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Relationship between Decision-Making Inputs and Productivity among Paddy Farmers in Integrated Agriculture Development Areas (IADAs), in Malaysia

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***Abstract*— The Malaysian paddy rice industry has always been considered as an industry that produces an important commodity which is the main staple food for the nation. The government, during the Tenth Malaysian Plan (2011-2015) period, set a target for every paddy farmer of 10 mt/ha, to ensure that the availability and accessibility of rice are maintained and sufficient. However, the latest production numbers from 2011 revealed that the average production per farmer from the main granary areas was still only 4.77 mt/ha, while in certain parts of the country - such as in the state of Selangor - farmers achieved up to 12 mt/ha. What is the cause of this disparity in production? Despite similarities in facilities, land area and resources, major differences remain in production. Although a multitude of factors could be relevant to this situation, this study aimed to focus on factors influencing the decision-making of farmers in correlation with farmers' productivity. Nine (9) factors were identified that could contribute towards higher paddy productivity. The findings showed a positive and significant relationship between farmers' productivity and knowledge about paddy ($r = 0.159$, $p < .01$), and a negative relationship with age ($r = -0.148$, $p < .01$). Hence, having knowledge about paddy farming and being young were the two factors most highly correlated with higher productivity in paddy. These results are an important first step towards understanding factors that could make the agricultural sector in Malaysia more sustainable by increasing the productivity of paddy farmers and increasing the supply of the national staple food.**

***Keywords*— Agricultural Sustainability; Paddy Farmers; Farmers' Productivity; Decision Making.**

I. INTRODUCTION

Malaysian paddy rice has always been the main commodity and major staple food for the nation. The paddy industry in the country has moved drastically from traditional practices relying on the soil's inherent fertility to conventional practices that depend on high levels of chemical usage and energy saving production. On conventional practices may boost food production but it has an indirect cause of the whole economic and environmental process [1].

These practices have led to the global consumption of pesticides, inorganic fertilizers, animal foodstuffs, tractors or other machinery. In addition, the increased use of chemicals in agriculture also affected consumers, who worry about food safety. As a result of this, farmers are starting to seek an alternative agricultural system. Hence, an ideal system that can preserve the environment, conserve resources, enhance the health and safety of citizens, as well as continue to be productive and profitable can best be referred to as sustainable agriculture [1].A great deal of effort has been made to define what is the actual meaning of sustainable agriculture. Since the publication of the Brundtland Commission‟s report on "Our Common Future" [2] and the Rio Earth Summit in 1992 [3], several definitions of sustainability and sustainable agriculture had been proposed [4], [5].

Sustainable agriculture can best be defined as the ability of farming systems to be continued in the future [6]. This indicates that it will maintain the embracing of farming systems, which allows conserving the ability of farming and producing food for the future, without reducing the options of availability for future generations [7]. The National Research Council (1993) claims that sustainability is necessary to keep the productive capacity of natural resources in line with population growth and economic demands while protecting and, where necessary, restoring environmental quality. Hence, the Food and Agricultural Organization (FAO) [8] agree that sustainable agriculture consists of five major attributes; (1) conserves resources, (2) environmentally non-degrading, (3) technically appropriate, (4) economically, and (5) socially acceptable. Despite all the definitions given so far, there is a multi-functional approach that can describe sustainable agriculture, and it is commonly

used in economic, environmental and social contexts [9], [10], [11], [12].

These approaches can be seen to address the needs of rural communities and food security, as well as agricultural practices either from local ecosystem services and the global environment [13], [14]. While research into sustainable agriculture systems has produced much information regarding all of the alternative practices, little attention has been paid to the farmers‟ decision-making inputs and productivity that may lead to sustainable agriculture. Most of the studies focus more on the researchers‟ and extension agents‟ perspectives, rather than on the decision-making process from the farmers‟ standpoints. Thus, in order to promote sustainability in agriculture, there is a need to better understand the farmers‟ perspective [15].

Decision-making is the essential part of determining farmers' productivity, regardless of any particular cultivation practices. Farmers who are able to make the right decisions will have a better understanding of how to manage their farm and be a successful farmer. Basically, decision-making can be viewed as the mental processes (cognitive processes) which result in a selection of choices of action. Every decision-making process may produce a final choice [16]. Decision theories represent several concepts and models, which are significantly influenced by almost all of the biological, cognitive and social sciences [17].

A lot of authors have discussed the importance and influence of beliefs, values and behavior in the decision-making process [18], [19], [20], [21]. Farmers need to think systematically about their information needs, the cost of information, alternative sources and the value of information, identifying what is the necessary information to collect before making a decision [22]. This statement is also supported by another researcher, who says that information can be seen at the input towards every step of the decision-making process, for example goal formulation, problem recognition, problem formulation (identifying the causes of the problems), pre-selection of alternative actions and, in more general terms, in uncertainty reduction [23], [24]. Therefore, farmers have to make a good choice of decisions in order to achieve higher yield and become more productive.

A good decision-maker should weigh the positive and negative consequences of the decision and the success of the decision very much depends on emotions, beliefs, values, attitudes and people whose cooperation is needed. This paper aims to highlight the decision-making input that contributes towards farmers' productivity, particularly in the rice and paddy industry and may lead to the sustainability of agriculture. This paper is divided into the following sections: Section II provides the background and methodology of the study, including a theoretical framework. Section III presents the results of the analysis as well as a discussion. Section IV deals with the conclusions and recommendations stemming from the results obtained.

II. Background And Methodology

A. Rice and Paddy Industry in Malaysia

Rice is grown in both Peninsular and East Malaysia. About 300,500 hectares in Peninsular Malaysia and 190,000 hectares on Borneo Islands are devoted to rice production. The Malaysian climate and rainfall distribution are suitable for an all-around-the-year cultivation of rice, even under rainfall conditions. Based on the water management system, the rice cultivation area (rice bowl) is divided into two parts, namely The Irrigation Scheme and Non-Irrigation Scheme.

The Department of Agriculture (DOA, 2008) claimed that the irrigation scheme could achieve higher yield, compared to the non-irrigation scheme, as it can receive water from the irrigation system continuously. Therefore, the main focus of the rice production is in the scheme itself. The management body that facilitates all of the rice production in the rice bowl area is called Integrated Agriculture Development Area (IADA). These main paddy areas which comprise eight (8) integrated paddy fields are identified by the Ministry of Agriculture & Agro-Based Industry Malaysia (MOA) as the main paddy producer, which meets 72% of the demand in this country (MARDI, 2010).

Currently, there are eight (8) IADA which cover Peninsular Malaysia, namely: i) Muda Agricultural Development Authority (MADA) in Kedah, ii) Kemubu Agricultural Development Authority (KADA) in Kelantan, iii) Kemasin Semerak Project (PKSM) in Kelantan, iv) Northwest Selangor Project (PBLS) in Selangor, v) Seberang Perai IADA in Pulau Pinang, vi) Kerian Sungai Manik IADA in Perak, vii) Seberang Perak IADA in Perak, and viii) KETARA in Besut, Terengganu.

The government, during the Tenth Malaysian Plan (2011-2015) period, set a target for every paddy farmer, which was 10 mt/ha, to ensure that a sufficient amount of rice is available and accessible to the population. However, the latest production numbers from 2011 revealed that the average production per farmer from the main granary areas was still only 4.77 mt/ha, while in certain parts of the country - such as in the state of Selangor - farmers achieved up to 12 mt/ha.

On top of that, by comparing six (6) granaries average yield between 2007 and 2011, Northwest Selangor IADA shows the highest average production with 5.098 mt/ha in 2011. IADA KETARA became the most productive when the production was moving upward throughout the years, while another two IADAs, which were Seberang Perak and Pulau Pinang, maintained records above the granaries average yield (4.02 mt/ha) starting from 2008. On the contrary, two granaries were still below the average yield, which were IADA Kerian and also IADA Kemasin Semerak (Refer to Fig. 1).

What is the cause of this disparity in production? Despite similarities in facilities, land area and resources, major differences remain in production. Although a multitude of factors could be relevant to this situation, this paper focuses on factors influencing the decision-making of farmers in correlation with farmers‟ productivity. Therefore, this paper had adopted from Eckert and Bell [25], about the decision-making approach as a part of describing the farmers mental model.

They define a mental model of farming as an individual mental map that includes the individual beliefs, values, knowledge and skills in which guide farmers in processing information and applying skills to learn and solve the problems regarding the actual farming practices. Hence, it is

necessary to understand how exactly farmers think to solve their problem, besides their own values, beliefs and knowledge about the decision-making process in farming. This research will highlight the factors of decision-making that may contribute to helping farmers become more successful and productive.

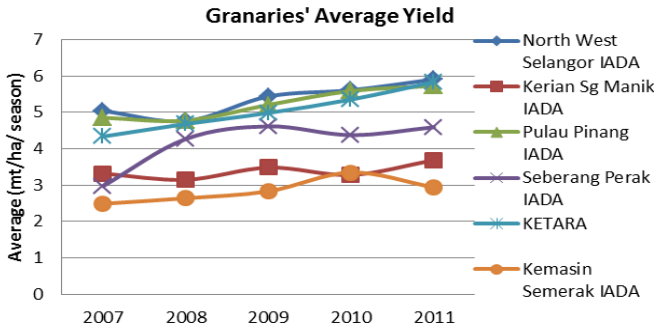

Fig. 1 Average yield by granary area (2007 - 2011)
Source: Department of Agriculture (DOA)

B. The Mental Model of Farmers

In decision-making theory, two important concepts of cognitive psychology are much related to a mental model, namely mental representation and cognitive maps [26], [27]. Mental representation refers to the way humans build reality in their minds [26]. The concept of representation can be best introduced by considering the mind and the brain, which are involved in coordinating the individuals behavior in its environment [28]. To coordinate such behavior, the individual must create some working understanding of its environment, and it does so by constructing a mental representation or model of the environment.

The primary source of mental representation is perception [29]. On the other hand, the cognitive map refers to the way in which the mind creates a map or a model of a territory or a situation that it uses as a reference point, which increases the likelihood of an individual being able to navigate in an unfamiliar environment [26]. However, the danger with the cognitive map is that, if an individual gets their facts wrong, their cognitive map will be wrong and the individual will do the wrong thing [26]. Kolkman et. al. [30] refers to this as self-contained solution, which is restricted by an individual conceptual model. One way to overcome this problem is through second order learning, for instance by updating a person's conceptual model [30].

In discussing the way in which farmers make decisions about farming, Eckert and Bell [25] had proposed a mental model of farming as an individual mental map or set of propositions that includes the individuals values and beliefs about the ideal and actual farming. It also includes the role and relative importance of values, beliefs, knowledge and skills and ways of processing information and applying skills to learn and solve problems. This statement is supported by Kolkman et. al. [30] by saying that in decision-making, our mental model determines what data and what perspective we examine in the world, based on an underlying frame that contain the actors knowledge, assumptions, interests, values and beliefs.

C. Theoretical Framework

The theoretical framework of this study is concerned about the decision-making factors associated with the level of productivity among farmers in IADA. An adoption of Eckert and Bell on Farmers‟ Mental Model [25] and rauss et. al. [31] on Preliminary Investigation Guide on Malaysian Farmers‟ Mental Model was used as the basis to support the theoretical framework in this paper. For the mental model of farmers in Malaysia, the definition does not deviate from the origin mental model definition, which explains the thought processes that incorporate one‟s beliefs, values, experiences, knowledge and subject-in-question-based perceptions that lead to decision-making. Both models can form the basis for the development of the farmers‟ mental map, and become the fundamental guidance in their decision–making process. Knowledge is a prominent mental model development that can reflect on factual information [32].

Knowledge can be defined as a belief that obtained from the available information by reasoning about the signals either it received or not [32]. Knowledge can be categorized into two types, namely 1) concept knowledge and 2) process knowledge, whereby the knowledge components of a concept are name, description and definition, while process knowledge refers to how something operates [33]. Farmers‟ knowledge on how to take the right decision about farming makes them determine and maintain the best farming methods. Previous research had demonstrated the importance of farmers‟ personal networks in gathering knowledge, besides the relationship between information gathering and technological learning [34]. Hence, in the context of farm management, it was suggested that by gathering the knowledge, it can give an impact towards individual farming practices.

Farmers can get knowledge from many sources, such as on-farm personnel and family involvement, representatives of corporations and government, social or sports club members, veterinarians, sales representatives and also farm advisors [35]. Mundlak [36] emphasizes that more productive farmers will manage and operate the available resources more effectively based on these considerations; first, farming is more likely to depend on family operation and second, the number of farmers and farms decline in the process of economic growth (might be due to redistribution of land). Therefore, there is a need to have knowledge as well as support from families and other representatives, such as government or extension agents to enhance farmers‟ productivity.

Prior experience is normally associated with peoples mental models and their involvement in the learning process [37]. Experience plays an important role in constructing mental models that influence users‟ attitudes and behaviors [25]. For instance, people who have vast experience in using traditional methods of farming rice have less involvement in the formal learning process with regard to the use of advanced methods on their traditional farms. Moreover, Baynes et. al. [37] add that the influence of peoples prior mental models might explain why they show little enthusiasm for new things, especially if new experiences vary greatly from peoples past experiences. Apart from that, one of the most important descriptive theories of decision-making is the naturalistic theory, which investigates

decisions that concern people in the real world and the factors that affect them.

This theory underlines the role of experience and personnel competence in this process. In general, the naturalistic approach to decisions tries to say that people can make the right decision without having to perform a formula [38]. Hence, they only need to use their experience to recognize the decision problem and evaluate all the variables that will affect each other. One of these aspects that is related to prior experience is age. Age is a common factor associated with advanced or traditional ways of doing things. Despite this, age can be taken into account where it is also involved in naturalistic perspectives and focus on subjects‟ experience, which are more normally acquired with age.

To a certain extent, without eliminating the existing mental model, farmers will build up and strengthen their existing mental model through discovery learning and problem solving [39]. It may require learners to discover concepts and procedures that might be communicated by direct instruction [40].

The attributes of the mental model include two types of discovery learning, that are self-guided and other-guided where it involves development activities such as exploratory learning and problem solving [41]. Farmers need to have self-directed learning as their self-guided discovery learning. Self-directed learning (SDL) is any increase in knowledge, skill, accomplishment or personal development that an individual selects and brings about by their own effort, using any method in any circumstances at any time [42]. For instance, farmers‟ efforts - include inspiring others to join them, going to the website to find information, contacting agencies to get help, consulting the front liner or extension agent, finding the suitable machinery, building a personal experimental plot - will succeed after many attempts. In addition, farmers also need other guidance to reinforce their mental model.

Other guidance can be provided by any agencies, government, or even non–governmental organisations that can assist farmers in improving their production. Here, since extension agents are the front-line helpers, they play a major role in assisting and supporting farmers in seeking information and technology.

Trust towards the credibility of extension agents must be strong enough so that all of the technologies and information can be channelled in the appropriate way. Subsequently, farmers will use their mental models to guide them in seeking information as well as sharing information with others. They will decide whether to accept, reject or adapt the feedback and advice and make the right decision [25]. In the current situation, where information is disseminated through presentations, it is not really explained how farmers interact with the existing mental model [39].

Farmers need to have verbal consultations, share their farming experiences with experts and get together with farmers with the best practices to share information and experiences with them. Farmers‟ networking is essential towards sustainable agricultural development, where through this link farmers can learn from each other, with each other, act as negotiating partner, invest collectively as well as involve in relevant partners [43].

Sharing and seeking information is crucial to provide knowledge as well as to tailor the information that they get to their individual needs and situations. This process may lead to good agricultural and sustainable business practices which result in enhanced farm production. In addition to that, past researchers had suggested that the importance of the level of expertise in the study of mental models in decision-making can be relevantly studied in the mental model of farmers.

The expertise can be referred to the expertise of farmers that know how to manage their farm and have the skills and ability to succeed. Individual farmers who are experts are much more disciplined in their behaviour. The level of expertise depends on knowledge [44]. The experts tend to form abstract knowledge representations and novices to form concrete ones. The abstraction is developed because experts have more conceptual portions of knowledge and more information contained within the portions. The study of farmers' decision-making has also relied primarily upon the Rogers Innovation Diffusion Theory [45], which argues that, following communication with experts, only a few innovative farmers will make good decisions and then they will be followed progressively by larger and larger numbers of followers.

Innovation diffusion has been proven by the fact that there are many successful innovations transferred to the farming community [46], [47]. On top of that, variables which affect farmers' access to information, such as extension, education and media exposure, are normally used in economic models of determinants of adoption decisions [48], [49], [50]. Instead of that, a potential modification of the dominant paradigm that may increase adoption can be actioned by addressing the individual decision-maker [51].Hence, the Farmers‟ Mental Model by Eckert and Bell (2005) [25] and Diffusion of Innovation Theory by Rogers (1964) [45] were chosen as the ground theory, since it is capable of explaining the factors of decision-making. In the current research, all nine elements of decision-making mentioned above were investigated to find out their relationship with farmers' productivity.

D. Methodology

The population of this study covers all the paddy farmers in IADA area. Eventually, the target population of this study was focused on 320 Malay male farmers who are involved in paddy cultivation in six IADA only. The six IADA that involved in this study are; (1) Kemasin Semerak Project (PKSM) in Kelantan, (2) Northwest Selangor Project (PBLS) in Selangor, (3) Seberang Perai IADA in Pulau Pinang, (4) Kerian Sungai Manik IADA in Perak, (5)Seberang Perak IADA in Perak, and (6) KETARA in Besut, Terengganu. While the other two IADA, which are MADA in Kedah and KADA in Kelantan, had been involved primarily in the pilot test of this study. A self-administered questionnaire had been employed in this study. Pearson Product Moment Correlation was used to measure the relationship between nine (9) factors of decision-making and farmers‟ productivity.

III. Results And Discussion

The main objective of this study was to determine the relationship between decision making inputs towards farmers' productivity. The data provided shows demographic information on the respondents, farmers' productivity measured by their average paddy yield, and the relationship between decision-making factors and farmers" productivity.

A. Demographic Information

The respondents were asked to provide basic demographic information, including IADA location, state of residence, age, years of experience as well as education level. The results showed that most of the farmers were from Perak (25.3%) and their highest education level was at primary school (41.6%). The mean age of the respondents was between 51 and 60 years, and the less than a third of respondents (29.7%) had 11 to 20 years of experience in paddy farming (Table 1).The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes. Recommended font sizes are shown in Table 1.

B. Farmers' Productivity

This section uses productivity data obtained from the farmers themselves. Respondents were asked about the average paddy yield they had produced measured in metric tonnes per hectare (mt/ha) per season. As a result, nearly half of the respondents (46.6%) had gained 4.1 to 7.0 mt/ha, followed by 36.3% who had achieved lower than 4.0 mt/ha (Table 2). Thus, the productivity of IADA farmers was at a moderate level, since the majority of the respondents achieved 5.35 mt/ha, and only 17.2% got the highest level of productivity.

C. Relationship Between Decision-Making Inputs and Farmers' Productivity

The mean score for each variable was calculated and the Pearson Product Moment Correlation Coefficient was used to describe the relationship between each independent variable and productivity. The results of the study revealed that only two of the factors were significantly correlated with productivity, which were farming knowledge and age, while the rest were not significantly correlated. As illustrated in Table 3, farming knowledge showed a weak ($r= 0.159$, $p \leqslant 0.01$) and positive relationship with productivity. As more educated farmers begin to have greater access to agricultural information, the tendency for them to become more productive are higher than the less knowledgeable farmers.

This result is congruent by another researcher where the knowledge can play an important role to improve farmers' productivity [52]. Thus, there is a need to enhance farming knowledge for a better farming practices through extension education and it also crucial in increasing rice productivity.

Age also plays an important role, as it shows significant correlation with productivity with $r= -0.148$ and $p \leqslant 0.01$. The analysis revealed that there was a negative and a weak correlation between age and productivity. The negative correlation of the age with the productivity level implies that as when the age increases, the productivity level decreases. This may be as a result of the limitation on the ability and energy to perform and giving the best to their paddy farming practices, and because of that they are not able to perform in the field work anymore. Hence, to overcome this situation, the young farmers with the energy and spirit that they originally have, may help to replace the mature and elderly farmers revitalize the agriculture activities especially in paddy farming to become most important sector in Malaysia.

Furthermore, the younger farmers are urged to achieve a great income by increase the yield potential, and become more productive farmers. This result is consistent with previous studies where the study indicated that the demographics (age) may influence on farmers strategic decision making towards farm production [53], [54]

TABLE I
FREQUENCY DISTRIBUTION OF THE RESPONDENS DEMOGRAPHIC DATA (n=320)

Variables	Freq	Percent	Mean	SD
State of Residence				
Perak	81	25.3		
Terengganu	71	22.2		
Kelantan	62	19.4		
Pulau Pinang	62	19.4		
Selanggor	44	13.8		
Education Level				
Illiterate	16	5.0		
Primary School	133	41.6		
PMR/ SRP	63	19.7		
MCE/SPM (V)	77	24.1		
STPM	12	3.8		
Other	19	5.9		
Age (years)			52.63	12.078
≤ 30	5	1.6		
31 – 40	49	15.3		
41 – 50	90	28.1		
51 – 60	86	26.9		
61 – 70	68	21.3		
≥ 71	22	6.9		
Farming Experience (years)			24.84	14.591
1 - 10	66	20.6		
11 - 20	95	29.7		
21 – 30	68	21.3		
31 – 40	42	13.1		
41 – 50	39	12.2		
51 – 60	10	3.1		

TABLE II
FREQUENCY DISRIBUTION OF AVARAGE PADDY YIELDS (n=320)

Variables	Freq	Percent	Mean	SD
Average paddy yields (mt/ha/season)				
			5.35	2.381
≤ 4 (Lower Productivity)	116	36.3		
4.1 – 7.0 (Moderate)	149	46.6		
≥ 7.1 (Higher Produtivity)	55	17.2		

TABLE III
PEARSEN PRODUCT MOMENT CORRRELATIONS BETWEN DECISION MAKING FACTORS AND FARMERS PRODUCTIVITY (n=320)

Variable	*r*	*p*
Decision-making factors		
1. Family involment	0.005	0.931
2. Trust in extension agent's expertise	-0.057	0.309
3. Farming knowledge	**0.159**	**0.004**
4. Information-seeking behaviour	-0.024	0.669
5. Information-sharing	-0.007	0.905
6. Self-directed learning	0.016	0.782
7. Farming discipline	0.019	0.730
8. Experience in paddy	0.044	0.438
9. Age	**-0.148**	**0.008**

IV. CONCLUSIONS

Based upon the findings of this study, the following conclusions were reached. Generally, paddy farmers in IADAs are still at a moderate level of productivity, which means their average paddy yield per season is between 4.1 and 7.0 mt/ha. . These results are in line with MOA statistics, that indicate that the average yield in the granary areas was 4.658 mt/ha in 2011. It also shows that there was not much difference in production between the years of 2010 and 2011.

There is a need for more effort to increase the farmers‟ potential to produce more than the current average. This could be achieved by improving their decision–making processes. Based on the farmers‟ mental model, there are nine (9) factors that contribute to higher productivity. However, this study has shown that only two variables influence the level of productivity in a significant way: knowledge about paddy and age. Hence, in order to get higher yields and become more productive, knowledge has become a priority need for farmers. They have to be good at finding ways of doing things and being creative in finding solutions by themselves.

It must be ensured that individual‟ farmers are knowledgeable and resourceful enough to guide and show better examples to other farmers to emulate. In addition to that, with a younger farmer that taking part and get together participate actively in the paddy industry perhaps can contribute directly to increase productivity levels in paddy farming as well as the rice production in the country. The following recommendations are made to move paddy farms more sustainable farming systems, specifically on the farmers' perspectives. The agencies which are in direct or indirect contact with farmers must have mutually bonding with farmers, which they know the right way on how to influence and encourage farmers to become successful. Extension agents, who are the front-line people involved directly with farmers, have to encourage farmers to develop good decision-making processes in order to become productive and get higher incomes.

This study revealed two major factors that influence productivity: knowledge and age. These two factors facilitate farmers in decision-making and help them in transferring the knowledge and skill as well as in developing their innovation-adoption practices. Furthermore, to enable the agricultural sector, particularly paddy farming, to be sustainable in the years to come, it is important to establish a strong link between paddy farming and universities or research institutions. Universities or research institutions should provide easier cooperation channels and make sure that they are easy to contact. With a strong intervention between government and various agencies perhaps may bring the paddy rice industry to become the main important commodity in Malaysia.

NOMENCLATURE

FAO	Food and Agricultural Organization
DOA	The Department of Agriculture
MOA	Ministry of Agriculture & Agro-Based Industry Malaysia
mt/ha	Metric tonnes per hectare
IADA	Integrated Agriculture Development Area
KADA	Kemubu Agriculture Development Authority
KETARA	North Terengganu Integrated Agriculture Development
MADA	Muda Agriculture Development Authority
PBLS	Nortwest Selangor Project
PKSM	Kemasin Semerak Project
SDL	Self-Directed Learning

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