Barriers to Sustainable Rice Farming and Food Security in Malaysia's Primary Granary Zones

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ABSTRACT

This study is an effort to explore and investigate the issues and challenging are facing rice production and food security in Malaysia. It is also to identify the contribution of the main granary areas in Malaysia to the national food security. The important of rice as a staple food crop in Malaysia and is currently grown on 637,935 ha of land, producing annually 2.2 million tons of paddy grain valued at RM 2 million, which is contribute with average growth rate of 1.1% of year, in the last five years. However, the current country's self-sufficiency level for rice production is still at 63% and the 37% balance are imported from other countries abroad. Efforts are being undertaken by government to increase the productivity, cropping intensity prediction and crop acreage to cope with the growing demand for the produce in Malaysia. This study examines the various issues of rice production for food security and analyses the challenging of rice production in Malaysia. Various rice production policies, strategies and programs will be thoroughly analyzed to achieve the objectives of the study that have been set. Kemubu Agricultural Development Authority (KADA), Kemasin Semerak and North Terengganu (KETARA), Muda Agricultural Development Authority (MADA) and Integrated Agriculture Development Area (IADA) in Peninsular Malaysia and in Borneo are among the granary areas, which emphasized on paddy cultivation to the country. The role of the granary areas important to enhance the self-sufficiency level of rice in Malaysia. Issues and challenges related to rice production, food security and self-sufficiency are discussed. Various efforts and government intervention have been implemented to ensure that these areas will remain as the important granary areas. Several approaches to improving productivity, stability and food security in food production as well as outlining the agenda to ensure the country's food supply are discussed.

Keywords: Rice production, rice farming, food security, granary area, Malaysia.

INTRODUCTION

Rice is one of the most widely grown cereal crops and the staple food for more than half of the world's population. Most people depend on rice for food calories and protein, especially in developing countries like Malaysia, Indonesia and Vietnam (IRRI, 2004). One fifth of the world's population, or more than a billion households in Asia, Africa and America, rely on rice systems for their main sources of employment and livelihoods. Rice has also been used on the frontline to fight against world hunger and poverty (Nguyen and Ferrero, 2006). Global rice production, so far, has been able to meet population demands. However, its ability performance is in question over the years unless there are appropriate actions taken in the future. The challenge that rice production industry are currently facing is the decline of productivity, degradation of soil and water resources because of climate change, increased use of agrochemical in the agricultural sector which has less effective impact on its use, land resources shortage and manpower to develop the rice farming sector and the risk to the health of farmers and consumers. FAO (2003) mentioned about stagnation of rice yield in many Asia countries and intensification of rice production has caused considerable damage to the

environment and natural resources, including the produce of greenhouse gas methane, water pollution, loss of soil fertility due to excessive use of agrochemicals and causing global warming which endangers the health of living things especially humans (Norliyana et al., 2022; Sean, 2024). Understanding the potential effect of these changes on agriculture is critical because it provides food for the world's population, now estimated at 8 billion and projected to rise to 10 billion by 2060 (United Nation, 2024). A large portion of this estimated population increase will take place in Asia (Kumar et al., 2022). Therefore, the efforts to identify the issues and challenging encountered in the production of rice is required and to ascertain the contribution of the granary areas in Malaysia, comprising KADA, MADA, IADA on food security in Malaysia.

National food security: Wen and Berry (2019) stated that the concept of food security originated 50 years ago, which was in the early 1970s when the global food crisis happened at that time. When the food crisis hit, food security efforts were focused only on ensuring that food availability could be achieved, and basic food price stability could be maintained due to extreme fluctuations in agricultural commodity prices as well as currency and labour market turbulence at that time. The definition of food security often changes due to the influence of various technical perspectives as well as the introduction of policies. Food security has also been considered as one of the elements of human rights in 1994 by the United Nation. Food security has several dimensions that can determine its meaning. There are numbers of definitions for food security which are at national, community and household level. The Worlds Food Summit (1996) defines food security as which is when all people, always, have sufficient access to safe and nutritious food to meet dietary needs and food reference for a more active and healthy life (FAO, 2006). There are four main elements in food security concept which are availability, accessibility, utilization, and stability (FAO, 2006).

Four elements of food security are:

- Availability: the food supply and food security are determined by the level of food production, stock levels and net trade.
- Accessibility: Adequate food supply at the national or international level does not necessarily guarantee food security among Concerns about inadequate food access led people to focus more on aspects of income, spending, markets, and prices in achieving food security.
- Utilization: Understood as the way human body makes the most of various nutrients in the food. Understood as the way the body makes the most of various nutrients in the food. Adequate energy and nutrient intake are the result of good food preparation and nutrition practices and food distribution in households equipped with dietary The combination of biology through the food taken can determine the nutritional status of individuals.
- Stability: Even if food intake is adequate today, some individuals are still considered to be food insecure if they have inadequate access to food on a periodic basis, risking a deterioration of their nutritional status. Factors such as political and economic instability as well as unemployment problems and rising food prices can threaten food security.

The Food and Agricultural Organization (FAO, 2006) defines food security as a situation that ensures that all people or all members in households always have both physical and economic access to the basic food that they need daily. At the community level, food security is defined by Hamm and Bellows (2003) as a situation in which all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that maximizes community self-reliance and social justice. This means food security at community level focuses on how to increase food production and availability, overcome hunger issues and focus on social aspects, so the problem can be addressed in a holistic way. The World Bank stated that food security at community level means today is when all people can always access enough food for an active healthy life (Kaylene Sattanno et al., 2017). The Community Nutritionist Council of British Columbia Canada in the Canada Forth Progress Report on Food Security, FAO (2006) stated that food security indicated a situation when people get safe food and receive a balance nutrient food diet through a sustainable food system that can maximize food choices of healthy, self-reliant community and receiving similar access for all people (Chamhuri et al., 2013).

This definition also includes:

- When the ability to get food is guaranteed
- It is obtained by means of holding on to human dignity
- The food is secure, adequate and can be personally acceptable and culturally
- The food quality and quantity are sufficient to maintain healthy development and growth and to ward off diseases
- There is no problem with production, processing and distribution of food in the use of land, water and air for the next generation in the future.

At the household level, food security can be defined as a household having assured supplies of entitlement from food production reserve of food or assets or cash income or government assistance programs such as they need to maintain sufficient nutritional intake for physical well-being (Marisol et al., 2001). There are three elements in food security at household level which are average level of household income, magnitude and probability of seasonal and annual fluctuations around the average and the value and form of stocks a household can maintain. Over the decades, climate change, growing population in the world and volatile food prices will put significant pressure on food security (IFPRI, 2024). One of the ways to overcome food security issue is through intensifying the production of rice which is an important food for the world society including Malaysia.

Food security also can be measured by several methods (Austin Fahy, 2022):

- Estimating calories per capita
- Household income and expenditure surveys
- Measuring an individual's dietary intake, health, weight and body composition
- Reports on individual experiences of food security

Rice self-sufficiency levels in Malaysia:

The Global Food Security Index (GFSI), a metric of global food security, was developed by Economist Impact and it has become a reference source for 113 countries regarding food security which consists of 28 indicators grouped into four domains namely affordability, availability, quality and safety, sustainability, and adaptation (Zaeidah et al., 2023). There are three key pillars in Malaysia food security context by Ministry of Agricultural (MOA, 2008):

- Availability of adequate food supply
- Achieve the target of getting sufficient and nutritious food
- Nutrient food that can provide sufficient nutrition to all Malaysian

Based on the context above, it can be concluded that food security at the national level is more focused on the country's efforts to provide sufficient food supply through the production of domestic supplies to people needs meanwhile at the household level, it is more focus on the ability of every household to get enough nutritious food in daily life without any obstacle in any aspect such as have enough money to pay for the food. The involvement of the government and certain parties in food safety is important in ensuring that all citizens have equal access to adequate food supply without any obstacles. However, this is certainly not something that is easy to achieve because it requires careful and effective planning and commitment from all parties in Malaysia. The introduction of food security policy is one of the government's ways to ensure that the food supply and national food security are guaranteed and sufficient.

Malaysia has more than 300,000 farmers depending on rice production for their livelihoods and many more working in rice-related industry (FFTC, 2024). Furthermore, the sustainable production of rice is critical for ensuring food security and addressing poverty. Increasing food safety is also a growing concern either locally or globally. Through National Agro-food Policy, it showed that rice production increased from 1,885

metric tons in 1990 to 2356 metric tons in 2020, despite a slight decrease around 3 years which are in 1998, 2006 and 2019. This decline happened due to adverse weather conditions, pests, disease outbreaks and virus pandemics such as Red Stripe Disease and COVID-19 (Syahmi et al., 2022). The National Agro-food Policy 2.0 (NAP) is intending to replace the National Agro-food Policy. NAP 2.0 aims to empower modernization through smart agriculture and enhancing research, development, commercialization, and innovation (R&D) activities, strengthening the value chain of agrifood products for domestic and international markets, talent development and skilled workforce, emphasis on sustainable farming practices, and facilitating the business ecosystem including land use, finance, infrastructure, investment, and governance. The focus of this policy is to increase food security which means ensuring the availability of food supplies so that all people always have access to sufficient and nutritious food, contribute to economic growth and increase the income level of food producers to ensure their well-being. NAP 2.0 also focuses on 4 sub-sectors including rice and rice-based products (MOA, 2024). The local rice production should be increasing to ensure sufficient rice supply as only 7% of total world rice production is traded. In 2022, the consumption of rice in Malaysia reached around 2.9 million metric tons with the average consumption of rice by Malaysian citizen is about 82.3 kilograms per year (Department of Statistic, 2024). The stability of supply, growing demand and the small quantity of rice being traded in the international market tend to cause volatility in prices of rice. In this regard, the contributions of eight granary areas are needed to help achieve the self-sufficiency level of rice production in the country. The government's efforts on strengthening the national paddy and rice industry will focus on strengthening the relevant institutions, increasing productivity and efficient stockpile management.

To ensure the stability of food security, the government interprets the achievement in the form of self-sufficiency level (SSL) of rice production. The level of SSL is derived from the total production country compared to the total domestic demand of rice (Fatimah, 2010). It has been used as a proxy to indicate the level of food security of rice, which is the staple diet of most of the population in the country (Fatimah and Abdel Hameed, 2010). SSL target and achievement of this commodity are shown in Table 1. Malaysia is a high-cost producer of rice and for this reason the National Agricultural Policy (1992-2010) does not aim for full self- sufficiency (Najim et al., 2007). But because of the war that have occurred between Russia and Ukraine in 2022 and the rice export restrictions from India in 2023 has also affected the food supply in Malaysia. The National Agrofood Policy 2.0 target that Malaysia would achieve a rice SSL of 75% in 2025 and 80% in 2030, which is a target of 17% increase from 2019 to 2030 (PNB, 2023). Under this policy, the government target in 2030, the total rice production will reach 2.32 million Mt, with an increase of 53.6% compared to 1.51 million tons in 2019 (FFTC, 2023). Indirectly it also reflects the effectiveness of the government investment and agrarian reform in rural areas, especially in granary areas for enhancing the productivity target of the country.

Table 1: Self-sufficient level of rice in Malaysia

Plan	Period	Self - sufficiency level (SSL) target	SSL achieved (%)
First Malaya Plan	1956-1960	-	54.0
Second Malaya Plan	1961-1965	-	60.0
First Malaysia Plan	1966-1970	-	80.0
Second Malaysia Plan	1971-1975	-	87.0
Third Malaysia Plan	1976-1980	90	92.0
National Agricultural Plan I	1984-1991	65	75.9
Fourth Malaysia Plan	1981-1985	65	76.5
Fifth Malaysia Plan	1986-1990	65	75.0
Sixth Malaysia Plan	1991-1995	65	76.3
National Agricultural Plan II	1992-2010	65	65.0
Seventh Malaysia Plan	1996-2000	65	71.0

National Agricultural Plan III	1998-2010	65	71.0
Eighth Malaysia Plan	2001-2005	65	71.0
Ninth Malaysia Plan	2006-2010	65	72.0
National Food Security Policy	2008	80	72.0
New Economic Model	2010	85	60.3
National Agrofood Policy	2011-2020	70	63
National Agrofood Policy 2.0	2021-2030	80	63.0 in 2022

MOA 2011; Fatimah et al., 2010; MAFS 2021

MATERIALS AND METHODS

Integrated approach: In Malaysia, the concept of integrated agricultural development based on 'in-situ' program was introduced in 1970 with the establishment of the Muda Agriculture Development Authority (MADA) then followed by the establishment of KADA in 1972. Then, under the Ministry of Agriculture and Agro-based Industry Malaysia, the government establish Integrated Agricultural Development Project (IADA) in 1983, using the same approach as MADA and KADA, to increase paddy production and provide rice cropping infrastructure to help farmers (IADA, 2024). Muda Agricultural Development Authority (MADA) also works on rice crops in certain areas such as in Kedah and Perlis which are the largest rice contributors in Malaysia (Fig. 1). To ensure the securing of food security, KADA, Kemasin Semerak IADA and KETARA IADA are three main granary areas that are in the East Coast Region Development Council (ECER), are also identify as a contributor to the production of paddy rice in Malaysia beside eight others granary areas which are MADA, Rompin IADA, Seberang

Perak IADA, Pulau Pinang IADA, Kerian-Sg. Manik IADA, Kota Belud IADA, Batang Lupar IADA and Northwest Selangor IADA. The study areas are in these eight granary areas (Fig. 1). The secondary data was used to identify the location, objective of the implementation and contribution of rice production of these eight areas in 5 years (2018-2022) to the national food security in Malaysia.

Fig 1: The granary areas in Malaysia: Malaysia Space Agency (MYSA), 2024

RESULTS AND DISCUSSION

Paddy production: KADA, MADA, and other IADA areas are important granary areas that focus on rice cultivation in this country with the aim of increasing rice self-sufficiency in Malaysia. The contribution of the eight-bowl area in rice production is presented by Table 2. Based on Table 2, the rice production in the eight-granary areas contributed about 36%- 47% to the national SSL in the period of 5 years. The table shows that rice production is increasing marginally in 2018-2022 both domestically and nationally but contract to the SSL which is reducing from 73 to 63 respectively. The SSL in 2022 is 63%, which is lower than 70% in 2019, the difference is as much as 10%. Albeit the contribution to the SSL is still in average 30% percent in three years (2018-2020) but it is slightly increase to 40% in 2021 and 2022. Kemasin Semerak IADA has been attacked by several diseases such as Bena Perang, stalk rot, mice, golden apple snails, leaf rolls worm, stem worm, and hawksbill disease, which has caused damage to the rice crops and the production of rice belonging to the farmers (Chamhuri et al., 2013). Meanwhile, in the Northwest Selangor IADA region, they have had to deal with disease outbreaks such as Bacterial Panicle Blight (BPB) and water supply problems (Izzatul, 2024). In Kota Belud IADA, the drainage and irrigation system problems faced by farmers have affected rice production causing floods to occur frequently (Anon, 2024). Weedy rice was a threat to rice production in the KETARA area and climate change causes drought and flood occurring in some areas under KADA and MADA. However, the average paddy yield shows that KADA and MADA able to rival the average level of granary and national rice production. The trend of rice production in Malaysia can also be influenced by several other factors such as the small economic marketplace, the shrinking area of rice agriculture sites as a result from the urbanization process or land being used for other industries, lack of advanced agricultural technology and lack of labour to cultivate paddy field. On average, the percentage contribution and volume of production indicate that the productivity of rice in the granary areas should be upgraded to ensure that Malaysia can achieve 100% SSL for rice production so that we do not need to import rice from other countries anymore in the future. The contribution of eight granary areas in Malaysia and the average of paddy yield between 2018 to 2022 can be seen below in table 2, table 3 and figure 2.

Table 2: The contribution of KADA, MADA & IADA to national rice production (2018-2022)

Region	Rice Production (mt/yr)				
	2018	2019	2020	2021	2022
MADA	668,763	645,584	632,395	843,947	853,360
KADA	252,149	131,958	156,673	256,321	212,740
IADA: Kerian	165,790	97,605	80,816	141,687	124,762
Northwest Selangor	174,432	113,158	103,698	155,631	153,492
Pulau Pinang	133,636	83,282	79,036	136,919	122,321
Ketara	29,295	32,718	34,274	50,886	43,011
Kemasin Semarak	16,390	18,351	19,370	30,716	32,538
Pekan	17,183	11,372	8,383	23,959	21,791
Rompin	14,756	7,878	13,935	24,306	25,011
Kota Belud	22,805	16,126	16,784	25,105	28,561
Batang Lupar	2,252	1,852	1,893	3,220	3,666
Total (mt/yr)	1, 302, 400	1, 211, 809	1, 194, 681	1, 865, 343	1, 724,280
National Rice Production (mt/yr)	2,639,202	2,352,870	2,356,392	2, 441, 597	2, 281, 739
SSL (%)	73	70	75	63	63
Contribution to SSL (%)	36.02	36.05	38.02	48.13	47.60

KADA Annual Report 2022; Department of Agriculture 2023

Table 3: Average yield of paddy 2018-2022

Region	Average Yield of Paddy (mt/ha)				
	2018	2019	2020	2021	2022
MADA	5.111	4.933	4.833	4.192	4.240
KADA	4.695	4.032	4.621	4.874	4.096
IADA: Kerian	3.957	3.584	3.223	3.830	3.372
Northwest Selangor	4.731	4.756	4.431	4.337	4.319
Pulau Pinang	5.228	5.012	5.022	5.655	5.052
Ketara	5.349	5.162	5.407	5.218	4.410
Kemasin Semarak	4.079	3.733	3.666	3.656	3.673
Pekan	2.673	2.637	2.707	3.218	3.090
Rompin	2.910	2.373	4.156	4.610	4.431
Kota Belud	3.112	2.908	2.914	3.540	3.523
Batang Lupar	2.492	2.754	2.599	2.847	3.117
Granary Area	4.496	4.682	4.420	4.480	4.137
Malaysia	3.750	3.770	3.501	3.768	3.693

KADA Annual Report, 2022

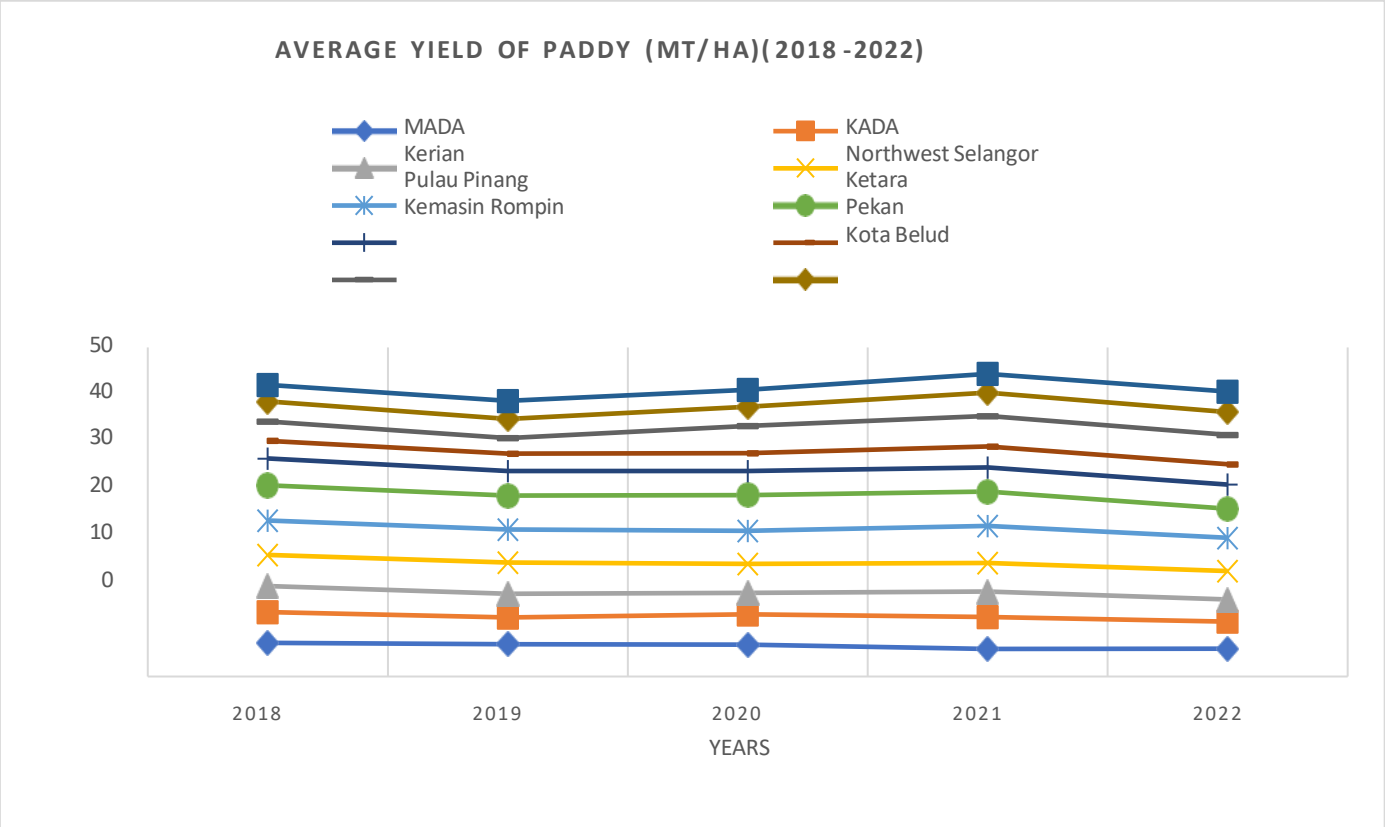

Fig. 2: Average yield of Paddy (2018-2022)

Strategies to increase rice production yield: Under the supervision of the Ministry of Agriculture and Food Security (MAFS) and the Department of Agriculture (DOA), KADA, MADA and IADA have planned strategies and implemented various programs to increase rice production, the implementation of which has successfully increased the contribution of these granary areas to the national rice SSL. Among the programs that have been seen to have successfully increased rice yields that have been carried out are as follows:

Paddy Mini Estates (MEP): MEP is a project related to effective farm management to increase rice production and social relations among farmers and officials through established committees and avoid manipulation by middlemen in the rice sector in Malaysia (LPP, 2014). Through this project, farmers can obtain credit facilities from farmers' associations in their respective areas that can help them to develop, manage and assist their paddy areas and increase rice production that can contribute to the nation rice self-sufficiency level (SSL). The production of rice using the Mini Estate method is expected to be more efficient because the rice area is a combination of several small farms that are rearranged under one management or one production system and cultivated in groups. Farms can be cultivated in a capital-intensive manner such as the use of machinery, resulting in better drainage and water management and modern farm management (Hashim Mustapha & Nordin Muhamad, 2012). Paddy Mini Estate Project (MEP) is a systematic approach for the purpose of increasing optimal rice yields as well as adapting and disciplining farmers to Good Agriculture Practice (GAP) (KADA, 2021). In KADA in 2009, a total of 107 MEP is operating an area of 6,231 ha compared to 6,146 ha that involving about 2,145 farmers that has a positive impact on the average yield of rice which is 3.64 ton/ha compared to 3.48 ton/ha and 3.45 ton/ha in two seasons, which is main and offseason in that year (Chamhuri et al., 2014). In 2021, there was a total of 215 MEP operating at KADA areas involving 3,955 participants or farmers with the average yield of paddy in main season and offseason which is 6.00 ton/ha and 5.14ton/ha in an area of 12,913.65 ha (KADA, 2021). MADA areas are in Kedah and Perlis which in 2016, the rice production area in MADA in Perlis covers an area of 6024.9 ha compared to the previous year which was 5863.8 ha (Norhaslinda et al., 2023). In 2023, two paddy mini estates were being developed in Sabah in the area in Beluran and Northern Pitas in effort to increase the rice production (Muguntan, 2023). Paddy Mini Estates also have water source supply that farmers group can use to carry out regular and organized rice cultivation activities (Pulau Pinang IADA, 2024).

Ten (10) tons project: This project is an initiative Malaysia aimed at significantly increasing the production of rice to meet the country's food security needs. Ten tons project also focuses on increasing the yield of paddy fields to achieve a production target of 10 tons of rice per hectare. This project is also intended to improve technology on paddy crop management to achieve higher yield in the future and to make paddy industry more commercial and competitive (Chamhuri et al., 2014). In 2001, MADA introduced the paddy yield expansion program towards 10 Tons Project by start covering an area of 740 ha involving 551 farmers. Based on the yield of paddy area until 2008, the average yield of paddy was 6.13 t/ha with the farm size of 35,257 ha (Jamal, 2012). The rice yield obtained through the 10 Tons Project in MADA, KADA and IADA areas is different. In 2021, the average yield of paddy obtained in MADA is 9.0 ton/ha to 9.5 ton/ha while KADA managed to achieve an average yield of paddy which is 8.5 ton/ha in the same year. Meanwhile, IADA managed to achieve an average yield of paddy which is 9.0 ton/ha to 9.5 ton/ha in 2021 in some areas such as Northwest Selangor IADA, and Pulau Pinang IADA (IADA, 2024). The implementation of the 10 Tons project involved the provision of farming inputs, soil analysis, and land flattening programs as well as farm mechanization programs.

Ladang Merdeka project: Ladang Merdeka project is a commercial and large-scale farm management concept which is interested in liberating the target group from poverty, designing farms with appropriate size, viability and helping to increase the income of participants. Ladang Merdeka was created to eradicate poverty through increasing paddy yields, liberating wasteland, liberating rice paddy owners and tenants, increasing agricultural productivity through estate management methods, effective use of labour, use of farm machinery, effective use of agricultural inputs and creating a systematic production operation (KADA, 2020). Ladang Merdeka began to be implemented in 1991 with the initial management of 5 farms with an area of 211.78 hectares (Chamhuri Siwar et al., 2014). Apart from being able to increase the rice production, Ladang Merdeka concept can also reduce the cost of farm management because it is a holistic infrastructure development project because irrigation and drainage systems, farm roads, and land leveling are provided in one complete package (KADA, 2021). The implementation of SOP (Lamer-Tech) can help to manage farm crops well because the problem of golden Gondang snails and windy rice can be overcome well so it is no longer an obstacle for farmers to achieve high quality farm status. In 2021, there are 16 locations of Ladang Merdeka in KADA. The Ladang Merdeka average yield of paddy during the main season in 2020/2021 is

6.47 ton/ha meanwhile during the offseason is 6.55 ton/ha. Overall, the impact of Ladang Merdeka project on farmers is to increase income, increase the value of land, registered seed sources and producers, create job opportunities that can reduce the problem of unemployment, encourage farmer participation in paddy and rice industry, get zakat assistance, create a harmonious relationship between managing agencies and participants or agriculture and increase the yield of seed and rice production (Chamhuri et al., 2014). Ladang Merdeka Project at Senor center is production the fragrant rice seeds which are MRQ76 type that has helped KADA to provide seed supplies to farmers who cultivate this type of rice crop.

Large-Scale Smart Padi Project (SMART SBB)

SMART SBB was introduced by the government in February 2021 to develop paddy cultivation with a target of 150,000 hectares per season to produce an average yield of seven metric tons per hectare. This program helps Malaysia to achieve its self-sufficient level (SSL) target for rice production in the next few years. The project aims to minimize the involvement of middlemen and improve production and distribution of rice in the country. SMART SBB is a collaboration project with the agencies in Malaysia and private sector to boost paddy production and to increase farmers revenue. There are three models that have been introduced through this program which is SMART SBB White Rice and Fragrant Rice Model, SMART SBB Asnaf Model which is worked on by The Kedah State Zakat Board and SMART SBB Ala Sekinchan Model (Abd. Halim et al., 2024). The adaptation of integrated farm management, IoT and mechanization, will help local farmers to optimize both the quality and quantity of the yield that can lead to higher returns. The government is also introducing rice varieties that are more drought resistant and can be harvested in just 80 days compared to the current 105 to 110 days to help farmers in this country increase their crop yields. KADA has expanded 80 hectares of land in Kelantan to increase the production of rice multiple times compared to the normal cultivation method that obtains a yield of 10 tons of rice for an area of 0.4 hectares. This model also has been applied in other IADA areas such as in Kota Belud IADA and in Pekan IADA. The program has rolled out nationwide except Johor and Melaka and has a benefiting of 10,585 farmers involving 35,357 hectares of area in 79 locations (Noramalina et al., 2021). In 2023, the income of farmers from the rice harvest increased to RM6,000 this season from RM2,000 in the previous harvest season. In Kota Belud IADA, the average rice yield has increased to 4.15 metric tons per hectare from 2.6 metric tons per hectare in 2023 (KRI, 20022).

Pemacu Pertanian Padi Project (PPP): This project is one of Entry Point Project (EPP) which is an EPP 10 project under MADA. This project aims to increase the average yield of rice by 8.0 tons per hectare and for the entire MADA area by 7.0 tons per hectare by the year 2020. PPP carried out a soil fertility improvement program and a project to expand and monitor rice pests to reduce attacks by 20% for one season (MADA, 2024). Launched in 2010 under the Economic Transformation Program formerly known as the National Economic Key Area (NKEA) EPP 10. The allocation given is as much as RM2.7 billion (2011-2020) but it has been reduced to RM1.986 billion in 2019 to develop 50,000 hectares of rice estate centrally and to increase the density of irrigation and drainage infrastructure to the level of 30 m/hectare. The efficiency of the water management system as well as the access to logistical facilities provided such as roads and farm crossings are seen to be able to maintain the rice yield obtained through this project. The rice productivity produced through this project in 2018 is 5.89 tons/hectare with rice cultivation covering an area of 5,000 hectares. This project aims to plant rice in an area of 10,000 hectares and rice productivity of 6.50 hectares by 2025 (Nor Aziani, 2021). Muda Area under MADA is the largest rice granary in Malaysia which covers an area of 130,282 hectares of which 100,685 hectares are rice cultivation areas located in Kedah and Perlis (Astro Awani, 2023). This project contributed to the nation's rice in 2018 and the target for 2025 is 42%. The average monthly net income of rice farmers involved in this project is RM2,000 per month in 2018 and is expected to increase up to RM2,500 to RM5,000 by 2025.

Water management group (KPA): There are two definitions of KPA by IADA. KPA is a group of rice paddy farmers who are grouped based on one unit of irrigation area that can function independently. KPA also refers to groups of farmers and mini estates who have interests and use facilities from the same source of water supply to carry out rice planting activities in an orderly and planned manner (IADA, 2024). So, we

can understand that KPA is a community- based organization that is established to manage and optimize the use of water resources for agricultural purposes such as paddy farming. These groups play an important role in ensuring the efficient distribution and use of water within irrigation schemes, for maximizing crop yields and ensuring the sustainability of paddy fields. If there is any conflict related to rice irrigation sources, KPA will act as a monitor and the party that resolves conflicts between farmers to maintain harmony in the rice industry farming community. The concept used by KPA is where financial resources are used to increase rice production which is seen to help several activities to produce higher yields. Among the activities carried out under KPA are farm projects and farm projects lacking training. The implementation of the projects includes several other activities such as farm infrastructure development, soil conservation, training sessions and visits on the exposure of current technology practices to farmers (Chamhuri et al., 2014).

Irrigation scheme: The Malaysian government has implemented various projects and provided significant allocations to build and upgrade irrigation infrastructure in key paddy areas such as MADA, KADA, and IADA. The government has provided an allocation of RM37 million to build Sungai Yong irrigation in Pasir Puteh under Kemasin Semerak IADA which will allow rice planting to be done twice as well as rice plants will no longer need to rely entirely on rainwater as a source of irrigation. The construction project of the Paya Peda dam located in Hulu Besut, Terengganu which involves Sungai Angga, Sungai Peda and Sungai Besut. This irrigation was built in 2010 as an irrigation system to supply water to 2,759 rice farmers in the Besut Irrigation Scheme. The 77 square kilometer dam will be used as a catchment area and reservoir to accommodate 168 million cubic meters of water for rice crops twice a year in Besut district (MCMC, 2024). The construction of water supply projects in two areas, namely Paya Peda and Besut Baru, is a long-term effort of KETARA IADA for the purpose of irrigating paddy areas and flood mitigation which is expected to also benefit non- rice granary areas in the region. It is expected that rice production will increase by more than 3 tons/hectare compared to the year before the project which was 2.3 tons/hectare (Chamhuri et al., 2014). In 2020, six irrigation systems have been built in the Pekan IADA involving six areas of 7,211 hectares which are at Paya Mambang, Pulau Jawa or Pulau Tambun, Ganchong, Pahang Tua dan Serandu while in Merchong still depends entirely on rainwater. This allows the granary area to be expanded and rice production to be doubled to guarantee the security of the country's food supply, especially rice which is a staple food for the people. In 2017, a total of RM7.3 million was used to upgrade the infrastructure and irrigation system in Paya Mambang under Pekan IADA (Sinar Harian, 2020).

Government intervention in rice production and food security: To strengthen and improve the Malaysia rice production industry, the government has provided several types of subsidies as a mechanism to encourage community participation and help the rice industry to achieve the rice production target that has been set for the benefit of all Malaysia citizen. Accordingly, the government has allocated RM 4.47 billion for agricultural development in the 12MP (2023) has decreased compared to RM 5.3 billion in 11MP. The percentage decrease in allocation from 11MP to 12MP is 15.66%. The government intends to strengthen the agricultural sector to ensure food security, especially the supply of rice, as well as promote the production of high-quality agricultural-based products, which can contribute to the country's economic sector. Subsidies and incentives to strengthen the paddy and rice industry were also given amounting to RM1.6 billion. The government has introduced the Price Rice Subsidy Scheme (SSHP) to help ease the burden on rice farmers in covering the cost of managing the rice crop and the increasing cost of living. Previously, rice was sold at a price of RM360 per metric ton, but through the upgrade of this scheme, farmers can sell the harvested rice at RM500 per metric ton (Agrimag, 2023). In 12MP, the government has introduced some new form of subsidies and incentives to boost the country’s staple food production. There are other schemes and incentives related to rice production that have been introduced in this country which is the Rice Production Incentive Scheme (SIPP) amounting to RM180 per metric ton for farmers who achieve rice production results of more than 7 tons/ha, Rice Production Input Subsidy with the provision of fertilizer and rice seed amounting to 50%-70% of the price set by the market, Irrigation Subsidy where the government allocates financial resources to build a rice irrigation system, Federal Government Rice Fertilizer Scheme Subsidy (SBPKP) to help farmers cover the cost of living, Allocate Rice Subsidy and so on. The subsidies and incentives can be seen below at table 4.

Table 4: New government incentive/subsidize for paddy sector in Malaysia

Incentives/Subsidies	Rate
Rice fertilizer scheme of the federal government	240 kg/ha: 12 beg ×20 kg of compound fertilizer;100 kg/ha: 5 beg ×20 kg of urea fertilizer
Paddy price subsidy scheme	RM360 to RM500 for every metric ton paddy production
Rice production incentive	RM160 per hectare per season for plowing RM50 per hectare per season for rice harvest
Increase in revenue incentive	RM650/mt of yield for at least 1% increases from the base season
Rice price subsidy	RM2.60 x 1kg for rice price
Paddy seeds incentive	RM35 to RM45 (20 kg) to the farmers

Agro food policy, 2011

To improve the country's agricultural sector, the agricultural sector has been classified as one of the elements in the National Key Economic Area (NKEA) under the Economic Transformation Program that has been created. NKEA Agriculture will focus on subsectors that has great growth potential that can help Malaysia join the global market that is growing. At the same time, focus will also be given to strategic sub-sectors in efforts to guarantee the country's food supply. 16 Entry Point Projects (EPP) and 11 Business Opportunities (BO) have been identified which are targeted to provide Gross National Income (GNI) amounting to RM21.44 billion and create new job opportunities of 74,600, where most of them will be created in rural areas. Three of the 16 EPP are related to the rice production industry which is EPP 9 is variety of fragrance rice cultivation in idle land, EPP 10 about cultivation of rice in Muda Area and EPP 11 which is about rice cultivation in the granary areas (Department of Veterinary Services, 2011). Furthermore, the government has allocated about RM839.3 million for the projects which is RM6.75 million for EPP9, RM97.78 million for EPP 10 and RM136 million for EPP 11 (Chamhuri et al., 2014).

Challenges in rice production in Malaysia: The following discussion below is about problems related to rice production and food security on a global and Malaysia scale. The problem of rising commodity prices, uncertain climate conditions, overpopulation and limited resources are the main issues and challenges faced by the rice production sector and food security in Malaysia.

Food price increase: The sharp increase in food prices in recent years has been found to have affected the income and savings of people around the world. The increase in the price of fertilizers and other inputs such as poisons and seeds, high global demand for food, natural disasters such as droughts and floods that have created a situation of food insufficiency, the lack of land for agriculture, as well as other problems are seen to have contributed to the situation of increased prices food. The world food crisis that occurred in 2007 to 2008 was the worst food crisis in history that also had an impact on Malaysia. During that time, many main food prices experienced price increases including the price of rice which at that time rose sharply up to 74%. In 2021/2022, we also experience a food crisis because of the Covid-19 pandemic that occurred (Chamhuri et al., 2014). However, after the pandemic, global food prices are still rising due to food shortages problem in some countries which make some of them decide to restrict their food exports abroad to ensure sufficient domestic food supply for the people of their respective countries. This situation also happened because of the uncertainty of global rice prices and export policies have limited the export of rice abroad. India has stopped exporting rice abroad due to lack of food supply for domestic consumption due to the monsoon season that has damaged rice in the country. Malaysia also becoming one of the victims of this situation. The increase in the price of imported rice has caused people to switch to local rice. Some sellers in Malaysia also have inflated the local supply of rice which is then sold to the people at a high price to make a profit. There are also a few irresponsible individuals who have changed local rice to import rice, causing farmers to continue

to be poor (Badra, 2024). The conflict and war between Russia and Ukraine also affect the world's food supply because Ukraine is known as one of the world's main food suppliers. Russia's invasion of Ukraine caused Ukraine to lose access to agricultural land, labour shortages, crop damage and destruction of food system assets and infrastructure, worsening the world food crisis after the Covid-19 pandemic (Nooryati, 2022). The rise of food prices has been seen in the increase of the Consumer Price Index of Food from 115.2 in 2014 to 152 in the year 2023 with contribution of food and beverages by 20% (Department of Statistic, 2024). These issues are expected to become more challenging due to the limited production factors and land and water resource, climate change, the increase in input prices and competition in the use of food to biofuel production, food safety, lack of capital to advance the agriculture sector and others (MOA, 2011; Fatimah et al., 2011). In 2023, the increase in the price of rice seeds (BPS) caused the rice planting process in the Kedah and Perlis areas to be unable to start. The rice planting process for the 2023/24 season was only 10.6%, not as expected by MADA which should have been 50% (KADA, 2024). From this situation, an increase in paddy price which is associated with higher production cost may result in a shrink of paddy planted area in Malaysia (Tey, 2010). In 2021, Malaysia has imported a total of RM 681 million of rice which is 27.5% from India, which make India as Malaysia's 2nd largest rice importing country, after Vietnam which is RM 1.04 billion (42%) (Department of Statistic, 2020). According to IRRI, the world rice price expected will be higher than the level when the 2008 food crisis. The government must review the current policy of self-sufficiency through increased production. The government has decided to provide a temporary subsidy of RM500 per tons to millers compared to the previous year, which is RM360 per tons, to ensure enough supplies of rice to poor consumer (Ministry of Finance, 2023). Based on a study conducted by Yeong Sheng Tey et. al (2010), rice production in Malaysia from 1961 to 2007 has a significant and positive relationship with government intervention through allocations for the country's rice production in the period in question. By using the Nerlovion Expectation Model method, it is expected that a one percent increase in government allocations is estimated to increase rice production by 0.289 percent in the short term meanwhile for the long-term period, it is expected that production revenue will increase by 0.605 percent with a one percent increase in government allocations (Zulkifli & Nor Asmat, 2018). This means the impact of government intervention on rice on fertilizer can protect farmers from world price volatility of rice.

Climate change: The climate change is affected the world's rice production, including Malaysia. For example, India has restricted rice exports due to fears that the food supply will not be sufficient for the people in that country meanwhile in Pakistan, drought and floods have destroyed farmers' rice harvests. In fact, a study in China shows that extreme rains have reduced the average yield of rice produced over the past 20 years (Sengupta, 2023). Rice farmers who own small land are forced to adapt to the changing climate. The impact of climate change on rice crops is very significant which can be seen when in the five years from 2019 to 2023, as many as 40,828.28 hectares of rice crops in Peninsular Malaysia was destroyed by floods, while 9,336.45 hectares were affected by drought (Abdul Aziz, 2024). In Malaysia in the period of 39 year from 1978 to 2017, the average annual rainfall recorded was found to have increased every single year, resulting in land experiencing excess water that caused agricultural areas to be filled with flood water. According to MAFS, some rice farming areas in Malaysia also experienced a decrease in the average annual rainfall, causing the soil to crack and lose moisture, resulting in the process of planting and harvesting rice not being possible (Abdul Aziz, 2024). Temperature changes also affect rice production in Malaysia. The suitable temperature of rice cultivation in Malaysia is 25ºC. If the temperature increases by 1ºC, it will decline in rice production between 4.6 to 6.1 percent (Ahmad Zubir, 2012). Meanwhile, a study conducted by Md. Mahmadul et al. (2011) in the IADA Northwest Selangor Project area found that an increase of 1ºC will reduce rice production by 3.44 percent in the current season and 0.03 percent in the following season. The analysis carried out on the amount of rain on rice production in the area also found that a 1% increase in the amount of rain will reduce to 12% of rice in the current season and 0.21 percent in the following season. The production and yield changes may be due to the reduction of water available for irrigation, loss of land due to sea level rise and the risk insects and diseases may increase (Chamhuri et al., 2014). In May 2023, 7,800 ha of rice crops in the (KADA) area were affected due to the hot weather in Kelantan and in December, KADA suffered a RM17 million loss due to the destruction of rice stalks inundated by flood waters (Audrey Dermawan, 2024). In the next following year, 40,000 tons of rice yield are affected due to

the drought in the state, and it involve 5,000 hectares (ha) out of 9,100 ha of paddy fields where the paddy is cracked and badly damaged (New Straits Times, 2024). Kelantan, which is one of the biggest contributors to the country's rice production, has lost approximately 40,000 metric tons causing rice production to decline to 50,000 metric tons compared to the set target of 90,000 metric tons (Torek, 2024). In conclusion, the impact of climate change on rice harvesting and production can be avoided through the construction of an irrigation system so that the effects of drought and floods can be reduced. The government needs to ensure that research on fertilizers and rice seeds that have high resistance needs to be carried out to maintain and increase the production of rice which is a staple food and guarantee the country's food supply. The lack of food supply will directly affect the well-being of consumers.

Population growth: Rice production in Malaysia faces a major problem when the number of farmers cannot produce the rice supply requirements that can support most population needs in Malaysia (Syahmi et al., 2022). According to the Department of Statistic (2024), the total consumption of rice has increased from 7 million metric tons in 1985 to 2.9 million metric tons in 2022 because of the increasing population. Meanwhile, the growth of the country's population is 34.1 million in 2024, compared to 29.5 million in 2012. This will affect the national SSL level of rice in the country. To increase food supply and the country's staple food, the government needs to review the level of SSL from time to time by considering various aspects such as input and output costs of rice production, global rice market prices and food safety as well as the cost of importing food supplies that the country must bear. To accommodate the rate of population growth in Malaysia and the increasing cost of living, Malaysia is estimated to need rice production of approximately 1,320,000 tons per year to meet the needs of the population and self-sufficiency in rice production by the year 2060 (Chamhuri et al., 2014). Therefore, issues related to increasing rice production should be given primary attention through an effective and efficient approach. Changes in people's tastes that are becoming more significant due to changes in living standards and increased incomes will also have an impact on rice production in Malaysia.

Resources scarcity: The land to work on the rice production industry in Malaysia is found to be limited which is at the same time has an impact on the country's food supply because rice is the main staple food in this country. Factors such as the price of rice and rice yields being uncertain, the factors of farmers getting older and none of their family members wanting to continue working on rice crops have caused a few farmers to sell their land to other parties or individuals, indirectly this can be seen as a threat to the food chain food in this The factor of reasonable price offers by buyers has also caused many rice farmers to sell their land to avoid losses due to rice production being affected by natural disasters or pest and disease attacks. There are several rice paddy areas that have 'changed their face' which are redeveloped with urbanization, industrialization, various infrastructure, commercial and housing projects and more, resulting in a shrinking area of rice paddy fields (Berita Harian, 2019). Therefore, the national rice SSL target cannot be fully achieved because it cannot meet the demand due to the increase in the population. According to Chamhuri et al., (2014), rice production in this country can only cover about 70% of the country's domestic needs. Although the area under rice cultivation in Malaysia has increased from 416,398 ha in 2021 to 416,841 ha in 2022 with an increase of 443 ha, the average yield of paddy decreased from 4,480 tons/ha to 4,137 tons/ha the following year. Some areas of IADA and KADA except MADA experienced a decline in average yield of paddy in 2022. Malaysia's rice production in 2021 is higher compared to 2022 which is 1,865 million Mt to 1,724 million Mt (KADA, 2024). The rice production and the average yield of paddy in the KADA areas in 2022 by season is 212,751 tons of rice production with an average yield of paddy of 4,096 mt/ha in all seasons, 115,785 tons of rice production with an average yield of paddy of 4,402 mt/ha in the main season and 96,967 tons with an average yield of paddy which is 3,782 mt/ha in the off-season (KADA, 2024). This has happened because of drought and floods in KADA areas which have affected rice production in KADA. Water resources are very important for the agricultural sector, especially rice cultivation. Each rice granary area needs to have an irrigation system or sufficient water source to help to improve the rice industry. Before the irrigation system was built, rice cultivation in the past only depended entirely on natural water sources such as rivers and rainwater. In the 19th century, rice planting activities in the state of Kedah were intensified due to the decline in trade activities that occurred at that time. Kedah is

known as the 'rice granary state' because it has a low terrain that is often flooded by water, so to reduce excess water, the government decided to build an irrigation and drainage system (Roshila, 2020). According to Chamhuri (2014) rice production is highly dependent on irrigation, it is used as much as 70% in agricultural areas in other areas and it covers 90% of irrigated rice areas in East Asia. Water serves to give freshness and needs to the rice crops so that it can carry out the growth and production of healthier rice production (Norzia, 2009). The impact of irrigation on rice crops can be seen through some paddy areas that suffer from lack of water resulting in rice production activities not running smoothly. This situation can be seen when some MADA area in Perlis does not get water resources from irrigation which will affect the rice harvesting process (Berita Harian, 2019). To overcome lack of water resources, the Malaysia government will decide to use the underground water system in preparation for the hot weather that is expected to be worse next year. A pilot project of this method has already been implemented in the granary area of Integrated Agricultural Development (IADA) Batang Lupar, Sawarak and if it is effective we will expand it to the whole country (Astro Awani, 2024).

Approach to ensuring the nation's food supply: The government has outlined a few approaches and efforts in improving the agricultural sector to ensure the country's food supply is sufficient through the 12th Malaysia Plan. Credit financing to farmers through Agro Bank to help increase rice yields, the provision of rice subsidies and rice incentives such as fertilizers and pesticides, as well as smart farming using IoT is seen to guarantee food security in Malaysia by the year 2060. In addition, the government will also ensure that the level of self-sufficiency of rice can be increased through work methods to upgrade the existing rice production infrastructure not only in rice granary areas but also in non-rice granary areas. According to Chamhuri et. al (2014), through a study that they referred to, found that the government should follow these three elements to achieve the efforts as stated before, which is to build instruments related to management and infrastructure as well as instruments that can be built by the community for a long-term strategy in effort to improve agricultural sector and rice production in Malaysia to ensure food security. There are several suggestions that can be made by the government to solve the issue of lack of food supply in Malaysia due to rapid population growth after the rapid urbanization process in Malaysia. Chamhuri et al., (2014) study has suggested several approaches to overcome the problem of food supply and rice production in Malaysia.

- **National food industry development policy:** the government needs to evaluate all the national food industry development policies to achieve the level of SSL that has been set and ensure the adequacy of the national food supply according to the current The R&D process in the agricultural sector needs to be done using advanced technology and the use of allocations and incentive packages from the government and supported by infrastructure and market development. The involvement of parties such as MADA, KADA, IADA, RISDA implementers is very important in strengthening the country's food sector.
- **Increased investment in the national food sector:** Investment in the national food sector is very important to ensure the growth and security of the national food sector.
- **Safety net program:** Malaysia is very efficient in dealing with the food crisis where the volatility of food prices can be controlled and supported by other markets. However, the government still needs to create a food safety network and certain programs to improve the quality of food and nutrition practices among groups that need attention such as children, marginalized people and the poor.
- **Sustainable agriculture and food production agenda:** Excess waste from the rice production sector should be recycled as a step to promote sustainable rice farming methods in Malaysia. The residues can be produced into a product of high value and bring profit to the farmer. With this step, the impact of the rice production sector on the environment and human health can be reduced and can be channeled back to the consumption system. Processing and marketing activities also need to be expanded to increase the country's value-added commodities and food products
- **Paddy policy to increase rice production**: The government should build policy based on the interests of farmers, manufacturers, distributors and retailers in this country to control the country's rice production so that all parties receive fair profit.

CONCLUSION

The establishment of MADA, KADA and IADA as rice granary areas in Malaysia is seen as a strategic move by the government to overcome the food supply crisis in Malaysia. The provision of rice subsidies, credit financing, allocations for the construction of rice farming projects as well as the provision of incentives are to strengthen the country's food sector and achieve the target of the country's Agro-food Policy 2.0 which is a subsistence level of 80% by the year 2060. The rice planting and production sector in Malaysia can be improved if the challenges and issues related to this sector are addressed immediately through the establishment of policies and other holistic strategies. By increasing rice production, our country can also reduce its dependence on imported food supplies from foreign countries. The government also needs to constantly study and monitor industry from time to time so that the country's food supply can meet the needs of people who have a variety of different tastes and accommodate population growth in the future.

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