Cost and Return Analysis of System of Rice Intensification (SRI): Evidence from Major Rice Producing Areas in Malaysia

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***Abstract*— Rice (*Oryza sativa L.*) is the staple food and being the most important ingredient of the food basket for most nations in Asia. The declining productivity of rice and its availability of per capita is therefore a policy concern. Nevertheless, the production of rice in Malaysia is primarily implemented by adopting the conventional technique. This technique has increased the production cost of rice and became a constraint to achieving the production potential for the farmer. Thus, the System of Rice Intensification (SRI) was introduced in the rice cultivation as a relevant innovation which to offset the high cost of the conventional technique. Besides, such technique also decreases the production cost, reduces yield gap and increases profits of the farmers with less agronomical inputs. SRI also minimizes water use by scientific water management. As a result, such water minimization increases the productivity of rice farms in Malaysia which subsequently has an enormous potential for resource conservation and sustainability. Therefore, this paper attempts to determine the profitability and the factors affecting SRI adoption among rice farmers. The result revealed that the yield can be increased by changing the management of plants, soil, water and nutrients. The multiple linear regression analysis indicated that age, educational level, field size, role of information and environment condition had a positive impact and significantly influenced SRI adoption. Considering the substantial advantages, the suitable strategy for upscaling the SRI adoption is required to accomplish sustainable agriculture and food security.**

***Keywords*—** SRI, profitability, rice, adoption, Malaysia

1. Introduction

Asian Rice (*Oryza sativa L.*) is the staple food and one of the most widely and leading cultivated cereal in the world. It is also second to wheat in its annual contribution to the consumption of food. Rice is consumed by more than three billion people around the world. Therefore, rice is the most vital nourishment for most countries in Asia. For instance, rice comprises almost 90% of the worldwide rice region, production and utilization in Asia alone. Numerous countries have already prohibited or restricted their rice exports which result in the higher price increase of rice when the number of populations of the world is as of currently reeling from higher food prices. Indeed, according to [1], the rice production needs to be increased by 30% by 2025 to fulfil the demand for the growing population in the world. Rice production in Malaysia is mainly produced by the farmers who own smallholding land size of about 1.06 hectares. As a result, the rice production is unable to fulfil the aggregate demand in Malaysia since Malaysia only produces 70 per cent of its total rice needs. The other 30 per cent are imported from suppliers such as Thailand, Vietnam, and Pakistan. Thus, Malaysia is categorized as a small rice producing country, with only contributed about 0.4% to the total rice output globally. As the population and consumption of rice keep increasing, the gap between demand and the supply of rice will continue to widen. Thus, lack of self-sufficiency in rice production has led to the reliance on rice imports, which costs millions of Malaysian Ringgit (MYR) annually and thus increases its trade deficit [2].

The challenges include the decline or the stagnant of rice productivity, decrease in profit due to rising input costs, degradation water resources, high use of agrochemical inputs, fragmentation of land as a result of intensifying usage of chemical fertilizer and pesticide, shortage of labour for rice cultivation, energy, and the risk of health for farmers and consumers [3]. For all intents and

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purposes, there are two different ways to expand the production of rice: (i) by expanding the growing area of rice or arable lands, and (ii) by increasing its productivity. Nevertheless, it is impossible to establish the first option as it is difficult in expanding urbanization on agricultural lands. Thus, the improvement of the productivity through better management with existing resources is the only method to overcome the issue. This circumstance shows that the change towards an existing method of rice cultivation needs to be conducted towards enhancing the physiologic ability of the rice plant to produce more [4]. Hence, under the current Rice Yield Improvement Program, new emphasis has been given mainly on the practices in technology innovation for the management in paddy crop to accomplish the high return of yield in a specific period of time and to turn the industry of paddy to be more commercial and competitive.

The SRI is widely considered as an encouraging systemic approach to enhance the rice production at reasonable costs without compromising the environment in the country as being envisaged in the New Economic Model. For instance, SRI was developed in Madagascar as a technique to increase the rice paddies productivity by saving water and decreasing other input requirements. Besides, SRI is a technique to increase the productivity of the cultivation of irrigated rice by adapting the plants, soil, water, and nutrients management while external inputs are able to be reduced [5, 6]. Due to yield advantages, many governments in South-east Asian countries such as Timor Leste, Cambodia, Indonesia, Vietnam, Thailand, Philippines and Myanmar, the rice is their main staple food and thus their farmers are encouraged to adopt SRI practices. Nevertheless, the adoption rates among the Asian farmers have found to be low despite tremendous government supports [7]. Therefore, this study mainly focused on how (i) to determine the profitability of SRI in rice cultivation, and (ii) to identify factors influencing the adoption of SRI among rice farmers.

2. Materials and Methods

2.1. The Study Area

The present study was conducted in three major rice producing states i.e. Kedah, Sabah and Kelantan with SRI cultivation.

2.2. Data Instruments

A census sampling technique was adopted for selecting a sample of SRI farmers. 50 was the total number of SRI farmers being interviewed. The total sample consisted of the paddy farmers who were currently practising SRI technique in their farming activities. To achieve the objectives, the necessary primary data was collected by using a pre-tested and structured-survey questionnaire which was conducted from February until April 2018. The data consists of general farmers' information such as age, experience, educational level, marital status, size of the paddy field, total land size and others. Subsequently, other detailed information includes production cost and returns of rice and data relating to the factors which affect the adoption of SRI among rice farmers such as the status of farmer organization participates, the role of information, availability of inputs, extension services, access to irrigation and environment condition.

2.3. Data Analysis

The collection of primary data was employed to identify the cost return analysis of the implementation of SRI to achieve the first objective. On the other hand, the multiple linear regression was used to analyze the second objective which was to identify the factors influencing the decision of the farmer in adopting SRI technique for rice cultivation.

2.4. Analytical Framework

The production costs relating to return and profitability involved in SRI technique was computed on a per hectare basis. The costs involved were calculated based on the actual expenditure incurred. The total cost was classified as fixed and variable costs. The fixed costs include land rental, whereas the variable costs include the cost of irrigation, purchased seeds, fertilizers, plant protection chemical such as pesticides. The profit or loss is measured by the difference between revenue and cost [8]. The gross revenue was calculated by multiplying the quantity of rice produced with respective prices received. Profitability is a measure of the index which shows the ability of a firm to make a profit. In this study, the profitability was calculated by summing the rice sales with rice subsidy scheme deducting with production cost. On the other hand, the cost-benefit ratio was calculated by dividing net revenue with a total cost to reveal how much the expected present profit could be earned from SRI.

The formula for calculating benefit costs ratio is below:

$$\sum\{Rn/(1+r)n\}\{Cn/(1+r)n\} \quad (1)$$

where: R = revenue
C = costs
n = number of years
r = interest rate

Thus, the overall formula for the cost-benefit ratio is to divide the sum revenues generated during production life over the sum of costs incurred.

2.5. *Empirical Model*

This present study was conducted to determine the factors affecting the adoption of SRI cultivation through Multiple Linear Regression. Ten explanatory variables were identified through a process of the literature review.

$$\boldsymbol{Y} = \beta_0 + \beta_1\mathbf{X_1} + \beta_2\mathbf{X_2} + \beta_3\mathbf{X_3} + \beta_4\mathbf{X_4} + \beta_5\mathbf{X_5} + \beta_6\mathbf{X_6} + \beta_7\mathbf{X_7} + \beta_8\mathbf{X_8} + \beta_9\mathbf{X_9} + \beta_{10}\mathbf{X_{10}} + \boldsymbol{\varepsilon} \quad (2)$$

Where: Y is the dependent variable which is adoption level; β_0 is the constant; β_1- β_{10} are the coefficients to be estimated; while X_1- X_{10} are the independent variables comprised of age (X_1), educational level (X_2), experience (X_3), field size (X_4), organization status (X_5), role of information (X_6), input (X_7), extension service (X_8), irrigation (X_9), environment condition (X_{10}) and ε is an error term.

3. Results and Discussions

3.1. Production Cost

Table 1. Production Cost of SRI technique

Parameter	Kedah	Sabah	Kelantan
Land rental (RM/ha)	1500	1800	1000
Seed cost (RM/ha)	4	32.8	15.6
Fertilizer cost (RM/ha)	84.5	106	63.4
Pesticide cost (RM/ha)	14.4	16.09	25.14
Weedicide cost (RM/ha)	-	-	-
Fungicide cost (RM/ha)	-	-	-
Labour cost (RM/ha)	1445.5	1529.78	1334.58
Irrigation cost (RM/ha)	-	-	-
Maintenance cost (RM/ha)	200	350	260
Total cost (RM/ha)	**3248.4**	**3834.67**	**2698.72**
Yield (tonne/ha)	10.37	8.73	6.4
Total profit/loss (RM)	7229.3	5506.93	3764.68
Gross Revenue (RM)	10477.7	9341.6	6463.4
Income (RM)	20000	15800	9800
Cost Benefit Ratio (CBR)	**3.22**	**2.44**	**2.40**

Source: Own Field Survey, 2018 [1]

Table 1 above showed that the total cost of cultivation in Kedah was RM 3248.4 per hectare, whereas, in Sabah and Kelantan, the total cost of cultivations was RM 3834.67 per hectare and RM 2698.72 per hectare respectively. The productivity and income from the paddy production are better examined by analyzing the different costs incurred in the technique. The expenditure cost in Sabah was quite high compared to Kedah and Kelantan. The land rental was the highest in Sabah compared to other states. In Kedah, the seed cost was relatively low due to own seed production. Apart from that, the labour costs were the major expenditure on production cost and recorded the highest cost compared to other costs for all states. This was due to the high labour requirement in the cultivation process as this technique implemented by using a manual application instead of mechanization. Nevertheless, the study revealed that the SRI technique considerably generated more profits due to the low cost of expenditure through all the processes incurred.

3.2. Cost-Benefit Ratio

The finding showed that the SRI technique was profitable in all the states (Table 1). This indicated this technique could be conducted as the cost-benefit ratio is greater than one. Kedah had the highest ratio value of 3.22, whereas Sabah and Kelantan had only 2.44 and 2.40 respectively. Nevertheless, all states confirmed high profits by adopting this system. This was corroborated by the findings that yield and productivity of SRI almost double that under the conventional method in the most Asian rice fields region [9,10,11].

3.3. Yield and Profitability

Table 2. Yield and Profitability of SRI

ITEM	Kedah	Sabah	Kelantan
Yield (tonne/ha)	10.37	9.3	6.4
Deduction rate (20%)	8.30	7.40	5.12
Rice Sales (RM)	10477.7	9341.6	6463.4
Rice Subsidy Scheme (RM)(1	-	-	-

[1]Exchange rates: USD 1 = MYR 3.89 and EUR 1= 4.86 (January 31, 2018)

tonne=RM248.10)			
Production cost (RM)	3248.4	3834.67	2698.72
Profitability (RM/ha)= (Rice Sales + Rice Subsidy Scheme) - (Production Cost)	**7229.3**	**5506.93**	**3764.68**

Source: Own Field Survey, 2018[2]

After providing an overview or production cost and yield of paddy in Kedah, Sabah and Kelantan, it revealed that the yield produced in Kedah had wise growth compared to the other states. The yield obtained in Kedah was 8.30 tonne per hectare and was the highest, followed by the yield in Sabah and Kelantan. The finding showed Kedah gained the highest profitability (RM per hectare) for RM 7229.3 compared to Sabah and Kelantan which gained RM 5506.93 and RM 3764.68 and only obtained the profit by RM 1356.80. The net profit per hectare in Kelantan was insufficient for the farmers as they tended to face the losses due to bad weather or monsoon. The total net revenue of SRI farmers in Kedah was RM 10477.70 per hectare due to high yield generated. The result implied that the productivity of paddy for SRI farmers was high in Kedah, Sabah and Kelantan. Thus, SRI project was more efficient especially at production and yields obtained due to low production cost and high yielding.

3.4. Factors Influencing Farmer's Adoption of SRI

The Multiple Linear Regression analysis was used to determine the influential variables on the extent of SRI adoption. There are five variables (i.e. age, educational level, field size, the role of information and environment condition) which affect the dependent variable (the adoption level of SRI) are shown in the following table (Table 3):

[2] Exchange rates: USD 1 = MYR 3.89 and EUR 1= 4.86 (January 31, 2018)

Table 3. Multiple Regression analysis of SRI adoption in paddy production

Variable	Coefficient	Standard Error	t-ratio
Constant	20.795	0.8690	3.2150
Age	0.3630**	0.1340	2.7000
Education	0.1150**	0.0260	4.4720
Experience	0.0170	2.5690	1.2490
Farm size	0.5470**	0.9201	1.6560
Organization	1.5120	2.0560	3.0020
Information	-0.1075***	0.0240	2.9470
Input	3.7840	0.0980	1.0210
Extension service	-0.0005	0.0003	4.5100
Irrigation	2.3021	0.7802	3.8840
Environmental condition	-2.8750**	2.3740	2.7730

*** Significant at the 1% level, ** significant at the 5% level, R-Sq = 82.9% R-Sq (adj) = 78.9% Probability> F = 0.000

Age was discovered to have a significant impact on the adoption of SRI. Experience had a significant value of 0.008. Previous studies suggested positive findings between age and adoption decision [12,13]. The study expostulated that the older farmers had more experienced and assembled with greater in physical and social capital thus tended to adopt SRI technique.

As hypothesized, educational level was discovered to have a positive and significant influence on SRI adoption. The significant value for the educational level was 0.020. The education enables the farmers to increase their ability to better understand and apply this technique. Subsequently, the formal education is an effective tool to capture the awareness on environmental, especially among the farmers who are literate. The factors of literacy have been directly associated with the accessibility to information on agricultural innovation. This result is consistent with the literature, supported by [14] which discovered a positive relationship between education and the adoption of sustainable agricultural practices.

The next variable is the size of the paddy field. It was discovered to have a significant impact on the adoption of SRI among farmers. This was due to the fact that the farmers who have a larger size of paddy field are more willing to allocate part of the land to the new method instead of the farmers with smaller ones. The result is consistent with the literature by [15] which found that the size of the farm is a significant factor determining

the adoption. The size of the farm affects the adoption could be positive, negative or neutral.

The role of information was discovered to have a statistically positive and significant influence on the adoption of SRI among the farmers. The significant value for access to irrigation was 0.000. The study conducted by [16] highlighted the significance of information role in the decision of farmers to adopt SRI technique. SRI is a knowledge-based innovation, where the role of information plays a greater role in the adoption of SRI. For instance, to increase the awareness among farmers towards the benefits of the new technology, the farmers need to access extension information.

As hypothesized, environment condition was discovered to have a positive significant influence on adoption of SRI. The significant value of environment condition is 0.012. The implementation of the SRI technique has several benefits: (i) an improvement of soil fertility due to the reduced use of agrochemicals; (ii) paddy is more resistant to heavy metal toxic and resistant to strong weather; and (iii) improved health condition of the people in the farming community and the surrounding areas due to low usage of chemicals. This indicated that the benefit gain of an environmental condition for SRI has increased the propensity of the farmer to continue with SRI implementation. This result is consistent with [17] finding which discovered that environmental condition (which in this case was drought) affects the decision of farmer to adopt SRI.

4. Conclusions

Based on the findings of this study, the SRI contributed significant benefits in term of financial, environment and sustainability aspects. This technique has a better performance in generating high profit and increases the yield gain. The limited inputs required in this technique and high yield capacity are the major indicators which enhance the performance of SRI technique in a sustainable way. Last but not least, the age was significant in the adoption of SRI among farmers. This was followed by the educational level, field size, role of information and environment condition which were affecting the adoption of SRI in Malaysia. The study indicated that SRI technique has high potential to be development booster rice sector in Malaysia and to improve the living standards among the farmers due to lower production cost, high yield and reduction in water usage. Nevertheless, the SRI extension service should be improved so that a large number of farmers will have high awareness towards SRI innovation. Therefore, the finding requested the urgent needs of popularizing SRI technique through an initiative by the government and other agencies.

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