00	200.00	159.61	41.13	53.33	300.00
Fertilizer (kg/ha)	494.53	262.55	183.33	1700.00	529.51	244.95	196.67	1700.00
Pesticide (litre/ha)	10.07	8.13	1.25	45.79	5.85	3.76	0.42	18.75
Labour cost (RM)	185.60	155.97	25.00	857.14	154.26	216.54	19.23	1770.83

Table 1 shows the summary statistics for 121 respondents who participated in this study and 50 of the total respondents used PadiU Putra technology package. Results show that the mean output of rice realized by rice farms with PadiU Putra in IADA KETARA was 6.51 ton/ha and 5.06 ton/ha for non PadiU. From the input side, the average size of farms is 0.73 hectares for padiU Putra compared to 2.17 hectares for non padiU PUTRA. Additionally, most of the farmers use around 112.2 kg of seeds, 494.5 kg of fertilizers, 10.1 litre of pesticide for PadiU Putra while 159.6 kg of seeds, 529.5 kg of fertilizers, 5.8 litre of pesticide for non PadiU Putra.

Technical Efficiency of IADA KETARA Granary Area

The TE level of each farmer was classified according to the class used in the productivity analysis by Raziah et al. (2010).

Table 2: Number of farms by range of efficiency

IADA KETARA		
Range of Efficiency	**PadiU Putra**	**Non-PadiU Putra**
0 – 0.25	1 (2.0%)	2 (2.8%)
0.26 – 0.50	0 (0%)	11 (15.5%)
0.51 – 0.75	12 (24.0%)	33 (46.5%)
0.76 – 0.99	20 (40.0%)	17 (23.9%)

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1.00	17 (34.0%)	8 (11.3%)
Total	**50 (100%)**	**71 (100%)**

Table 2 indicates the distribution of farmers according to range of efficiency. The use of PadiU Putra technology package by farmers in IADA KETARA had a significant impact on technical efficiency. The number of farmers achieving scale efficiency, where the value of technical efficiency is equal to 1, increased from 11.3% (before using PadiU Putra seed) to 34.0% (after using PadiU Putra seeds). Most farmers in IADA KETARA (46.5%) usually had a technical efficiency of 0.51-0.75 without the use of PadiU Putra seeds. However, with PadiU Putra technology, the percentage of farmers in the range of 0.51-0.75 decreased and shifted to a higher range of 0.76-0.99 and 1.

Table 3: Technical Efficiency in IADA KETARA

	IADA KETARA (n=121)							
	Padiu Putra				**Non-Padiu Putra**			
	Mean	*Std. Dev.*	*Min*	*Max*	*Mean*	*Std. Dev.*	*Min*	*Max*
CRS	0.87	0.16	0.20	1.00	0.68	0.21	0.12	1.00
VRS	0.92	0.15	0.20	1.00	0.75	0.22	0.12	1.00
SE	0.95	0.08	0.69	1.00	0.91	0.11	0.54	1.00

The distribution of technical efficiency under CRS and VRS are presented in Table 3. The mean technical efficiency under CRS, VRS and SE for rice farms with PadiU PUTRA technology were 0.87 (87%), 0.92 (92%) and 0.95 (95%), respectively. On the other hand, the mean technical efficiency CRS, VRS and SE for rice farms without PadiU PUTRA technology were 0.68 (68%), 0.75 (75%) and 0.91 (91%), respectively. These results suggest that rice farms with PadiU Putra technology could potentially expand output by 13 percent compared to 32 percent for rice farms without that technology. This result consistent with Abu (2011), where farmers using fertilisers are more efficient than those who do not use fertilisers. Furthermore, the mean scale efficiency of 95 percent for rice farms with technology compared as 91 percent for rice farms without technology suggest that by operating on an optimal scale further increase output can be achieved beyond the projected value by as much as 5 percent and 9 percent, respectively. This indicates that rice farms with PadiU Putra technology were more efficient compared to rice farms non PadiU Putra technology. The SE scores may be decomposed into three types of returns: increasing return to scale (IRS), decreasing return to scale (DRS) and CRS. For IRS, the percentage change of rice yield (output) is greater than the percentage change in the inputs. In DRS, the percentage change in output is smaller than the percentage change in input. Finally, CRS shows the percentage change in inputs is equal to the percentage change in output.

Table 4: Scale Efficiency Scores in IADA KETARA

	IADA KETARA (n=121)					
	PadiU Putra			**Non-PadiU Putra**		
Types of Returns	**CRS**	**DRS**	**IRS**	**CRS**	**DRS**	**IRS**
No. of Farms	21	12	17	10	20	41
Output (tons/ha)						
Mean	6.19	5.96	6.09	6.30	4.87	4.85
Minimum	0.83	3.33	4.38	5.00	0.89	1.67
Maximum	8.33	8.17	7.50	8.33	8.00	7.50

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Table 4 showed that the number of farmers in the IADA KETARA has increased from 10 for non padiU PUTRA to 21 farms for PadiU technology used. The maximum production produced by farmers is 8.33 ton/hectare for IADA KETARA. With the use of PadiU Putra technology, there are 17 farmers performed below their optimal size and therefore encountered IRS. These results indicate that every 1 % increase in input will increase output by more than 1%. The use of inputs is still needed to improve productivity. The remaining farmers have been classified as operating in the DRS region, so reducing inputs appears to be an acceptable choice for these farmers to improve productivity.

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