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Socio-Economic Impacts of Rice Variety Technology on Paddy Farmer's Livelihood

Roslina Kamaruddin[1], Azizah Md. Yusof[2], Wan Roshidah Fadzim[3], Ruhaida Saidon[4]

Abstract

The purpose of this paper is to assess the impact of the new rice variety technology known as 'PadiU-Putra' on socio-economic variables such as production, cost of production and farmer's income and livelihood. Primary data were obtained through a survey with 192 recipients of the PadiU-Putra rice variety in IADA KETARA, Terengganu, using a structured questionnaire. Cost and return analysis were used to analyse the impact of the PadiU-Putra rice variety, objectively. While the socio-economic impact index was calculated to analyse the subjective socio-economic impacts perceived by farmers. There were 26 indicators dedicated to four dimensions of socio-economic aspects, such as production, income, livelihood assets and confidence in technology introduced. The findings of this study show that the introduction of PadiU-Putra rice variety in IADA KETARA has successfully increased the production and reduced the cost of rice production in the region. While in terms of farmer's livelihood result showed that majority of farmers perceived that this technology had a moderate impact on their socio-economic variables, paddy production and farmers income. Based on the results, the study recommended that research towards quality seed production should be intensified, training on the use of technology for extension staff in relevant agencies needs to be executed and regular visits by extension staff and training for farmers are important to promote the use of technology in accordance with the Good Agricultural Practices (GAP).

Keywords: *Socio-Economic Impacts, Padiu-Putra, Rice Variety, Paddy Farmers, Livelihood.*

Introduction

In 2020, the agricultural sector contributed 7.4% (RM99.5 billion) to the Malaysia Gross Domestic Product (GDP). The production of paddy rose 2.5% from 2,570 thousand tonnes in 2019 to 2,640 thousand tonnes in 2020 with total cultivated area was 689, 268 hectare (Department of Statistics Malaysia, 2021). This production contributes to 72.85 percent of self-sufficient level (SSL) of rice in Malaysia. Paddy cultivation is really important in rural area because it is the main job for the community that can create employment and also the main source of their income, as well as to reduce the dependency of Malaysia on rice importation (Fauzi Hussin, and AB. Wahab Mat, 2013).

Nowadays, the uses of technology in agricultural sector is really important and is a need. Technology is not only used to help the farmer but also to increase the productivity and farmer's livelihood as well as to improve this sector (Das *et al.* 2016). Technology and innovation are important in paddy production in order for input efficient and yield increment. However the benchmark index of paddy production technology in Malaysia still in moderate level and there is a huge gap between high performance and low performance farmers with their technology practices (Nor Amna A'liah Mohammad Nor *et al.* 2016).

[1]Economic and Financial Policy Institute (ECOFI), Universiti Utara Malaysia, Sintok, Malaysia, School of Economics, Finance and Banking, Universiti Utara Malaysia, Sintok, Malaysia
[2]School of Economics, Finance and Banking, Universiti Utara Malaysia, Sintok, Malaysia
[3]School of Economics, Finance and Banking, Universiti Utara Malaysia, Sintok, Malaysia
[4]School of Economics, Finance and Banking, Universiti Utara Malaysia, Sintok, Malaysia

Government always strive to transform the traditional agriculture to modern agriculture through the agricultural development programs and MARDI is a government agency responsible for research and development activities related to the agricultural sector in Malaysia. In the case 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 by the machinery introduction, package in the use of high production paddy variety with biochemical inputs such as fertilizers, herbicides, and others that supported by infrastructure facilities (Fauzi Hussin, and AB. Wahab Mat, 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 for 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. Between1970-2018, 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 were 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, 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.

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 humic 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. Definitely the main objective of each technology introduced is to increase the yield of rice and consequently the living standard of paddy farmers. The objective of this study is therefore to evaluate the socio-economic impacts of this technology package on farmers in the selected region.

Adopting PadiU-Putra package technology has directly benefited 215 rice farmers through farmer's participatory research in IADA KETARA, Terengganu. PadiU-Putra technology has increased rice productivity between 25 to 50 percent in most of the rice farming in Translational Research activities which is 1.459ton/hectare or RM 2188 per hectare increased. Rice grain quality of this new improved PadiU-Putra variety is comparable and possess higher quality compared to few rice brands in the market.

This paper is divided into five sections: (i) an introduction that describes the topics, problems, agricultural development programmes, and technological development, particularly in the paddy sector, (ii) a literature review that reviews previous empirical studies related to the socio-economic impact of agricultural technology development and methods used in analysing the impact, (iii) methodology that describes the methods used to achieve the objectives of this study in terms of data collection, indicators, and analytical tools applied, (iv) results and discussion that divided into Impact of PadiU-Putra technology on production, operating costs, profit, input used, and farmers' livelihood, and (v) conclusion that summarises all of the study's findings.

Literature Review

Impact of technology introduced can be seen in term of economic, social and environmental. There are two economic indicators that reflect the degree of sustainability at household and community scales. The first economic indicator is on-farm net income. This is to measure household income status and whether it is increasing in a stable or unstable manner from year to year under the current conditions of farming sector (Dung, 2008). Farmer's income is an important indicator for economic impact to indicate the living standard of farmers either they involved directly or indirectly.

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 Salman bin Othman, 2009). With the use of modern technology in paddy cultivation, farmers can increase the efficiency and reduce the dependency on workers (Nor Amna A'liah Mohammad Nor *et al.*, 2016). For an example, in Taiwan, the use of drone technology for paddy production such as in pesticide and fertilizer spray had reduced the pesticides utilization and labor cost about 25% and 30% respectively, and hence increased by 10% (Rohaniza Idris, 2019). In India, Das *et al.* (2017) prove that the introduction of Modified System Rice Intensification (MSRI) have reduced the yield loss due to climate change since it have many advantages which are saving of water and seed, high yield and less dependence on chemicals The water-use efficiency (WUE) and water productivity (WP) increased substantially with MSRI practice.

Resfa Fitri *et al.* (2019) study about SALIBU technology (rice ratooning modification) which is an innovation in rice farming technology where the rice plant regrows after the stem is cut off and the farmers just only need to sow and transplant once and then they can harvest repeatedly. This technology have reduced the time taken for paddy cultivation, usage of water, seeds and labour. This is because, using this technology will reduce the need to do many activities like land preparation, sowing and transplanting. To assess the economic impact of SALIBU, author have use the indicators such as profitability, productivity, production cost and return on labour per day.

Cost-benefit analyses (CBA) is among the popular method applied for evaluating socio economic impacts of technology usage as in Juan et.al (2006), Hasan et.al, (2019), Sehal et.al (2021), Hile et al (2015), Siddick, S.A. (2019), Khade and Roy (2020) Barmon (2016). Hasan et al, 2019 employed financial analysis and CBA to evaluate the performance of combine harvester in comparison to manual harvesting of paddy and identify the impact on agricultural production system in Bangladesh. They found that the cost savings in mechanical harvesting of paddy was 57.61% for using combine harvester over manual harvesting. For the labor savings, they found that using combine harvester can save 70% labor over manual harvesting. The benefit cost ratio (BCR) of using combine harvester is 1.55 and the average total harvesting losses (including harvesting, threshing, and cleaning) for employing a combine harvester and manual harvesting were 1.61 % and 6.08 %, respectively. Using a combine harvester instead of a manual harvester will reduce paddy losses by 4.47 %. The findings implied that manual harvesting is a labor-intensive and costly technique, while mechanical harvesters on the other hand, save time, effort, and money as well as minimising harvesting losses.

Sehal et al (2021) also used BCA to estimate the cost and returns in cultivation of paddy (basmati) in IPM-INM and CPM farms in Haryana. IPM-INM and CPM are two alternative paddy cultivation technologies. Overall, the total cost of cultivation for IPM-INM technology was 38% higher than CPM paddy. However, the per quintal cost of production of IPM-INM paddy was lower than CPM paddy due to higher productivity of IPM-INM paddy. As indicated by a BCR of 2.73:1 for IPM-INM and 2.45:1 for CPM implied that IPM-INM technology is more viable. This study also proved that an adoption of IPM and INM technology by paddy growers is more beneficial in terms of economic as well as environment aspects. This method also being employed by Siddick, S.A. (2019) to compare the costs and yields of paddy cultivations in India under the farmers' practice and improved practice system. Findings showed that paddy production increased more than 25 percent under the improved practice as compared to farmers' practice with an extra production process cost per hectare of 1.5 percent and net income per hectare was 97.9% which 58.1 percent more than farmers' practice system.

Aside from BCR, Khade and Roy (2020) also employed other analytical techniques such as the technology adoption index and yield gap to analyse the impact of paddy cultivation production technology in the Nasik region of Maharashtra. Results showed the average technology adoption index of 71.57 percent. While, estimates of yield gap revealed the existence of a yield gap at all levels, ranging from 41% (low adopter) to 23% (high adopter). As a result, reducing or closing the yield gap may be a top priority for farmers in order to boost overall productivity and income. In addition to the BCR analysis, Hile et al (2015) also employed yield gap analysis, resource use efficiency and an adoption index to evaluate the impact of improved paddy technology. Kumar et al. (2021) estimate the change in yield owing to the adoption of new varieties using regression discontinuity design. The study discovered that introducing new types of varieties boosts yield significantly. Barmon (2016) estimates the impact of the Alternate Wetting and Drying (AWD) irrigation system on paddy production in modern varieties (MV) in Bangladesh. The study found that, in comparison to farmers who employed traditional irrigation, AWD farmers used less chemical fertilisers (with the exception of TSP) such as urea, MP, Gypsum, and Zinc. Furthermore, even within the same farming system, the amount of chemical fertiliser applied differed greatly. Revenue and profit per hectare of MV boro paddy were much greater in farms that used the AWD irrigation technique. Likewise, compared to their traditional counterparts, farmers employing the AWD irrigation technique required more irrigation and urea per hectare. AWD increases productivity by about ten percent.

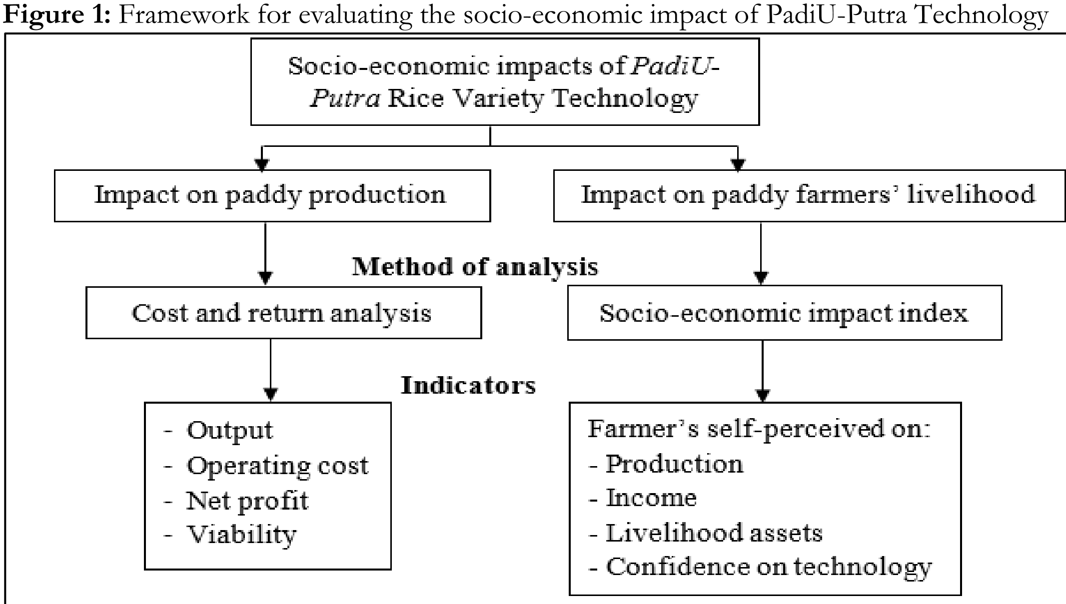
According to a review of previous studies, BCA, which includes cost and return and BCR analysis, is a popular method for assessing the economic impact of technology use in rice production. This is because most CBAs at the community level are financial in nature, focusing on facts and data where economic impacts can be easily monetized. This can make policymakers' decisions easier to make and free them from personal biases or preferences. However, CBA has traditionally failed to account for distributional effects. From a development standpoint, the distribution of benefits from technological development is diverse, including well-being and farmer livelihoods. Most previous studies examined the impact of technology on paddy production and farmer livelihood separately, despite the fact that these two aspects are inextricably linked. Thus, in addition to CBA, this study used a socioeconomic impact index to assess the socioeconomic impact of Padiu-Putra Technology. The use of a combination of CBA and socioeconomic impact index in this study emphasises the importance of ensuring that the quantitative analysis is embedded within a larger qualitative framework. Thus, the impact assessments in this study are comprehensive because they cover both objective impacts in paddy production, such as yield, production costs, and profits, as well as subjective impacts on farmers' livelihoods, which are based on farmers' perceptions of their income, livelihood assets, and trust in technology.

Methodology

To assess the impact of *PadiU-Putra* Technology on paddy farmers community, this study relies on primary data that were collected through a sample survey of paddy producing farmers in the granary area namely IADA KETARA in the states of Terengganu, Malaysia. Geographically the agricultural land of IADA KETARA covers an area of 9,701 hectare and it was divided into four compartments (I-IV). Based on the list of the technology receiver from University Putra Malaysia (UPM), which was the technology provider, there are a total of 192 paddy farmers received the new *PadiU-Putra* rice variety technology and all of them were successfully interviewed. PadiU-Putra Variety technology is distributed to farmers during the main season 2019/2020, which runs from August 2019 to February 2020. In February 2020, a pilot study was conducted on 30 farmers in the KETARA area who received the same technology. Some questions have been changed as a result of the pilot study, particularly in the measurement of input costs by separating subsidised and non-subsidized inputs and the separation of labour costs according to cultivation activities. The actual survey was then conducted in Mac 2020 by trained enumerators and researchers via group face-to-face interviews for a week using a structured questionnaire by trained enumerators and researchers. Since this is a quantitative study with a large number of respondents, structured questionnaires are the most appropriate and simple to manage in order to obtain a response that is consistent with the impact analysis that compares data before and after the use of technology. The questionnaire contains ratio, binomial, open-ended and 5-point likert scale questions. Before the questionnaire was distributed to the respondents, it was first sent to the Universiti Utara Malaysia (UUM) Research Ethics Committee for a review of the level of research risk involving the use of humans as research subjects and access to data; and the questionnaire was approved.

The socio-economic impacts were evaluated both objectively and subjectively (Figure I). The impact analysis was divided into two components which had an effect on objective economic variables such as production, operating costs and benefit. While the subjective socio-economic impact variables focused on production, the income of the farmer, the livelihood asset, and the confidence of the farmer towards the technology that will be reliant on the farmers' self-perceived. Since the variable used for subjective socioeconomic impact was in the form of a Likert scale, some statistical analysis such as Cronbach's Alpha Coefficient and Principal Component were performed to determine the reliability and validity of the Socioeconomic Impact Scale. Table VII in section 4.5 presents the findings of these statistical analyses.

Figure 1: Framework for evaluating the socio-economic impact of PadiU-Putra Technology



Cost and return analysis comprising both quantity and value-term yields, operating costs for input components, profit and Benefit-Cost ratio (BCR) is used to analyse the impact of *PadiU-P*utra package technology on output, operating costs, profit and viability by comparing the structured costs incurred during production seasons 1 and 2. This is due to farmers using the *PadiU-Putra* technology package in season 1 and returning to the regular practise in season 2.

Socio-economic impact index were calculated to analyse the subjective impacts that perceived by farmers. There are 26 indicators were dedicated to four dimensions of socio-economic aspects such as production, income, livelihood asset and confidence level toward technology introduced. Index was then constructed following Hahn *et al*. (2009). Indicators were identified and it is assumed that each indictor had equal weight to the individual dimension. The indicators was then standardized following the procedure adopted in measuring Life Expectancy in Human Development Reports (Hahn *et al*., 2009). For example, a standardized indicator j of a household was given by:

$$Index\ S_d = \frac{S_d - S_{min}}{S_{max} - S_{min}}$$

Where, Sd was the original sub-component for community d, and S_{min} and S_{max} were the minimum and maximum values, respectively, for each sub-component determined using data from the same community surveyed. An aggregated index for each farmer, were then constructed by averaging of all the four dimension of impacts with an equal weight of each. Each of the group's indices can be shown separately and an aggregated measure of Socioeconomic Impact Index can be displayed. The index was classified by quantile range, which was 0-0.25 as no impact, 0.26-0.5 minimal impact, 0.51-0.75 moderate impact and 0.76-1 high impact.

Results and discussion

Demographic of respondents

Table I indicates the distribution of the respondents in IADA KETARA by compartments. Most of the respondents in IADA KETARA were from compartment III (31.9 percent), followed by compartment I and IV of 20.6 percent and 28.7 percent respectively while the remaining 18.8 percent was from compartment II.

Table I: Distribution of Respondents by Granary Area.

Indicator	Frequency (number)	Percentage (%)
	IADA KETARA (PadiU-Putra-seed receiver)	
Compartment I	33	20.6
Compartment II	30	18.8
Compartment III	51	31.9
Compartment IV	46	28.7
Total	160	100

Table II indicates that the age range of paddy farmers in the IADA KETARA. The age of most farmers in the IADA KETARA region was 31-40 (21.3 percent), 41-50 (21.3 percent) and 51-60 (29.2 percent). Hence the respondents' mean age was 47 years in IADA KETARA. This findings is consistent with Rosnani *et.al,* (2015). This finding indicates that farmers in IADA KETARA are younger than farmers in Muda Agriculture Development Authority (MADA), Kemubu Agriculture Development Authority (KADA) and Integrated Agriculture Development Authority Barat Laut Selangor (IADA BLS) areas, where the average age of farmers is around 52 years, according to Azizah Md Yusof (2018), Mohd Rashid & Mohd Dainuri (2013) and Alam et.al (2011). In terms of marital status, the majority of respondents (83.1 percent) were married. The remaining 17 percent were single, widowed and divorced.

Table II: Distribution of Respondents According to Socio-Economic Characteristics

Indicator	IADA KETARA (n=160)	
	Frequency	**(%)**
Age		
≤ 30	20	12.5
31 – 40	34	21.3
41 – 50	34	21.3
51 – 60	47	29.2
61 – 70	22	13.8
≥ 71	3	1.9
Mean	*47*	
SD	*12.62*	
Marital status		
Single	24	15.0
Married	133	83.1
Divorced Alive	1	0.6
Widower	2	1.3
Number of Household		
0 – 5	81	50.6
6 – 9	65	40.6
10 – 13	12	7.5
14 – 17	2	1.3
Mean	*5.78*	
SD	*2.58*	
Educational Level		
No schooling	4	2.5
School founded on religion	6	3.8
Primary Education	38	23.8
Secondary schools (PMR / SRP / LCE)	26	16.3
High Schools (SPM/MCE/SPVM)	73	45.6
Certificates / STPM / Diploma	13	8.1
Experience		
1 – 10	51	31.9
11 – 20	63	39.4
21 – 30	25	15.6
31 – 40	16	10.0
41 – 50	5	3.1
51 – 60	-	-
Mean	*18*	
SD	*11.18*	

Table also reveals that the majority (50.6 percent) of household numbers were within the range of 0-5 individuals. Therefore, the mean for household number was around 6 individuals which is also consistent with Mohd Rashid & Mohd Dainuri (2013) and the agriculture census by Department of Statistic (DOS) (2005). Data showed that a higher proportion (45.6 percent) of the respondents attended high school (SPM/MCE/SPVM) in terms of education level. While 3.8% of respondents attended religious-based colleges, 23.8% attended elementary school, 16.3% attended secondary schools (PMR / SRP / LCE). There were 8.1% of respondents have qualification at Certificates/STPM /Diploma level. The remaining 2.5% did not have any schooling.

The table reveals that most respondents (39.4%) were engaged in rice farming for 11-20 years, while 31.9%, 15.6%, 10.0% and 3.1% were engaged in rice farming for 1-10 years, 21-30 years, 31-40 years and 41-50 years respectively. Hence the overall experience of paddy farmers in rice farming was 18 years, which is consistent with Rosnani et.al, (2015). This finding also indicates that rice farmers in IADA KETARA are relatively new compared to farmers in other granaries areas such as IADA BLS (27.6 years), MADA (23.4 years), and KADA (24.5 years) (Mohd Rashid & Mohd Dainuri, 2013).

Economic status of paddy farmers

Table III present the distribution of respondents by income range. The range of income is based on Malaysians income groups' categorisation: Top 20% (T20), Middle 40% (M40), and Bottom 40% (B40). However in year 2020 Department of Statistics expanded this classification of households into 10 categories based on 10 percentiles, while the B40, M40 and T20 classification is remain. Findings have shown that most paddy farmers in IADA KETARA (68.8 percent) falls into the B1 category with incomes less than RM2208 per month, which is already considered poor.

Based on Table IV, paddy cultivation is the main occupation for respondents in IADA KETARA. This is demonstrated by a share of more than 65 percent of the overall household income came from paddy farming. The average income of the farmers in IADA KETARA was RM1449.18/month. Meanwhile, the share of income from non-paddy activities was RM783.4/month and the total income was RM2224.66 monthly. As compared to national level, the average income for a farmer was around RM1340 per month, while the additional income from other activities was around RM550, to make the total income of around RM1990 per month (Mohd Rashid & Mohd Dainuri, 2013).

Table III: Distribution of Farmers by Income Level.

Indicator	IADA KETARA	
	Frequency	Percentage (%)
B1 (≤ 2208)	110	68.8
B2 (2209-3170)	16	10.0
B3 (3171-3970)	9	5.6
B4 (3971-4850)	1	0.6
M1 (4851-5879)	6	3.8
M2 (5880-7099)	3	1.9
M3 (7100-8699)	3	1.9
M4 (8700-10959)	1	0.6
T20 (≥ 10960)	3	1.9
Total	152	95.0
Mean	2228.38	
SD	2863.23	
Minimum	141.67	
Maximum	23050.00	

Table IV: Income Distribution of Paddy And Non-Paddy.

Region	**IADA KETARA**	
Source of Income	Mean (RM)	Percentage Contribution
Income from Paddy (RM/month)	1449.18	65.14
Income from Non-paddy (RM/month)	783.4	35.21
Total Income (RM/month)	2224.66	100.00

Paddy Field Acreage

The average cultivated paddy area by farmers in IADA KETARA is 2.57 hectares (Table V). As far as the number of farmers per area of rice fields is concerned, 53.8 percent of farmers in IADA KETARA have rice fields of less than 2 hectares and 40.6 percent have rice fields of between 2 and 5 hectares, and 5.6 percent have rice fields of more than 5 hectares. Overall, the average size of rice fields is 2.57 hectares, which is close to the national average of 2.5 hectares per farmer (Department of Statistic, 2020). This area is larger than the average area of MADA farmers, who have only 2.21 hectares (Mohd Rashid & Mohd Dainuri, 2013). The area of farmers' paddy fields in KADA and IADA BLS areas, on the other hand, is relatively large, at 5.22 hectares (Mohd Rashid & Mohd Dainuri, 2013) and 2.97 hectares (Alam et al, 2011), respectively. Table V also shows the types of land ownership for respondents. It was found that the majority of respondents in IADA KETARA were tenants of 58%, owners and tenants of 33.3% and owners of 8.3%.

Table V: Distribution of Farmer's According to Acreage of Paddy Production in IADA KETARA.

	Number of farmers	**Percentage (%)**	**Mean**	**SD**
IADA KETARA (n=160)				
≤ 2	86	53.8	2.57	2.44
2.01 – 5	65	40.6		
≥ 5.01	9	5.6		
Own	13	8.3		
Rental	91	58.0		
Own + Rental	53	33.8		

Impact of Padiu-Putra Technology on Production, Operating Cost, Profit, Input Used and Viability

Analysis of production costs and return takes into account the subsidies provided by the government. Table VI shows the production costs and returns for IADA KETARA area. The average yield in the IADA KETARA area is 6.51 tonnes/ha for the use of PadiU-Putra technology and 5.06 tonnes/ha without the use of PadiU-Putra technology. Most farmers claimed that PadiU-Putra seeds produce longer and strong rice stalks, rice do not fall easily and longer rice grain. These features has directly increased the paddy yield by 28.7 percent in IADA KETARA area. This yield has surpassed the national average yield of about 4.3 tonnes/ha in 2019. (Department of Statistics Malaysia, 2020).

In terms of production costs, the data is calculated using the implicit cost method by imputing the subsidized input cost and putting wages on family/own labour. Study found that the use of PadiU-Putra technology can reduce the variable cost of rice production by 19 percent which is from RM3284.05/hectare to RM2657.11/hectare. In terms of cost component, land rental had the highest cost share (almost 30 percent) among the other inputs. This was followed by the harvesting and labour inputs. Both shared approximately 12 percent and 10 percent of total cost, respectively. There is no doubt that an increase in yields and a decrease in production costs indicate an increase in profitability. The use of PadiU-Putra seeds increased the profits of farmers in the AIDA KETARA area by 153 per cent.

Benefit-Cost Ratio Analysis (BCR) was also used to evaluate the degree of viability of paddy farmers in IADA KETARA who have used the technology of PadiU-Putra and do not use the technology. The results showed that the BCR for farmers using PadiU-Putra technology in IADA KETARA is higher than those who do not use the technology. However, the BCR exceeds 1 for the case, suggesting a positive degree of viability. Overall, the average BCR of farmers imply that farmers benefit from paddy cultivation, whether or not using PadiU-Putra technology.

This finding is consistent with Singh et al. 2015, who examined the impact of improved technology paddy variety "Birsa Vikash Dhan-109" in Madhya Pradesh's Sidhi district. The results showed that improved technology produced a 55% higher yield than farmers' current practises. When compared to current farmer practises, improved technology provided a higher gross return of 34331 to 38400 Rs./ha, a net return of

17299 to 27560 Rs./ha, and a benefit cost ratio of 3.18 - 3.54. Improved seed technology allows farmers to save labor and managerial time, thereby improving efficiency of farming operation (Ghimire et.al., 2015).

In Ghana, Abdul-Rahaman et.al. (2021) also revealed that Improved rice variety adopters obtained significantly higher productivity and technical efficiency than non-adopters. The results indicate that adopters are 24% more technically efficient than non-adopters. In addition, adoption of improved rice varieties is associated with about 76% increase in rice farmers' productivity, relative to non-adoption. In addition, Anang (2019) revealed evidence from Northern Ghana that productivity of improved rice variety adopters is 40 percent higher than for non-adopters. While, in Nigeria, Awotide et. al., (2016) revealed that the average yield of improved varieties was increased more than 100 percent as compared to local/traditional rice varieties either in upland or lowland area. The percentage increase is highest under the irrigated system. Adoption of improved rice varieties is positively and significantly influenced by gender, access to irrigation, group membership, access to credit, timely harvest, location fixed effects (Abdul-Rahaman, 2021) and proportion of household land allocated to rice production (Anang, 2019).

Table VI: Cost a nd Return Structure for Paddy Farming In IADA KETARA

Indicator	**IADA KETARA**		**Percentage change**
	With PadiU-Putra	**Without PadiU-Putra**	
Total Paddy farm area	0.73	2.07	
Total production (ton/ha)	6.51	5.06	28.7%
Price (RM/ton)	1201.85	1201.93	
Gross production (RM/ha)	7824.04	6081.77	28.7%
Variable cost (RM/ha)	2657.11	3284.05	-19%
Paddy field preparation	359.03	379.15	
Seed	534.94*	534.94	
Labour	416.93	508.35	
Pesticide	351.88	546.02	
Fertilizer	244.16	728.03	
Harvesting	750.17	587.56	
Fixed cost (RM/ha)	1255	1255	0
Rental (RM1250/ha)	1250	1250	
Tax	5	5	
Total cost (VC + FC)	4012.11	4539.05	
Net profit (RM/ha) (Gross Production-Total cost)	3911.93	1542.72	153%
Benefit cost ratio (BCR)	1.95	1.34	46%

4.5 Socio-economic impacts of PadiU-Putra technology on farmer's livelihood

In order to evaluate the impact of PadiU-Putra technology on the livelihood of the paddy farmer, the socio-economic impact index was generated based on four dimensions of impact: impact on paddy production, impact on farmers' incomes, impact on their livelihood and confidence in PadiU-Putra technology. Descriptive analysis of all indicators used, as shown in Table VII. The data showed that the mean score for most dimensions was greater than three, with the exception of the impact on livelihood assets, which was less than three. Respondents also demonstrated a high level of trust in the technology, with a mean score of more than 4 for all indicators.

Table VII: Descriptive Analysis of Indicators Used in the Socio-Economic Impact Analysis

Label	Indicator	Mean	Std. Deviation	Factor loading	Cronbach's Alpha
	Impact on Production				
PE1	Paddy yield has increased.	4.04	0.89	0.65	0.9
PE2	The percentage rate of paddy cuttings in mills is reduced.	3.26	1.17	0.7	
PE3	Production costs are reduced.	3.12	1.16	0.78	
PE4	Maintenance costs are reduced.	3.35	1.11	0.85	
PE5	The net profit of paddy production increased.	3.94	0.89	0.57	
PE6	Working time in the paddy fields is reduced.	3.34	1.08	0.78	
PE7	Fertilizer consumption is reduced.	3.13	1.08	0.84	
PE7	Pesticides are being used less.	3.23	1.11	0.83	
PE9	The planting season is becoming shorter.	3.2	1.04	0.82	
PE10	Rice's disease resistance has improved.	3.85	1	0.62	
	Impact on Income				
IN1	The farm price of rice have increased.	3.47	1.18	0.6	0.78
IN2	Rice yields have increased.	3.87	1.08	0.71	
IN3	Provisions for daily expenses were increased.	3.29	1.01	0.55	
IN4	Capable of making savings from rice cultivation	3.67	0.89	0.81	
IN5	Savings from rice yields have increased.	3.61	0.92	0.83	
IN6	The ability to repay debts improves.	3.51	0.89	0.66	
	Impact on livelihood assets				
AS1	Home furnishings have been replaced.	3.09	1.01	0.79	0.86
AS2	Ownership of gold assets increased	2.72	0.94	0.74	
AS3	Vehicle ownership (examples: cars, motorcycles) increased	2.81	1	0.87	
AS4	Residential home improved	3.01	1.02	0.81	
AS5	Land ownership is expanding	2.54	1.03	0.81	
	Confidence in Technology				
CN1	PadiU-putra technology has performed admirably for me.	4.37	0.73	0.74	0.85
CN2	I have no reservations about telling other farmers about the advantages of using PadiU-putra seeds.	4.33	0.72	0.87	
CN3	Overall, I believe that using PadiU-putra seeds is less risky than using regular padi seeds.	4.06	0.95	0.8	
CN4	I'm confident in the locally developed seed variety (PadiU-putra).	4.42	0.65	0.85	
CN5	The performance of locally developed seed varieties can compete with that of imported varieties.	4.21	0.82	0.77	

To ease the analysis, the socioeconomic impact index was classified by quantile range, which was 0-0.25 as no impact, 0.26-0.5 minimal impact, 0.51-0.75 moderate impact and 0.76-1 high impact. Table VIII shows the distribution of farmers by their degree of self-perceived socio-economic impacts of the *PadiU-*

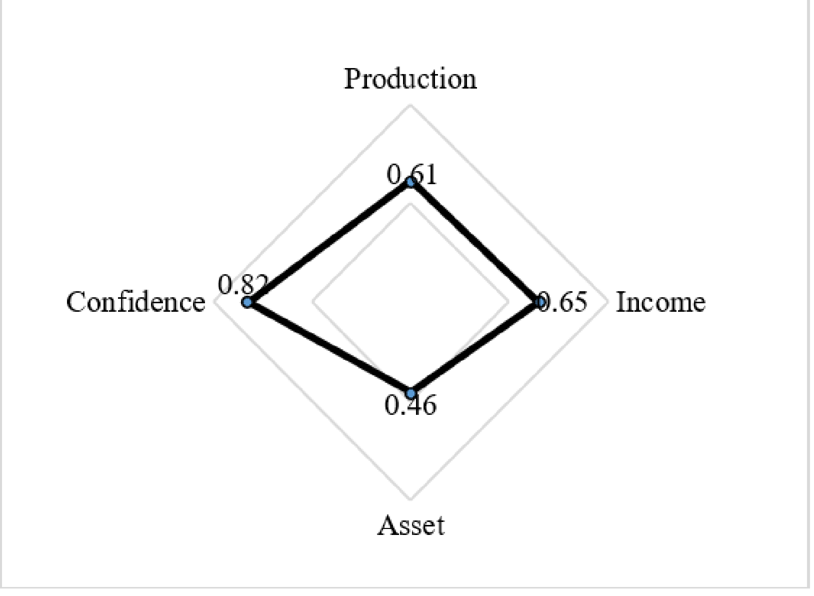
Putra technology introduced by UPM. Generally, the majority of farmers, 65.7% in IADA KETARA, perceived that this technology had a moderate impact on their socio-economic variables in the granary area. Approximately 18% of farmers in IADA KETARA have indicated that this technology has a high impact on their socio-economic status. Overall the mean socio-economic impact index was 0.64 in IADA KETARA.

Table VIII: The Distribution of Farmers by The Degree of Impacts.

Socioeconomic Impact range	IADA KETARA (n=134)	
	No.	%
No impact (0-0.25)	0	0
Less impact (0.26-0.50)	23	17.16
Moderate impact (0.51-0.75)	87	64.93
High impact (0.76-1.00)	24	17.91
Mean	0.64	

Figure II provides the socio-economic impacts index of *PadiU-Putra* technology in selected granary area by dimensions. Farmer's confidence in the use of technology was a key factor that leads to socio-economic impacts as a whole. The index for this dimension was high among farmers in IADA KETARA with an index of 0.82 (major impact). The introduction of *PadiU-Putra* technology had moderate impact on paddy production and farmers income in the area with an index range from 0.61 to 0.65. However, *PadiU-Putra* technology have less impact on livelihood asset of farmers. With an index of less than 0.5, this result suggested that although the respondents had confidence in the technology, the impact is not so pronounced because the use of the technology was only for one production season.

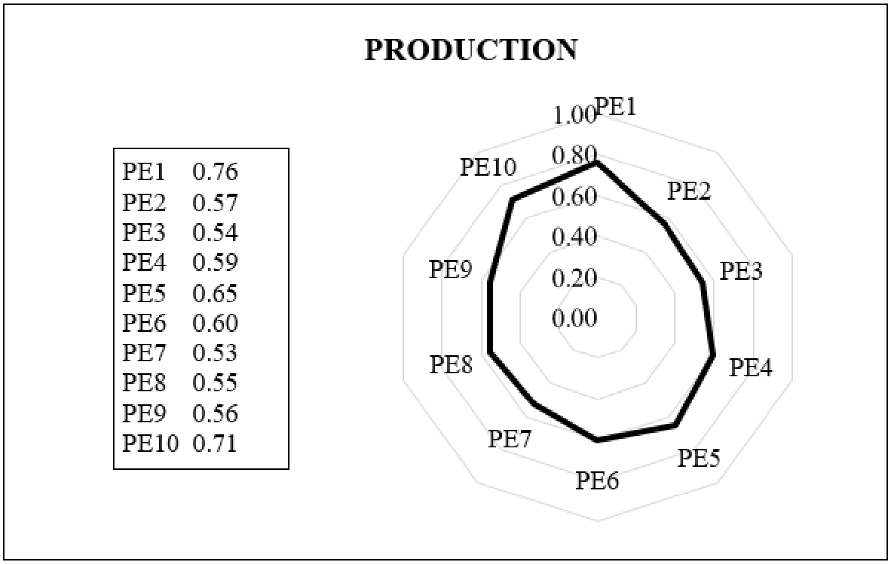
Figure II: Socioeconomic Impact Index By Socioeconomic Dimension for IADA KETARA.



In order to provide a better picture of the socio-economic impact, it is important to evaluate the index on the basis of each variable representing each dimension. Figure III shows the impact of using *PadiU-Putra* Technology on production's dimension for paddy farmers' in IADA KETARA area with the average index was 0.61 This means that farmers in IADA KETARA had a high impact.

If we detail individually for each indicator we found that score indexes for IADA KETARA is high with for the paddy production impact among the farmers is between 0.53 (lowest score) to 0.76 (highest score) with the overall average score is 0.61 which is falls in moderate range.

Figure III: The Impact of the used of PadiU-Putra Technology on Production.



A total of ten components represent the paddy production effects, namely PE1 to PE10, each component represents the farmers' agreement on the impacts related to paddy production. Indicator PE7 'fertilizer used' has a lowest score (0.53) while indicator PE1 'total production' score the highest index (0.76). The score index for indicators PE2, PE3, PE4, PE5, PE6, PE8, PE9 and PE10 are 0.57, 0.54, 0.59, 0.74, 0.6, 0.55, 0.56 and 0.71 respectively. Except for indicator PE1 (total production), the impact of the used of *PadiU-Putra* Technology on production for IADA KETARA's farmers is moderate which is in the index range of 0.51 to 0.75.

Farmers' incomes are also among the factors highlighted in the analysis of the impact of *PadiU-Putra* Technology usage in IADA KETARA granary area. Six indicators were used to reflect the impact on farmers' incomes from the use of paddy technology (Figure IV). We analysed the impact on the income itself (indicator IN2), the allocation for daily expenses (indicator IN3), the ability to make savings (indicator IN4), the rise in saving (indicator IN5), the ability to pay debt (indicator IN6) and also the buying price in paddy processing centre (indicator IN1).

From the analysis we found that the average level of index score for an impact of income for IADA KETARA farmers is 0.59 which is at the moderate impact range. For IADA KETARA's farmers allocation for daily expenses (indicator IN3) has a lowest index score which indicates the used of *PadiU-Putra* Technology has a less impact on farmer's daily expenses allocation. Although the effect on income is moderate (indicator IN2) with the index score being the highest at 0.74, it does not have a major impact on the allocation of farmers' expenditure, as they prefer more to debt repayment (indicator IN6). This is obvious when the value of the second highest index score for IADA KETARA farmers is given by this IN6 indicator. IADA KETARA farmers often choose a saving instead of increasing the allocation of their daily expenses. That statement is clear based on the IN4 and IN3 indicators' index score value. The impact of using *PadiU-Putra* Technology for IADA KETARA on farmers ' income varies from less to moderate.

Figure IV: The Impact of PadiU-Putra Technology on Income.

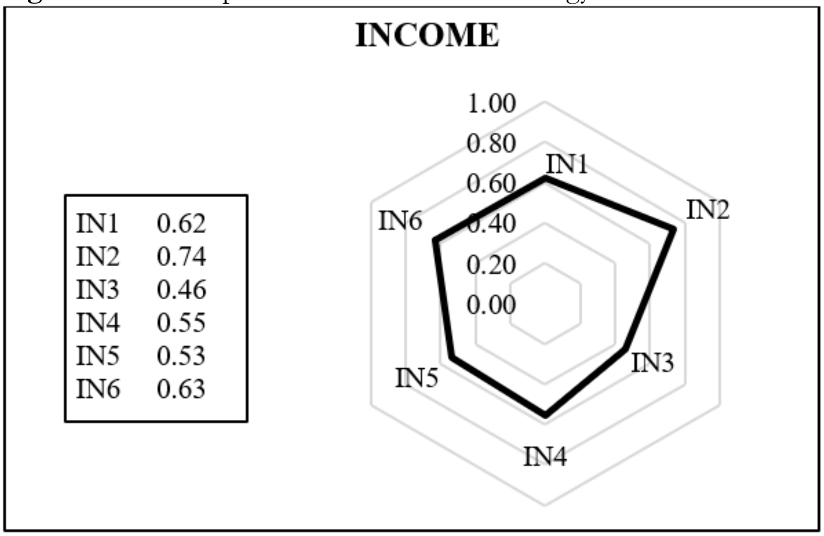
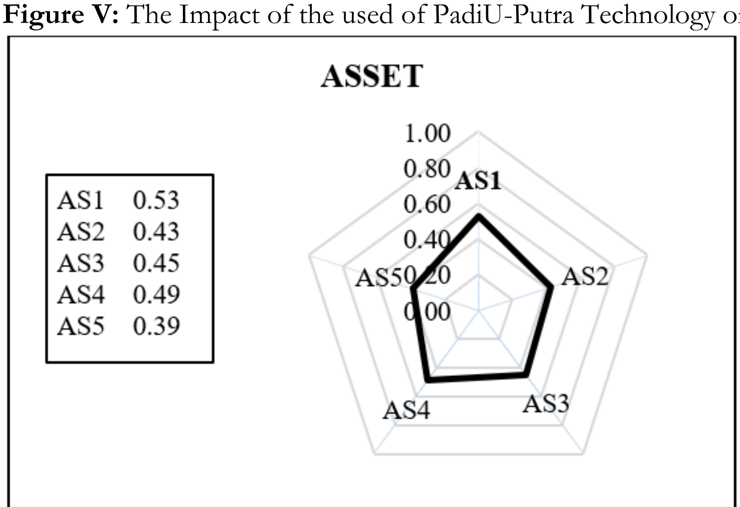


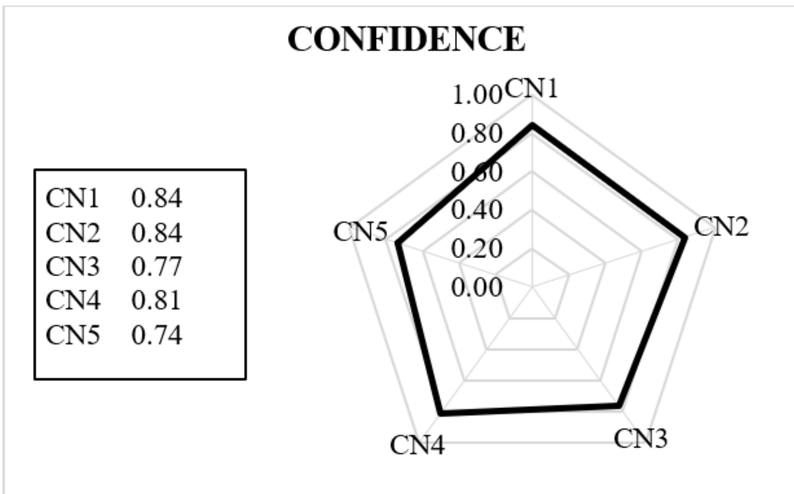
Figure V shows the impact of the used of *PadiU-Putra* Technology on farmers' asset. Physical assets such as furniture (AS1), jewellery (AS2), vehicle (AS3), house renovation (AS4) and land (AS5) are all referred to, in this touch. The effect of the technology on asset ownerships is very low as farmers only use the technology for two seasons at most. The score for each indicator is ranging from 0.39 to 0.53 for IADA KETARA' farmers and the average score index is 0.46 which is less impact. Although the overall impact on assets falls within the spectrum of less impact, the impact is dominant in IADA KETARA of study in 'buying a furniture'. An increase in income from the use of *PadiU-Putra* Technology enables farmers to purchase a home furniture.

Figure V: The Impact of the used of PadiU-Putra Technology on Asset.



The last socio-economic dimension on the impact of using *PadiU-Putra* Technology is the confidence of farmers, will be analysed. Using Figure VI will help us understand the effect. After using the *PadiU-Putra* technology, this index score can be used to calculate farmers' confidence levels. The average score for this dimension is 0.80 for IADA KETARA. This implies that the confidence of IADA KETARA farmers in the *PadiU-Putra* Technology is high. The IADA KETARA score index falls in high impact range except for indicator CN5 which is in a moderate impact range. The score index says farmers have confidence in the performance of the technology after using the provided technology and they also confidence in telling others about the goodness of *PadiU-Putra* Technology. Farmers also believe that *PadiU-Putra* Technology has a lower risk, and if compared to other varieties, they were proud of the *PadiU-Putra* variety. Farmers also have confidence in the quality of the *PadiU-Putra* as comparable with imported seeds.

Figure VI: The Impact of the used of PadiU-Putra Technology on Farmers Confidence.



Based on the findings of the socioeconomic impact, it is possible to conclude that the use of the PadiU-Putra rice variety can improve the well-being of farmers, particularly in terms of increased production, income, and livelihood assets. This finding is consistent with Awotide et al., (2016), Villano et al., (2015), and Dontsop-Nguezet et al., (2016). (2011). According to Dontsop-Nguezet et al. (2011), adopting NERICA varieties increased household per capita expenditure and income by an average of 49.1% and 46.0%, respectively, lowering the possibility of adoptive households falling below the poverty line. It can be stated that higher adoption of Improved Rice Varieties (IRVs) would lead to an increase in rice yield and rural farmers could, consequently, have marketable surplus. It this is marketed it would lead to an increase in household income and by extension generate improvement in household's welfare. in fact, according to Awotide et.al., (2016), adopters of IRVs are better off in terms of welfare than the non-adopters.

Conclusion

The findings of this study show that the introduction of *PadiU-Putra* rice variety in IADA KETARA has successfully increased the production and reduced the cost of rice production in the region, implying an improvement in efficiency and productivity. Increased in productivity as a result of the development of high-quality seed varieties can boost farmers' income, improve their standard of living, and, as a result, eradicate farmer poverty. Aside from that, the development of high-quality seed varieties can boost the country's rice production, reduce rice imports, and further ensure the country's food security, as rice is Malaysians' staple food. Therefore research towards quality seed production should be intensified in order to boost the efficiency and productivity of paddy. The government needs to provide more grants to enable more researchers to have the opportunity to conduct research in this important sector in order to ensure Malaysian food security. Then, in order to ensure that the technology produced reaches the target group efficiently, training on the use of technology for extension staff in relevant agencies needs to be executed. Regular visits by extension staff and training for farmers are important to promote the use of technology in accordance with the Good Agricultural Practices (GAP). Clearly, the introduction of a technology to a community should be followed by a study of its socioeconomic impacts in order to determine whether the technology is effective in improving the community's livelihood. In addition, the findings can serve as a reference for policymakers to establish development programs that will help the farming community and ensure national food security.

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References

Abdul-Rahaman, A. Issahaku, and G. Zereyesus, Y.A. 2021. Improved rice variety adoption and farm production efficiency: Accounting for Unobservable Selection Bias and Technology Gaps among Smallholder Farmers in Ghana, *Technology in Society*, 64(2021), pp. 1-11.

Alam, M.M., Siwar, C., Talib, B., and Mohd Ekhwan, T. 2011. The Relationships between the Socioeconomic Profile of Farmers and Paddy Productivity in North-West Selangor, Malaysia, *Asia-Pacific Development Journal*, Vol. 18(1), pp. 161-173.

Anang. B.T. 2019. Are Adopters of Improved Rice Varieties more Productive than Non-Adopters? Empirical Evidence from Northern Ghana, *Ghana Journal of Development Studies*, Vol. 16 (1), pp. 92–107.

Awotide, B.A., Karimov, A.A. and Diagne, A. 2016. Agricultural technology adoption, commercialization and smallholder rice farmers' welfare in rural Nigeria. *Agricultural and Food Economics*, Vol. 4(3), pp. 1-24.

Barmon, B. (2016). Impacts of the Alternate Wetting and Drying Irrigation System on Modern Varieties of Paddy Production in Bangladesh: A Case Study of Jessore District. *The Bangladesh Development Studies, 39*(3 & 4), pp. 77-104.

Das, A., Layek, J., Ramkrushna, G.I., Patel, D.P., Choudhury, B.U., Krishnappa, R., Yadav, G.S. (2017). Modified system of rice intensification for higher crop and water productivity in Meghalaya, India: opportunities for improving livelihoods for resource-poor farmers. *Paddy and Water Environment*, *16*, pp.(23-24).

Department of Statistics Malaysia. (2021). *Selected agricultural indicators, Malaysia, 2019*. Retrieved from https://www.dosm.gov.my

Dontsop-Nguezet, P.M., Diagne, A., Olusegun, V. and Ojehomon, V. 2011. Impact of Improved Rice Technology (NERICA varieties) on Income and Poverty among Rice Farming Households in Nigeria: A Local Average Treatment Effect (LATE) Approach Quarterly Journal of International Agriculture 50 (3), pp. 267-291.

DOS (2005). *Agriculture Census*, 2005. Department of Statistic, Malaysia, Putrajaya

Fauzi, H., and AB. Wahab, M. (2013). Socio-Economic level of paddy farmers under the management of MADA: A case study in the Pendang district, Kedah. *Journal of Governance and Development*, *9*, pp.(79-92).

Fitri, R., Erdiman, Kusnadi, N., and Yamaoka, K. (2019). SALIBU technology in Indonesia: an alternative for efficient use of agricultural resources to achieve sustainable food security. Paddy and Water Environment, pp.(1-8).

Ghimire, R., Huang, W.C. & Shrestha, R.B. (2015) Factors Affecting Adoption of Improved Rice Varieties among Rural Farm Households in Central Nepal. *Rice Science*, 22(1): 35−43.

Ginting, J. (2019). Effect of liquid organic fertilizer on the rice varieties field production. *IOP Conference Series: Earth and Environmental Science*, *260,* pp. (1-6).

Hasan, M.K., Ali, M.R., Saha, C.K., Alam, M.M., & Haque, M.E.(2019). Combine Harvester: Impact on paddy production in Bangladesh. *Journal of Bangladesh Agricultural University. 17(4)*: pp583–591.https://doi.org/10.3329/jbau.v17i4.44629

Hile, R.B., Kamble, B.T., Dattarkar, S.B., & Darekar, A.S. (2015). Economic Analysis and Impact Assessment of Production Technology of Paddy of Western Maharashtra Region. *International Journal of Commerce and Business Management, 8(2).* Pp:174-183

DOI: 10.15740/HAS/IJCBM/8.2/174-183

Juan, Z., Wu, J., and Mike, M.D., (2006). Socio-Economic Impact Assessment of Intelligent Transport Systems. Tsinghua Science and Technology. 11(3), pp339-350.

Khade, S.D.& Roy T.N. (2020). Economic Analysis of Impact Assessment of Production Technology of Paddy Cultivation in Nasik Region of Maharashtra in India. *Economic Affairs, 65(1),* pp. 63-68 DOI: 10.30954/0424-2513.1.2020.9

Kumar, A., Tripathi, G., & Joshi, P. K. (2021). Adoption and impact of modern varieties of paddy in India: evidence from a nationally representative field survey. *Journal of Agribusiness in Developing and Emerging Economies, 11(3),* pp. 255-279.

Mohd Rashid, R. & Mohd Dainuri, M.S. (2013) Food and Livelihood Security of the Malaysian Paddy Farmers. Economic and Technology Management Review 8(2013), 59-69.

Mohd Syafiq Salman, O. (2009). *Use of mechanical technology (machinery) by ethnic farmers in Siburan, Sarawak*. Universiti Teknologi Malaysia. (in Malay)

Nor Amna, A.M.N., Nurul Huda, S., Syahrin, S., Rashid, R., Rosnani, H., and Hasnul, H.I. (2016). Impact study (socioeconomic) of agricultural technology project. Socioeconomic Research Report 2016, pp.(105-113). (in Malay)

Rohaniza, I. (2019). *FELCRA pioneered drone technology, robotics for smart farming models*. *BH Online*. Retrieved from https://www.bharian.com.my/berita/nasional/2019/07/588281/felcra-rintis-teknologi-dron-robotik-untuk-model-pertanian-pintar. (in Malay)

Rosnani, H. (2015). Benchmarking study and prospecting rice production technology. Socioeconomic Research Report 2015, pp.(171-189). (in Malay)

Rosnani, H., Syahrin, S., Mohd. Zaffrie, M.A., Nurul Huda, S. dan Noorhayati, S. (2015). Prospects and benchmarks of selected agricultural technology: paddy production technology. In: Socioeconomic Project Report 2013 – 2014, Serdang: MARDI. (in Malay)

Sehal, M., Pawar, N., & Malik, D.P. (2021). Economic Impact of Practicing IPM And INM Technology in Paddy (Basmati) Crop in Haryana. *Economic Affairs, 66(1),* pp. 85-92. DOI: 10.46852/0424-2513.1.2021.11

Shahrina, M.N., Shuhaida, M.N., and Moho Stamburi, M.S. (2014). Innovation diffusion of new technologies in the malaysian paddy fertilizer industry. *Procedia - Social and Behavioral Sciences*, *109*, pp.(768-778).

Siddick, S.A. (2019). Appropriate Technologies for Improving Yield and Income of Small Holders Growing Rice Paddy in Rain fed Low Lands of Agro-Biodiversity Hotspots in India. *Agricultural Sciences, 10,* pp: 1497-1505. DOI: 10.4236/as.2019.1011110

Singh, D., Singh, A.K., Singh, A., Patel, A.K., & Baghel, M.S. (2015) Impact Assessment of Short Duration Paddy Variety Birsa Vikas Dhan-109 in Sidhi District of Madhya Pradesh. *Journal of AgriSearch* 2(1): 53-56.

Villano, R., Bravo-Ureta, B.E., Solis, D., & Fleming, E. (2015) Modern rice technologies and productivity in the Philippines: disentangling technology from managerial gaps, *Journal of Agriculture Economics*, 66 (1): 129–154.