Factors Affecting Adoption of Paddy Estate Project among Rice Farmers For Increasing Rice Production and Supply

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***Abstract*— Rice is an important commodity in Malaysia as it is the most prominent staple food of the population. The National Agrofood Policy of Malaysia highlighted the need to ensure adequate rice supply and to increase farmers' income level. One of the efforts to increase rice production is the implementation of the Paddy Estate Project (PEP). The objective of the programme is to increase rice production with a lower operating cost. The present paper provides a case study of rice farmers in the Muda granary area, which covers the states of Kedah and Perlis, using primary data to identify the factors on the adoption of PEP among farmers. The research findings indicate that the key factors determining the farmers' adoption of the PEP are age, secondary jobs, effective communication with the extension agency, increased rice yield, lower operating cost, lower working time in the fields, and support services, such as assistance, incentives, and facilities from the government.**

***Keywords*—** *Paddy estate project, group farming, adoption, rice farmer*

1. Introduction

The improvement of rice production has always been the country's main goal as rice is a staple food among Malaysians. Therefore, the national rice production needs to commensurate the increase in Malaysia's population. In 2018, Malaysia's total population was 32.4 million, an increase of 1.1 per cent (356,400) compared to the year 2017 [14]. The increase in population is expected to raise the demand for rice. Based on the Crop Statistics (Food Crops Subsector) 2018, by the Department of Agriculture (2017) [14], the level of self-sufficiency of rice in 2017 was 70 per cent, compelling Malaysia to import rice to meet the demand of this commodity. Hence, efforts to increase rice production have to be proactive in reducing the dependence on imported rice in order meet domestic needs, thus ensuring food security in Malaysia.

Apart from food security issues, farmers in Malaysia's rice sector generate low level income. One of the main reasons for low income among rice farmers is the high operating cost that farmers need to bear. Although rice production can be improved, it cannot raise the income of farmers if the operating cost remains high. According to Najim, Lee, Haque, and Hisham (2007) [17], Malaysia would become a net importer of rice as the domestic operating cost for rice is extremely high. However, dependence on imported rice to meet the domestic demand will provide a negative impact to the local rice industry and the value of Ringgit against other currencies [20]. Since paddy is the most assisted crop in Malaysia, subsidized programmes are one of the government's initiatives to reduce the burden of its operating cost. An average of RM 1.9 billion per year was allocated for subsidies from 2010 to 2018 [15]. Nevertheless, the subsidizing initiative is not a smart solution in addressing the low income among farmers because it will foster a reduced motivation in farmers' attitude towards raising income, which could cause them to rely for constant assistance.

Therefore, one initiative in improving paddy production with low operating cost is through the implementation of group farming. It has shown a positive impact in achieving its objective of improving rice productivity in the granary area. According to Norsida (2008) [18], at the beginning

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of its introduction in 1970, rice yields increased from 2 tons/hectare to 5 tons/hectare. Apart from the success in increasing rice yields, the successful implementation of group farming can also be seen in the increase of the farmers' average annual income from RM3,523 in 1970 to RM32,427 in 2018 [12]. Based on the previous achievement of the group farming programme, another group farming programme was conducted in the Muda area under the supervision of MADA (Muda Agriculture Development Authority) in 2011, named Paddy Estate Project, MADA (PEP, MADA). The Muda area was chosen for the implementation of this programme since it is the largest granary area in Malaysia. The total area of rice parcel under the supervision of MADA is 100,685 hectares [13]. Table 1 shows the total area of rice parcel for each rice granary area in Malaysia.

Table 1: Total Area of Rice Parcel for Each Granary Area in Malaysia for the year, 2014 - 2018

Granary Area	2014	2015	2016	2017	2018
	Parcel (ha)	Parcel (ha)	Parcel (ha)	Parcel (ha)	Parcel (ha)
MADA	96,558	96,558	100,685	100,685	100,685
KADA	29,450	29,450	28,072	28,072	32,167
IADA Kerian	21,108	21,108	21,108	21,108	22,084
IADA BLS	19,021	19,057	19,057	19,057	19,021
IADA Pulau Pinang	12,782	12,782	12,782	12,782	13,375
IADA Seberang Perak	14,140	14,140	14,140	14,140	14,140
IADA Ketara	4,876	4,876	4,876	4,876	5,156
IADA Kemasin Semerak	5,047	5,053	5,053	5,086	5,220
IADA Pekan	4,940	5,322	5,322	5,555	4,940
IADA Rompin	2,290	2,290	2,290	2,290	2,290
IADA Kota Belud	-	-	-	-	-
IADA Batang Lupar	-	-	-	-	-
Total	210,842	211,266	214,015	214,281	219,708

Source: Department of Agriculture, 2017

Despite PEP, MADA being an agricultural development programme adapted from a previous successful programme, the participation of rice farmers in the Muda area in PEP, MADA is still low. According to MADA, only 31 per cent of rice farmers in the Muda area participated in the programme compared to the total number of rice farmers under MADA [12]. Any programme implemented will not achieve its objectives if participation from the target group is low. It is therefore important for the government, particularly for the extension agency, to identify the factors that determine farmers' acceptance of the programmes organized for them so that the objectives of such programmes can be achieved, especially in the efforts to improve the country's rice yield production. Thus, this study aims to determine the factors affecting rice farmers' adoption of PEP in the Muda area.

PEP, MADA is a form of innovation in rice cultivation management. It is planned centrally, and managed systematically and efficiently. The project aims to increase rice production to ensure food security [3]. In addition, the main purpose of PEP, MADA implementation is to reduce production costs by minimizing the involvement of middlemen for mechanization services, especially in rice cultivation and harvesting activities [3], [10]. The project is being implemented commercially by MADA and 27 Farmers' Organization Authority (FAO) in all four MADA's regions, namely Region I (Perlis), Region II (Jitra), Region III (Pendang), and Region IV (Kota Sarang Semut). To smooth out all activities on rice plots, PEP was designed by combining small-scale rice plots into a large-scale rice plot [10].

PEP, MADA is implemented by handing over all affairs regarding rice plots activity to FAO. The FAO will provide a group of farmers called the operation brigade to manage the farmers' rice plot, starting from land preparation to post harvest handling. The operation brigade members consist of individuals who have been appointed by the FAO and have been given intensive training to manage the rice plot. They are paid according to the tasks assigned to them. The operation brigade is divided into groups, each group comprises five brigade members and a supervisor. Each group is assigned to deal with 50 hectares of rice field.

2. Literature Review

According to Rogers (1983) [21], innovation and technology are two synonymous terms, basically having the same purpose to facilitate the production process or to enhance the production efficiency that will benefit the individual or group of individuals.

This statement is in line with [25] emphasis that innovation can solve problems or difficulties in production.

Although it has been proven that an introduced innovation has particular benefits for its target group, its acceptance among individuals in the target group is still slow. Rogers (1983) [21] argued that most innovations take a long time to be accepted by the target group, and for some cases, even when it has obvious advantages, it is often difficult to be adopted by the target group.

Therefore, the Utility Theory was introduced to explain the decisions made on the adoption of innovation. The Utility Theory assumes that an individual will opt for the choice that can maximize the utility [8], [1]. Several studies from the literature discussed utility definitions; among them was Von Neumann and Morgenstern's (1947) [25], which stated that the goal of decision makers in an economic system is to maximize returns in the form of profits earned by minimizing cost and maximizing output. However, Rahm and Huffman (1984) [22] stated that utilities are not limited to monetary form. Other researchers also defined utility in non-monetary form i.e. the form of new technological advantages over old technologies, such as [22], stating that utility is the level of technological complexity. Bowman and Zilberman (2013) [2] defined utility in terms of the compatibility of an innovation to the current situation. Kwasi et al. (1999) [11] confirmed that utility can be in non-monetary form, where social rewards can be some of the factors that maximize utility.

In addition, the Diffusion of Innovation Theory by Rogers (1983) [21] also discussed on the decision of innovation acceptance among the target group. The Diffusion of Innovation Theory suggested five factors that make up the target group's perception of innovation. These factors are relative advantage, compatibility, complexity, trialability, and observability. The Diffusion of Innovation Theory also stated that monetary factors are the driving force for innovation acceptance by the target group, discussed under the relative advantage factor. In spite of that, the Diffusion of Innovation Theory also widened the discussion on the decision-making goal of the target group towards the acceptance of innovation, by not merely focusing on monetary returns alone. Non-monetary factors have also been discussed in the Diffusion of Innovation Theory, which are compatibility, complexity, trialability, and observability.

3. Methodology

3.1 Selection of Study Site

This study was carried out in the Muda area under the supervision of MADA. This area overlaps two states, namely Kedah and Perlis, with a total area of 126,155 hectares, covering 105,851 hectares in the state of Kedah and the remaining 20,304 hectares in the state of Perlis. There are various agricultural activities in MADA: mixed farming covers an area of 9,544 hectares; rubber plantations cover an area of 1,976 hectares; a variety of permanent plants covers an area of 779 hectares; farms cover an area of 446 hectares; and a variety of cash crops covers an area of 198 hectares. However, rice cultivation activity is the largest area, covering 96,558 hectares. MADA has been obliged to handle three dams, namely the Pedu Dam with the capacity of 1,013 cubic meters, the Muda Dam with the capacity of 160 million cubic meters, and the Ahning Dam with the capacity of 275 million cubic meters.

3.2 Data Collection and Sampling Method

This study involved the population of rice farmers in the Muda area who adopted PEP, as well as rice farmers who did not adopt PEP. Based on MADA's report, the total number of rice farmers under PEP, MADA is 6,871 farmers, with the total area of 10,145 hectares for rice cultivation. Meanwhile, the number of rice farmers who did not adopt PEP, MADA is 30,987. The rice farmers' population is divided into four regions: Perlis, Jitra, Pendang, and Kota Sarang Semut. This study used a stratified random sampling approach. The stratified random sampling has a higher degree of representation and efficiency compared to other sampling designs [23], [26]. The stratified random sampling was performed as follows:

1. Target population was divided into two strata i.e. adopting PEP, MADA and not adopting PEP, MADA.

2. The sample size for each population stratum was determined based on the Sample Determination Table by Sekaran (2000) [23], as follows:

- Adopting PEP, MADA (population : sample) = 6,701 : 364
- Not adopting PEP, MADA (population : sample) = 30,987 : 380

The instrument used for data collection was a well-structured close-ended questionnaire. The questionnaire consists of questions regarding socio-demographic characteristics of the farmers, characteristics of the farm, extension agency, and the technological features or farmers' perceptions on the advantages of the current technology compared to the previous technology. The data collection was carried out in March 2015 to July 2015, after the rice harvest activity had been completed for 2014's main seasonal paddy planting. Therefore, the variables, especially operating cost, rice yields, total working hours, and subsidy and incentive, are the information needed for the main seasonal paddy planting in 2014.

The data collection was accomplished with the help of the enumerators, explained by the researcher on the questionnaire content and research objective.

3.3 Theoretical and Empirical Framework

Decisions made by target groups toward several options are subjected to optimization of heterogeneous agents [2]. In the case of rice farmers, the optimization takes place in the presence of several agents such as information, budget, and other inputs. Thus, rice farmers in MADA are assumed to have maximized their utility functions subject to these constraints. The primary assumption of the economic analysis on the farmers' decision whether to join PEP or otherwise is represented by Ui * (π), where π is one of the factors contributing to the utilities. It is assumed that individual and farm factors, institutional factors, economic factors, perception on innovation advantages, and subsidy and incentive, contribute to the utilities. Therefore, farmers would only join PEP if the expected utilities upon joining PEP are higher than those of not joining PEP, or $U_A^*(\pi) > U_N^*(\pi)$. In line with Gujarati (1992) [6], the decision by farmers whether or not to join PEP can be modelled in a random utility framework as follows:

$$U_i^* = X_i'\gamma + U_i$$

$$U_i = \begin{cases} 1 \; if \; U_i' > 0 \\ 0 \; otherwise \end{cases} \quad (1)$$

U_i^* is the latent variable, which represents the probability of the farmer's decision to join PEP, taking the value '1' if the farmer joins PEP, or '0' if otherwise. The term X_i' represents explanatory variables of the farmer's decision to join PEP. γ is the vector of parameters to be estimated, and u_i is the error term assumed to be independent and normally distributed as $u_i \sim N\,(0,1)$.

Logit model was used to determine the probability of adopting PEP among paddy farmers in the Muda area. According to Hair, Anderson, Tatham, and Black (1998) [7], logit regression is a popular statistical technique to determine the decision for adopting innovation. This is because of the probability of a dichotomous result, i.e. whether an innovation is accepted or rejected, determined by a set of variables based on hypotheses affecting those decisions.

Selection of the variables included in the model was based on the theories that have been discussed in past studies relevant to this current study [19], [4], [5], [24], [9], [16]. This study included four variables that have expectedly influenced the decision of farmers in the Muda area towards the adoption of PEP. The variables are (1) socio-demographic characteristics of farmers; (2) institutional factors; (3) economics factors; (4) farmers perception on the advantages of the current technology compared to the previous technology; and (5) subsidy and incentive. Therefore, the logit model for this study is as follows:

$$U_i = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \gamma_7 X_7 + \gamma_8 X_8 + \gamma_9 X_9 + \gamma_{10} X_{10} + \gamma_{11} X_{11} + \gamma_{12} X_{12} + \gamma_{13} X_{13} + \gamma_{14} X_{14} + \gamma_{15} X_{15} + \gamma_{16} X_{16} + \gamma_{17} X_{17} + \gamma_{18} X_{18} + \gamma_{19} X_{19} + U_i \quad (2)$$

U_i is the adoption of PEP (binary dependent variable), X_1 represents the age of respondent (years), X_2 represents gender (dummy), X_3 represents marital status (dummy), X_4 represents level of education (dummy),

X_5 represents main occupation (dummy), X_6 represents off-farm work (dummy), X_7 represents experience in rice cultivation (years), X_8 represents farm size (hectares), X_9 represents total income (RM), X_{10} represents frequency of reading pamphlet from extension agent (dummy), X_{11} represents relationship with extension agent (dummy), X_{12} represents communication with extension agent (dummy), X_{13} represents rice yield (tonne/hectares), X_{14} represents operating cost (RM/hectares), X_{15} represents satisfaction on rice field management (dummy), X_{16} represents satisfaction on mechanization facilities (dummy), X_{17} represents total working time (hours), X_{18} represents subsidy (score), and X_{19} represents incentive (RM); meanwhile, γ_0 to γ_{19} represent coefficients to be estimated and U_i represents error term. Refer to Table 2 for a complete description of each variable.

Table 2: Variables and Description of Each Variable

Variables	Description
Socio-demographic characteristics	
Gender	1 if farmer is male; 0 otherwise
Age	age of farmer in years
Education	1 = IPT; 2 = STPM; 3 = SPM; 4 =PMR; 5 =UPSR; no formal education
Main occupation	1 = non-rice farmer; 0 = rice farmer
Off-farm work	1 = participate in off-farm work; 0 = otherwise
Income	total income (RM)
Experience	experience in rice cultivation (years)
Institutional factors	
Frequency of pamphlet reading	1 = read more than 5 times a year, 0 = read less than 5 times a year
Relationship with extension agent	1 = very bad; 2 = not good; 3 = not sure; 4 = good 5 = very good
Communication with extension agent	1 = very bad; 2 = not good; 3 = not sure; 4 = good 5 = very good
Economics factors	
Rice yield	rice yield (tonne/hectares)
Operating cost	operating cost (RM/hectares)
Farmer perception on the advantages of technology	
Rice field management	1 = very bad; 2 = not good; 3 = not sure; 4 = good 5 = very good
Mechanization	1 = very bad; 2 = not good; 3 = not sure; 4 = good 5 = very good
Working time	total working hours (calculated by summing the hours for each stage of the rice cultivation process)
Subsidy and incentive	
Subsidy	subsidy (score)
Incentive	incentive (RM)

4. Result

4.1 Descriptive Statistics

Table 3 presents the summary statistics of the variables and differences between means of variables describing PEP adopter and non-adopter. As observed, 70 per cent of adopter households were headed by male. There appeared to be a significant difference in the age and the main job as non-rice farmer between PEP adopters and non-adopters. As expected, farmers who have non-rice farming main jobs are more likely to adopt PEP because they could hand over all affairs regarding rice field activity to FAO. Experience in rice planting was significantly higher for PEP adopters compared to that of non-adopters. These results are consistent with the higher average age of PEP adopters compared to that of PEP non-adopters. The adopting households also significantly differed in terms of farm size, which was expected to have a significant effect on PEP adoption.

Table 3: Characteristics of adopters and non-adopters of PEP

Item	Adopter (n = 264)	Non-adopter (n = 121)	Difference	t-value
1. Gender of household head male (%)	70.6	29.4	41.2	2.40
2. Marital status: Married household head (%)	67.50	32.5	35.0	0.86
3. Age (years)				
Mean	61	56	5	0.000***
Standard deviation	11.54	11.93		
4. Education: Secondary school and above (%)	71.3	28.7	42.6	2.17
5. non-rice farming main job (%)	70.7	29.3	41.4	4.26**
6. Off-farm work participation (%)	74.2	25.8	48.4	3.38
7. Experience (years)				
Mean	32	28	4	0.008*
Standard deviation	12.40	12.24	-0.14	
8. Farm size (hectares)	1.31	1.72		0.000***
Mean	0.96	1.13		
Standard deviation				
9. Total income (RM)				
Mean	2,542	2,651	-109	0.668
Standard deviation	2081	2411		

4.2 Factor Influencing Adoption of PEP among Paddy Farmers

The results from the logit analysis are shown in Table 4. Some of the variables had significant effects on the probability of adopting PEP and were parallel with previous studies [19], [4], [16]. Under the demographic factors, the age of the household head variable positively influenced the adoption of PEP. This result for the age variable is consistent with t-test result presented previously, thus reinforcing that older farmers are more interested in joining PEP. It is possible that older farmers are more interested in adopting PEP because of the convenience provided in operating their farms by the brigade team, since older farmers are unable to operate their field due to health constraints. This result is consistent with [19], which suggested that the older the farmers, the more experience they will be in a particular field, and the more interested they are in adopting innovation for the purpose of increasing the efficiency of managing their farm. Off-farm work is another variable under the demographic factors that shows positive impact to the adoption of PEP. Farmers who have off-farm work are more interested in adopting PEP, perhaps because they still can generate income from their rice field despite having a second job other than farm work that may be far from the farm area. To assess the effects of the institutional factors on the probability of adopting PEP, three variables were included in the model. However, only one variable positively influenced the adoption of PEP, which is communication with the extension agency. This result shows that farmers who have good social interaction with extension agencies are more likely to adopt programmes organized by the agencies, underlining the importance of extension agencies' role in promoting the adoption of PEP by increasing the visiting frequency of extension agency personnel to the farmers' rice plot. This result is consistent with [4] and [19]. Under the economics factors, two variables were included in the model to identify its effect on PEP adoption, which are the rice yield and the operating cost. Both variables have significant effects to PEP adoption. The significant effect of the rice yield variable indicated that farmers' involvement in PEP could increase rice yield; this becomes one of the reasons for PEP adoption. This result was in line with a report from MADA. At the beginning of the PEP establishment in 2011, the average rice yield was 4.7 tonnes/hectare while the rice yield in 2013's main season showed an increase to 6.0 tonnes/hectare. Nevertheless, the operating cost variable showed a negative, but significant relationship with PEP adoption. Based on the average marginal effect value, it means that RM1 reduction in cost could increase 12.1 per cent of farmers' adoption of PEP. This finding proved that the establishment of PEP achieves its objective in reducing the operating cost in rice production. Farmers' perception on the advantages of PEP in improving rice plot management was also included in the model as one of the variables to identify its impact on farmers' adoption of PEP. According to Chamhuri and Ahmad Zubir (2012) [3], rice plot management efficiency is one of the critical factors that could contribute to the increase in farmers' income. Table 4 shows that the rice field management variable has a positive and significant relationship with PEP adoption. This finding explains the facilities available in PEP implementation mechanism, such as the operation brigade's management of the farmers' rice field, were determinants of PEP adoption. Moreover, the rice field management variable is a proxy for measuring the PEP's complexity level, suggesting the Diffusion of Innovation Theory by Rogers (1983) [21]. Thus, this finding illustrates that PEP is effective in facilitating rice field work and becomes a determining factor in PEP adoption. For the working hours variable, the result showed a negative, but significant relationship with farmers' adoption of PEP. This result indicates that farmers' participation in PEP could reduce the allocated working time in the rice field. Farmers might be assisted by the operation brigade team, so the working hours spent in the rice field can be reduced and farmers can engage in other side jobs. Therefore, this finding explains the off-farm work variable that is significantly and positively related to the farmers' adoption of PEP. Other variables that have a positive and significant relationship with the adoption of PEP as expected are subsidy and incentive.

Table 4: Parameters Estimates of adoption of PEP

Variable	Parameter estimate	Odd Ratio	Average marginal effect	Robust standard error	Z value
Socio-demographic characteristics	0.893	2.441	0.058	0.653	1.37
Gender	3.097	22.141	0.156	1.503	2.06**
Age	-0.578	0.561	-0.029	2.353	-0.25
Level of education	-0.249	0.780	-0.014	0.678	-0.37
Main occupation	1.602	4.964	0.075	0.494	3.24***
Off-farm work	0.279	1.322	0.014	0.576	0.48
Income	-0.019	0.981	-0.001	0.030	-0.65
Experience					
Institutional factors	0.600	1.823	0.032	0.580	1.03
Frequency of pamphlet reading	-0.773	0.462	-0.039	0.492	-1.57
Relationship with extension agent	3.619	37.284	0.182	0.653	5.54***
Communication with extension agent					
Economics factors	1.089	2.971	0.0547	0.179	6.08***
Rice yield	-2.412	0.090	-0.121	0.622	-3.88***
Operating cost					
Farmers perception on the advantages of technology	15.890	0.001	-0.798	6.346	2.50**
Rice field management	0.746	0.746	0.037	0.900	0.83
Mechanization	-0.031	0.969	-0.002	0.009	-3.31**
Working hours					
Subsidy and incentive	787.486	0.000	0.800	232.238	3.39**
Subsidy	0.001e-0	1.000	-0.001	0.000e-08	3.01**
Incentive					
Constant	8.749			11.519	0.76
Log likelihood	-63.4406				
Pseudo R^2	0.7353				

5. Discussion and Conclusion

PEP is an agricultural development programme conducted in the MADA area and has shown a positive impact in increasing rice production and reducing operating cost. Understanding the factors that determine participation among rice farmers in the programme is important so that the programme is tailored to the circumstances and the farmers' needs, as well as to attain national goals. Therefore, this study was conducted to identify the factors of adopting PEP among farmers in the MADA area.

Based on the logit analysis conducted, older farmers are more interested in joining PEP. This indicates that PEP is a unique programme because most agricultural development programmes are usually attended by younger people. The operation brigades are assigned to carry out tasks in the rice plots to provide convenience to aging farmers; thus, the implementation of the PEP is appropriate to the circumstances and needs of the farmers. Apart from providing convenience to aging farmers, the implementation of PEP also provides opportunities for farmers to diversify their sources of income. Apart from the income of farmers can be improved through increased yield and reduced operating costs, increase farmers' income can also be achieved through a secondary job. The time allocated by farmers in the rice fields is reduced so that they can partake in off-farm work. It is confirmed by empirical results that the off-farm work variable and the working hours variable positively affected the decision to adopt PEP.

In addition, the empirical result also shows that the communication with extension agent variable is positively and significantly related to PEP adoption. Therefore, one effort that can increase the adoption of PEP among farmers is to improve social relations between extension agency staff and farmers. This can be done by increasing the frequency of rice plot visit by extension agency staff. During such a visit, the extension agency staff could motivate the farmers with promotional materials on the potential success of rice yield increase and the reduction in operating cost that can be achieved by PEP participants. Consistent with empirical results from the logit analysis, farmers who participated in PEP had successfully increased rice yields and had simultaneously reduced operating costs.

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