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Driving Forces of Paddy Land-Use Shifts: An Integrated Review of Sustainable Approaches for Malaysian Paddy Area Preservation

Faktor-faktor Perubahan Guna Tanah Padi: Kajian Bersepadu dalam Pendekatan Mengekalkan Guna Tanah Padi di Malaysia

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ABSTRACT

The demand for rice is increasing due to the rapid growth in the world's population, including people in Malaysia, causing a severe threat to the supply of food security. To meet future rice demand, the National Agro-Food Policy 2021-2030 (NAP 2.0) advocated for increased local rice production. This study set out to identify the causes of changes in land use, with a special focus on paddy in Malaysia. 31 finalized articles from Scopus database were chosen based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Four main themes were elaborated: (1) urbanization, (2) population expansion, (3) industrialization and (4) environmental values. This review shows that paddy fields are converted to non-agricultural land, agricultural output can be negatively impacted, which might have long-term effects on the nation's food security. Within the scope of this review, we suggest that further research is important to give information for land owner to maintain their paddy field. However, to sustain the paddy field and ensure sustainable paddy production in Malaysia to fulfill future population needs required cooperation among researcher, stakeholder and policy maker. This review shows the limiation of research and offer the interesting guidelines to sustain the paddy land-use in Malaysia.

Keywords: Agriculture; Driving forces; Food security; Human activities; Paddy productivity

ABSTRACT

Peningkatan penduduk di dunia menyebabkan permintaan terhadap beras terus meningkat termasuklah Malaysia sekali gus memberi ancaman terhadap bekalan jaminan keselamatan makanan. Bagi memenuhi keperluan bekalan beras pada masa hadapan, Dasar Agro-Makanan Negara 2021–2030 (DAN 2.0) telah dirangka sebagai inisiatif untuk meningkatkan pengeluaran beras tempatan. Justeru, kajian ini dijalankan bagi mengenal pasti faktor-faktor yang mendorong perubahan guna tanah, khususnya tanah sawah padi di Malaysia. Sebanyak 31 artikel telah dipilih daripada pangkalan data Scopus berdasarkan garis panduan PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). Empat tema utama telah dikenal pasti, iaitu: (1) perbandaran, (2) pertambahan penduduk, (3) perindustrian, dan (4) nilai alam sekitar. Hasil kajian menunjukkan bahawa penukaran tanah sawah padi kepada tanah bukan pertanian memberi kesan negatif terhadap hasil pertanian dan boleh menjejaskan jaminan keselamatan makanan negara dalam jangka panjang. Kajian ini mencadangkan agar penyelidikan lanjut dijalankan bagi menyediakan maklumat berguna kepada pemilik tanah dalam usaha mengekalkan fungsi asal tanah sawah mereka. Walau bagaimanapun, pengekalan kelestarian guna tanah sawah padi dan memastikan pengeluaran beras dalam memenuhi keperluan penduduk masa hadapan memerlukan kerjasama erat antara para penyelidik, pihak berkepentingan serta pembuat dasar. Kajian ini turut menekankan limitasi penyelidikan sedia ada serta menawarkan garis panduan yang berpotensi untuk memperkukuh dasar kelestarian guna tanah sawah padi di Malaysia.

Kata kunci: Pertanian; Faktor-faktor perubahan; Jaminan keselamatan makanan; Aktiviti manusia; Pengeluaran padi

INTRODUCTION

Rice (Oryza Sativa) is one of the most widely consumed grains, and it is a staple food for more than the world's population, of which more than 3.5 billion people depend on rice. The world's population has increased from 2.5 to 7.7 billion from 1950 to 2019, which has expected to reach 9.7 billion by 2050 (Rubaiyath Rahman & Zhang, 2023). The rapidly growing human population globally will increase the demand for rice in their daily food intake. The global paddy production has estimated to be around 755 million tonnes, with a worldwide rice-cultivated area of approximately 167 million hectares (Doni et al., 2022). However, the decline in paddy production stems from the land-use shift, climate change and paddy diseases. The land-use shift is one of the main challenges contributing to declining global paddy production because of human activity.

The definition of food security has been used to describe a situation in which all the population, at all times, have physical and economic access to sufficient, safe, and nutritious foods that meets their dietary needs for a healthy life. In figures 1 show food security also had four dimensions such as food availability, accessibility, utilisation and stability. The food availability refers to sufficient, that mean that there is sufficient the food security based on quantities and quality to meet the population. It is important to make sure the availability is enough through domestic production or imports. Meanwhile, food access is referred to indidual or household adequate income or resources to access their nutritious food like rice. Utilization is people utilise the food through healthy food, get clean water and maintaining sanitation conditions towards for healthy life. The stability in food dimension is describe the food secure, the population, household and individual access to adequate the food at all the times. When paddy output declines due to climate change issues, import country trade obstacles, and outbreaks, the food security will be more vulnerable and less stable. In Asia, rice is an essential staple food when rice consumption is very high, exceeding 100 kg per capita annually in many countries and the caloric supply from rice is approximately 50 per cent. Malaysia produces its own food but is still insufficient to meet rice production demand. Malaysia just only produced 63% of its own rice (self-sufficient level), also importing the rest from Thailand, Vietnam, and Pakistan (Syahmi Makhtar et al., 2022). Countries like Thailand and Vietnam, despite their strong export-driven rice economies, face their own challenges, including climate change-induced yield fluctuations, water resource management, and labor shortages. Thailand, known for its premium rice exports, struggles with shifting agricultural demographics and declining farmer incomes, while Vietnam grapples with salinity intrusion and the environmental consequences of intensive farming. Comparing Malaysia’s rice security strategies with these nations highlights both shared vulnerabilities and unique policy approaches. By analyzing global best practices and adaptive mechanisms, Malaysia can refine its food security framework, reducing import dependence while fostering a more resilient and competitive rice sector. Malaysia needs to produce more rice to feed its growing population. However, Malaysia has the natural resources for rice cultivation, but importing rice was cheaper than producing locally. As a result, local paddy production competed between the Malaysian paddy market and other low-cost rice producers in neighbouring countries. A lack of rice stock can affect the nation's economic and political stability.

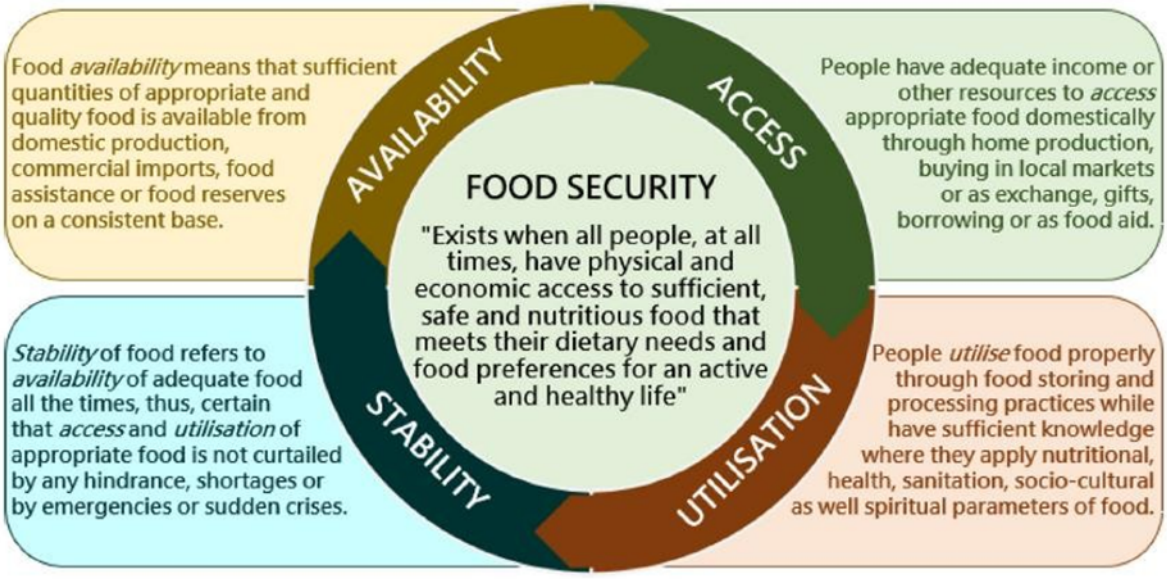

FIGURE 1. Four dimension of food security
Source: Gunaratne et al. (2021)

Paddy field is used to grow paddy and produce food for humans. Despite its importance, paddyfields are converted to non-agricultural land for urban development. As a result, there is not much agricultural land for paddy plantation, reducing the food supply and threatening national food security.These are worrying issues that the government should consider. The factor of paddy land used is also linked with the development of socioeconomic (urbanisation, industry, the development of institutionsand placement) and climate change that decreased the paddy production and changed the paddy function of paddy fields to non-paddy. The use of agricultural land in Malaysia had influenced by the implementation of policies by the government to enhance the nation's economic growth. These policies encompass global trade, infrastructure development, and subsidies. In recent years, problems associated with paddy production have gained worldwide attention. Human activities mainly cause problems related to rice production. These problems include climate change, urban planning, land-use paddy changes, insufficient agricultural land for paddy plantation, and increased production costs. Production instability and decreasing agricultural areas are among the main issues affecting the sustainability of paddy farming in Malaysia (Muhammad Yasar et al., 2016). Land-use paddy change is likely unavoidable, although the level of food security is low in Malaysia. Therefore, it is crucial to understand the driving forces of land-use paddy change to prevent its adverse effects and ensure a sufficient food supply for the community.

The decline in the food supply in countries (e.g.,Vietnam, Thailand, Pakistan, and Myanmar) is apparent mainly due to global financial crisis, wars, climate change (e.g., drought and flood), disease outbreaks (Siti Hajar et al., 2020), and other obstacles stunting the growth of paddy. The decline in the level of food security can create a panic situation in society. The Malaysian government needs a strategic plan to ensure that the food supply is sufficient for the community. In the event of unforeseen circumstances (e.g., disease outbreaks and environmental disasters), there will be an increasing demand for rice by the community. Thus, Malaysia must have a sufficient stock of rice. This study focuses on the driving forces of land-use paddy change and its effect on paddy production. The study analysed the literature on the recommendations made

by farmers and stakeholders to enhance national food security in the future. These recommendations are believed to help the government and farmers supply food to society and provide affordable food in the long run. The effects of driving forces of land-use paddy change on socioeconomic and food security in Malaysia were discussed. The four major driving factors are (i) the use of precision technologies in agriculture for monitoring purposes, (ii) the development of unused paddy areas, (iii) increasing the farmers' knowledge and skills, and (iv) strengthening and encouraging the involvement of young farmers in paddy industry.

AN OVERVIEW RICE PRODUCTION AND LAND USE PADDY IN MALAYSIA

RICE PRODUCTION

Paddy is the fourth largest plantation in Malaysia after cocoa, palm oil, and rubber. In Malaysia, rice grown from paddy plantations is the main staple food for the people of Malaysia and is considered to be food security by the government. However, Malaysia's rice production is rising, although at a slower rate than the population. In 2020, paddy production was 2.32 million tonnes and trend paddy production production had fluctuated in 1971 until 2022 period. Malaysia has always practised production-oriented agriculture and has increased national rice production since the 1940s. Increasing self-sufficiency level (SSL) is important because the government does not need outside help to meet basic needs, especially to increase the production of food crops such as rice. As a result, the government must improve SSL to ensure that food security (rice) meet the needs of the local people.The history of SSL in Malaysia is fluctuating, during the first Malaysia Plan (1966-1970) SSL was 80%, the second Malaysia Plan (1971-1975) was 87%, the third Malaysia Plan (1976-1980) was 92%, the fourth Malaysia Plan (1981-1985) was 76.5%, the fifth Malaysia Plan (1986-1990) 75%, the sixth Malaysia Plan (1991-1995) 76.3%, the seventh Malaysia Plan (1996-2000) and the eighth Malaysia Plan (2001-2005) 71%, the ninth Malaysia Plan (2006-2010) 72%, the tenth Malaysia Plan (2011-2015) 71.4% and the target of the eleventh Malaysia Plan (2016-2020) is 100%. However, the SSL in Malaysia in 2022 is still low, 63%, and still relies on importing rice from other countries. According Fatimah, (2020), farmers had to face two problems to increase SSL, such as low yields and production costs. Yields increased slowly, but production costs remain high as most products are imported since the domestic market for inputs is still underdeveloped.

Figure 1 show that the production Malaysia's rice production, consumption, import (Metric tonnes) and self-sufficiency level. The forecast of consumption of rice will increase in 2026, while production shows a widening gap, as production is lower than consumption. In 2026, SSl is predicted to be only 60%, which means that Malaysia will continue to rely on imported rice. According Syahmi Makhtar et al.(2022), Malaysia's rice import costs increased from RM1.5 billion in 2019 to RM2.5 billion in 2020 as the country increased its rice imports by 30 until 40% during the period. This situation needs serious atttention from the government to increase rice production to full fill the demand among the local people. According Tey et al. (2010), through the National Agricultural Policy (NAP), the government has enabled the rice industry to increase rice production from natioanl security especially to stablity in political and able to provide staple food for local people withot relying on other countries.

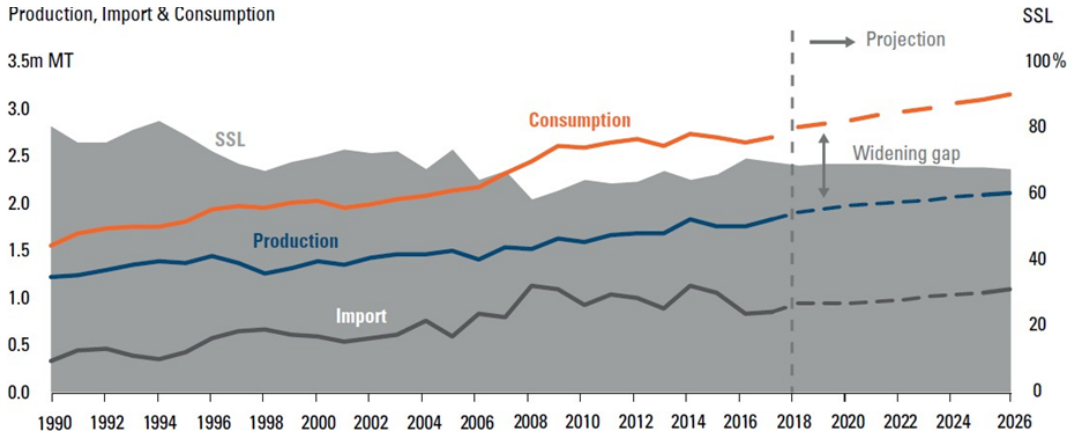

FIGURE 2. Malaysia's rice production, consumption, import (Metric tonnes) and self-sufficiency level
Sources: Khazanah Research Institute, (2019)

LAND-USE PADDY

To ensure the level of self-sustained rice as the national food security, the government has identified seven granary areas in Peninsular Malaysia: Kedah, Perlis, Kelantan, Terengganu, Pulau Pinang, Perak, and Selangor. These granaries are the Muda Agricultural Development Authority (MADA), Kemubu Agricultural Development Authority (KADA), Integrated Agriculture Development Area (IADA) Kerian Sungai Malik, IADA Barat Laut Selangor, IADA Penang, IADA Seberang Perak, IADA KETARA, and IADA Kemasik Semerak. In table 2, the average production per hectare of the granary in Malaysia in 2017 was 4.47 mt/ha and the national average yield of 4.03 mt/ha. Meanwhile, four granaries, such as MADA, IADA Pulau Pinang, KETARA and Barat Laut Selangor, had produced the average productivity of granaries per hectare. MADA is one of the largest granaries, with 100,603 hectares of paddy fields. Ahmad et al. (2017) state that the MADA granaries own 31.7% of total rice production and 24.1% of rice cultivation areas in Malaysia. Land-use reform activities for non- agricultural production or non-paddy cultivation are also inevitable for these areas. Kedah and Perlis are the two states in northern peninsular Malaysia that are well-known for the paddy industry. They also have many granaries to accommodate rice cultivation activities. As such, Kedah and Perlis had nicknamed the "rice bowl of Malaysia".

TABLE 1. Malaysia's total paddy production and productivity of the granary areas in 2017.

Main granary areas	State	Total production (mt)	Production (mt)
Muda Agricultural Development Authority (MADA)	Kedah	974,387	4.841
Kemubu Agricultural Development Authority (KADA)	Kelantan	240,490	4.448
Integrated Agricultural Development Area (IADA) KETARA	Terengganu	50,438	5.172
IADA Pulau Pinang	Pulau Pinang	146,660	5.172
IADA Barat Laut Selangor	Selangor	165,571	5.737
IADA Kerian	Perak	171,237	4.510
IADA Kemasin Semarak	Kelantan	26,938	3.779
IADA Seberang Perak	Perak	88,198	3.180
Total		1,863,919	-
Average		232,990	4.469

Source: Firdaus et al. (2020)

METHODOLOGY

The current study implemented the systematic literature review (SLR) approach by using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) through searching in the extensive database of scientific publications within specified time frame. According to PRISMA, inclusion and exclusion criteria were applied strictly. In this study we conduct the searching, evaluating and synthesizing peer-reviewed article from Scopus database. The four-phase systematic review procedure was carried out in April 2019.The keyword is similar with factor of driving forces and paddy such as (("paddy field") AND ("changes" OR "reforms" OR "conversion" OR "alterations" OR "deformation" OR "fluctuations" OR "metamorphoses" OR "variation" OR "displacement") AND ("factor") AND ("paddy" OR "rice" OR "oryza sativa" OR "food security")). According to Corrin et al., (2022), the keywords used in database searching should been based on the keywords used in previous studies. Based on table 1, the inclusion and exclusion criteria had defined with several criteria such as literature type, language, timeline and subject area. We focused on social sciences only such as geography, economics, sociology and political science & environmental policy and excluded other subject area such as medicine, engineering, nursing, chemistry, computer sciences immunology and microbiology and chemical engineering. This is due to the agricultural land-use changes are driven by economic, political, social and environment factors. Meanwhile, medicine and nursing not included because this subject area focus on human health, diseases and medical care which are unrelated to land-use changes. Next, the screening is limited to English language article only. Letters, news, editorial book series, notes, book, chapter in a book and conference proceedings were excluded in this study. Based on table 1, the inclusion and exclusion criteria had defined several criteria such as literature type, language, timeline and subject area.

TABLE 2. The inclusion and exclusion criteria

Criterion	Eligibility	Exclusion
Literature type	Journal (research articles)	Letters, news, editorial book series, notes, book, chapter in a book, conference proceedings
Language	English	Non-English
Timeline	Between 2019 and 2023	< 2019
Subject area	Social Science only (Geography, economics, sociology and political science & environmental policy)	Medicine, engineering, nursing, chemistry, computer sciences immunology and microbiology, and chemical engineering

There were four steps in the systematic review process: identification, screening, eligibility, and inclusion (refer figure 3). There were 504 articles in the identifying phases with keywords. Then, 58 articles were removed (letters, news, editorial book series, notes, book, chapter in a book, conference proceedings). Next, titles and abstracts of 446 full articles were screened, 415 articles were excluded due to not within subject area and lack of focus on driving forces paddy land use changes. This step was the eligibility phase, where the titles and abstracts were eliminated and removed because the study was looking for papers with relevant subjects (Dong Ruishu et al., 2024).

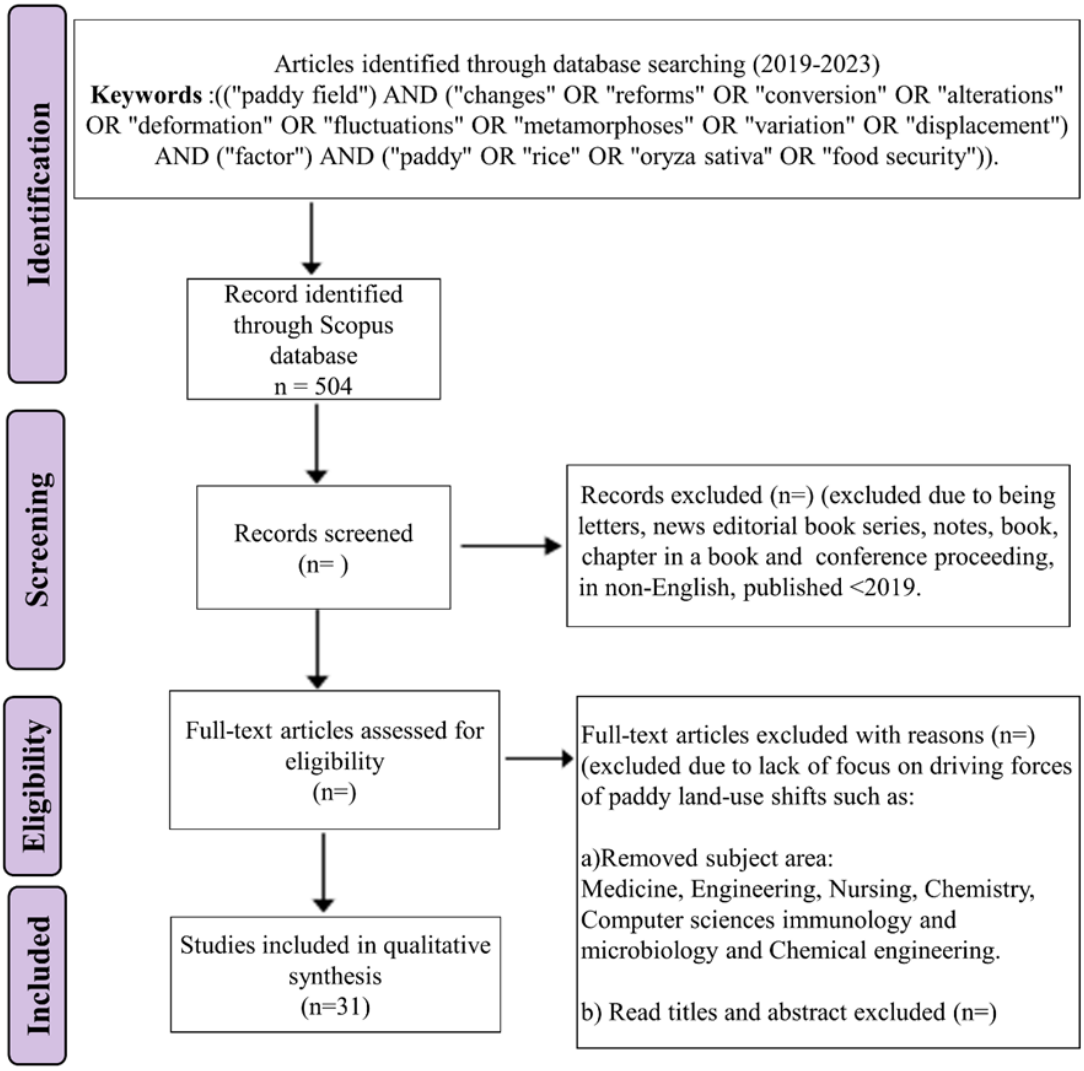

FIGURE 3. Flow chart of searching results and screening strategy using PRISMA

FACTORS AFFECTING LANDUSE PADDY CHANGES

URBANIZATION

Urbanization had led to rapid economic development cause by the increasing number of populations. The Malaysia, the growth with current population reached 32 million people in 2022 and the projected to continue growing and it expected to reach 39 million by the end of 2035. Increasing the population are becoming increaringly the urbanization, it has given a significant impact on agriculture sector. In many developed and developing countries, rapid economic transition and increasing socioeconomic status are the main driving factors for converting agricultural land (e.g., paddy land) to non-agricultural land (e.g industries, infrastuctures, residential, and urban development). Land is crucial resource for human especially to agricultural activities, urbanization, industrial and settlement. Although the development of food supplies, especially staple food (e.g., rice), is also necessary for national development. However,

agricultural activities such as paddy depend on land resources (paddy fields) for production. Meanwhile, land also essential resource for development. According to (Gandharum et al. 2022), agriculture land usually is being converted to some other development purposes or gives way to the urbanisation process. The phenomena land conversion cause by urbanization will pressure the agricultural land and affected agriculture production such paddy field. The paddy field had been converted by urbanization or economic development will threaten the national food security.

In Peninsular Malaysia, on the other hand, 517,586 hectares of land were used for paddy plantation in 2011. However, the size shrank to 514,381 hectares in 2014. Meanwhile, in East Malaysia (i.e. Sabah and Sarawak), the land used for paddy plantation increased from 99,442 hectares in 2011 to 101,326 hectares in 2014 (Tal, 2018). The factor of economic development led to the declining paddy production has a significant increase in rural residential land, which harms the availability of cultivated land, the environment, and the chain of supply food security. The total rice land area and its production have gradually decreased yearly because urbanization and economic development is crucial to ensure the sustainability of rice production in the future. Agricultural land-use change is not only in Malaysia but all over the world. For examples, urban expansion led to agricultural land-use changes in the Three Gorges region of China (Liang & Li, 2020). A similar scenario happened in Kunshan, China, where agricultural land use (e.g., paddy field) decreased by 16.4% from 1987 to 2000. Meanwhile, most farmers and rural communities in Thailand were also affected by this change, where they sold their valuable farmland to developers, who eventually converted the farmland to non-agricultural land for developing resorts, markets, and other commercial areas (Sakayarote & Shrestha, 2019). From the studies mentioned above, it is clear that human activities cause agricultural land-use change, especially for paddy plantations. The reduction in paddy plantation due to converting agricultural land to non-agricultural land is a significant concern as paddy is an essential crop. Therefore, decreasing paddy production may result in food insecurity.

RISING SEA LEVELS

Climate change affects the quality of people's lives worldwide and may also threaten the natural environment. Climate change has complex interactions between humans, the environment, and natural resources (e.g.land, water, and vegetation). Due to climate change, droughts, floods and heat waves will become more frequent every year, and further sea-level rise will threaten food security. In Malaysia, sea-level rise will lead to, among other things, increased flooding in low-lying coastal and tidal areas and is likely to cause coastal erosion, beach loss and higher wave surges that will affect coastal communities, infrastructure, industry and the environment. For instance, previous studies reported that most paddy-based agriculture is found in deltas around 65%. Sea level rise and its impact on coastal development in Malaysia is a critical factor for the continued growth of the country’s major urban and rural centres. Climate change is a global problem that cannot be avoided and is expected to lead to a rise in sea levels and impact on coastal areas. The paddy field in Kedah, a state in northwestern Malaysia, is closest to the coast and threatens rice production due to sea level rise. The average sea level rise is expected to be 2.5 mm to 5.2 mm per year, with the states of Kedah and Kelantan state being the areas with the highest sea level rise (SLR). According to Ehsan et al.(2019) one meter rise in sea level is expected to cause the loss of 180,000-hectare of agricultural land (such as paddy, rubber, coconut and oil palm plantation), 15% - 20% of mangrove forests loss along the coastline.

Meanwhile, the study about SLR in Malaysia by National Hydraulic Research Institute of Malaysia (NAHRIM) the rice-growing area in Kedah, which is 5 km from the sea, will be flooded and affect rice production in the future.The SLR contributes to the erosion and destruction of paddy soils in coastal areas. This problem is a severe issue, especially for the paddy farmers in the coastal areas, as the SLR can increase salt salinity and consequently stunt the growth of paddy, which has been the case in Kedah. Kedah is located at the north of Peninsular Malaysia, where most the nation's rice is cultivated are thus knows as granary areas. Although the paddy field is located 200 meters from the coastal line, increasing soil salinity due to saltwater intrusion into the paddy soils stunts the growth of paddy, damages stomata, and decreases cell productivity. Salt stress in paddy farming presence of seawater will occur the cells of transpiring and cause the death of the leaves. The studies added that most paddy fields are vulnerable to increasing SLR and soil salinity. Soil salinity is the most important physical factor affecting paddy growth and rice production. Several states in northwest peninsular Malaysia, including Perlis, Kedah, Penang, and Perak, are affected by climate change. The agricultural lands have been severely affected by the SLR and expected that 20% of the paddy land would be inundated entirely by the year 2100. For example, increase sea level had profound at Kampung Padang Garam, Kuala Kedah, which is located very close with coastal areas that are vulnerable to salt instrusion. As a result, most farmers have suffered losses in instruction seawater into the paddy field and its production have gradually decreased every year. This issue is crucial for farmers to continue their paddy farming specially to ensure the sustainability of rice production in the future and tend to convert their paddy cultivation areas to non-paddy cultivation.

INCREASING THE POPULATION

The agricultural sector (e.g., paddy industry) plays a crucial role in supplying food to the community. community. This sector also provides a continuous food supply to meet the demand. A food supply problem arises when the importing country cannot supply food (e.g., rice) or when the local farmers have problems with their plantations' productivity. One factor affecting the food supply is the increasing number of populations. The increasing demand for rice is a sign that the population is growing. As such, the increasing demand for food due to the high population growth and rising income may affect national food security, thus putting pressure on the government to ensure that paddy production is adequate. In Malaysia, the number of populations was 32.68 million in 2019. In addition to providing food for the population, the Malaysian government has to ensure that the food supply is adequate for the daily needs of non-citizens (e.g., immigrants). This dilemma increased the population and immigrants, leading to high rice demand. It was reported that in 2016 that a person consumed, on average, 80 kg of rice yearly, which is about 26% of the total daily calorie intake, costing an average of RM44/month per household. In 2016, 2.7 million Metric tonnes (MT) 67% of the local product) of rice was consumed, and the rest was imported mainly from Thailand, Vietnam, and Myanmar. However, in Indonesia, the high population number resulted in the government importing rice to meet the increasing domestic demand.

Increasing the population also one of part of driving of land-use paddy changes because the suitability to develop the economic and social development such housing, industrial purposes abusiness. The rededication of land for the construction of private houses or commercial dwellings by developers is due to the willingness of farmers to change the cultivation area, which will have a direct impact on future rice production. Paddy production has been affected by the expansion of

non-agricultural land and the conversion of agricultural land (e.g., paddy fields) into non-agricultural land (e.g., housing, industrial, and other facilities). The growing population and shrinking agricultural land are the driving factors to decrease the agricultural production and land resources. In addition, a decline in the size of the paddy field suggests a strong link with national paddy production. The less of paddy areas can reduce the paddy production while the population growth is expected to increase from year to year. To meet the shortage of local rice supply, the government had to rely on imported rice to address the rice demands in the country.

THE GOVERNMENT POLICY

Paddy sector in Malaysia is essential crop under food subsector because the rice is staple among the population and the paddy crop also provides the primary sources income especially for small-scale farmers. Meanwhile, Malaysian adults consumed 2.5 plates of white rice per day (Mohammad Kassim et al.2018). This sector also contributed 7.3% (RM99.5 billion) to the GDP in 2018, with oil palm (37.9%) being the major contributor, followed by other plantations (25.1%), livestock (14.9%), fishing (12.5%), forestry and logging (6.9%), and rubber (2.8%) (Department of Statistics Malaysia, 2020). The use of agricultural land in Malaysia is influenced by the implementation of policies (i.e., First to Third Malaysia Plan and the New Economic Policy) that started from 1965 until 1980. These policies focus on agricultural development, which is vital for Malaysia's economic growth. However, the Malaysian government provides many subsidies, incentives, and programs to support rice sector and help the paddy farmers. According Widiyanti et al.(2018), initiatives from government include increasing food production through optimal use of paddy landuse, sustainable intensive farming and large-scale cultivation of a rice bowl.

Agricultural land is under the government's jurisdiction; therefore, the government decides the allocation and use of agricultural land. Additionally, focusing on agricultural development denotes that Malaysia depends strongly on agriculture as the main income source. However, due to globalisation, a reduction in agricultural land use (i.e., paddy fields) happens every year. The rise in the global automotive industry (e.g., automobile and transportation) increases the Malaysian natural rubber price and its market size. This phenomenon continued until synthetic rubber was discovered, which reduced the price of natural rubber and caused investors to flee. Consequently, rubber plantations ceased and were replaced with other more profitable plantations, such as oil palm plantations. This transition from rubber to oil palm is the alternative strategy that the government currently adopts to generate a high income for Malaysia. Thus, the land used for rubber plantation was converted to oil palm plantation because the global market offers a higher price to oil palm than rubber. For a similar reason, other less profitable crops, such as cocoa, coconut, rubber, and paddy plantation, have been converted to oil palm plantations.

In Yuhang, China, a total of 5558 Mou of agricultural land was converted to non-agricultural land between 1988 and 1998, after the government approved 60 manufacturing-development projects. Surprisingly, in 2017, Zurinah & Jalauddin, (2017) found that the government approved several projects related to the oil pipeline, petrochemical, and supporting industry in Yan district, Kedah. These projects took 3200 hectares of land that belonged to the MADA farmers, causing them to lose their paddy fields. The conversion of the land paddy use also has a significant relationship with the government policy for development purposes causing the farmers to hand over their paddy fields to the government. Although the government give compensates to the owners, but it has an impact on the country’s rice production. A similar case happened in Taiwan, where the government implemented a 14-year plan that replaced paddy fields

with forage crops that were more stable in price. The land conversion rate (i.e from paddy fields to forage crops) is determined by the demand for forage crops and wheat flour. Therefore, the increased demand for forage crops and wheat flour reduced the demand for paddy fields. As a result, domestic rice consumption decreased, while the consumption of meat and imported wheat flour increased.

SHIFTING OCCUPATION

The shift of occupation among the farmers is another driving factor of paddy land-use change. This change usually happens among private landowner farmers. Typically, paddy land is situated in the suburbs and is prone to land conversion when there is an increasing demand for non-agricultural land. This study was thus intended to understand how paddy land is transformed since the price rise would tempt farmers to sell their land. Increasing land conversion will decrease paddy plantation. Besides, Paudel et al. (2019) noted that the farmers perceived shifting occupations as a driving factor of agricultural land-use change, its also derived from socioeconomic drivers such as the lack of labors, population growth, socioeconomic development, urbanisation and government policy. In the coastal areas of the Mekong delta of Vietnam, farmers have decided to permanently switch from rice production to shrimp cultivation due to saline water intrusion (Kruse et al., 2020). Furthermore, the Ministry of Fisheries of Vietnam encourages shrimp cultivation to increase the farmers' income. The expansion of the shrimp industry has been driven mainly by the high demand for shrimp in the international market. The industry is also more profitable than the paddy industry. A recent study by Morshed et al. (2020) shows that the salinity levels are higher in paddy plots closer to shrimp ponds. As such, profits per hectare are relatively lower in paddy plots closer to shrimp ponds due to the higher salinity levels. The conversion of privately-owned and rented paddy fields to non-paddy (i.e., shrimp cultivation) deteriorates the paddy soil. Also, this conversion has caused social conflicts with the neighbouring active paddy farmers.

Nowadays, it is a great challenge to attract young farmers to rice cultivation. Meanwhile, youths' is decreasing year by year. The young adulty not interested to work in agriculture including in rice cultivation. According Girdziute et al. (2022), young people migrate from the countryside to the city to find a new job, since agricultural work is not prestigious and difficult for them. Moreover, in developing countries like Indonesia, young people from farming families do not want their children work in agriculture (Widiyanti et al.2018). Besides that, the parents also want their young generation of farming community get better education such as the industrial sector had provided the attractive employment. Eliminating poverty among the farmers compare with other sectors such as industry, services and manufacturing leading young people to choose other professions than agriculture.The shortage of young farmers will lead to reduced labor availability in rice farming. In Malaysia, rice cultivation on 674,928 ha of land areas with 300, 000 farmers. The Malaysian rice farmers are mainly older adults in their 50s and 60s and youth farmers is less than 40 years is involved in rice and rice cultivation (Dorairaj and Govender, 2023). Paddy farmers are associated with poverty. For example, in the 1970s, more than 60% of rice farmers in the Muda Agriculture Development Authority (MADA) and the Kemudu Agriculture Development Authority (KADA) were living below the poverty line. Fig 2 show total household montly income, household expenditures and income from paddy among Projek Barat Laut Selangor (PBLS), MADA and KADA with national level. Paddy farmers PBLS had the highest average monthly household income of RM2,165/month, more than income farmers KADA and MADA. However, the total income from rice cultivation (RM 1,401/month) was not enough to cover their monthly

living expenses of RM 2,003. On the other hand, rice farmers in MADA only received an average income of RM1,806/month, of which RM1,267/month was from rice cultivation. However, MADA found that the income from rice cultivation in MADA was not sufficient to meet the monthly expenses of the farmers. However, the income from other economic activities could cover the households' living expenses. The Malaysian government is committed to helping rice farmers to improve their quality of life and income. For example, the annual income of farmers in MADA has increased 15 from RM1,096 in 1966 to RM15,392 in 2007.

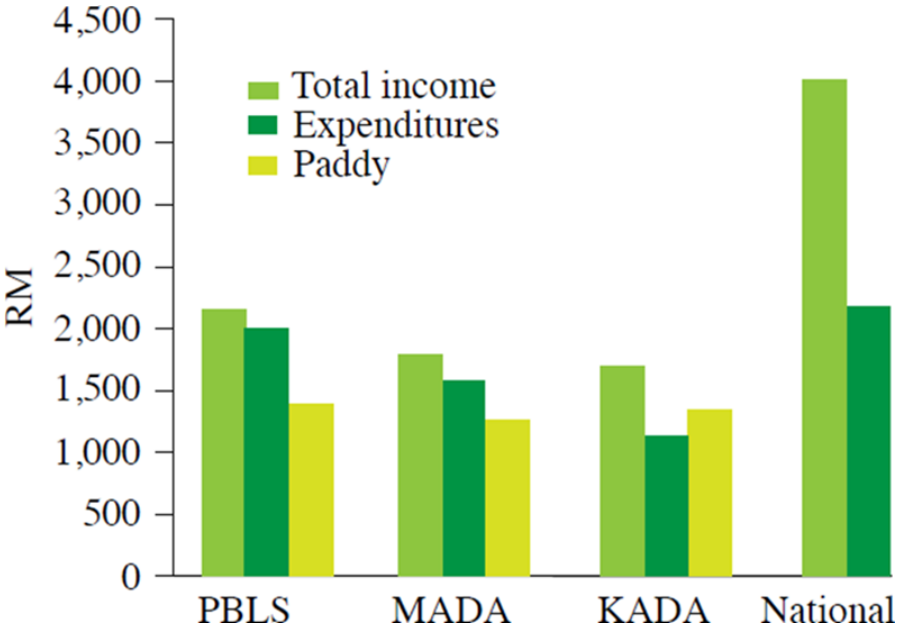

FIGURE 4. Total household montly income, household expenditures and income from paddy
Sources: Mohd Rashid and Mohd Dainuri (2013)

RESULTS AND DISCUSSION

This paper has attempted to critically and systematically analyse the existing literature on driving forces of paddy land-use shifts toward sustainable approaches in Malaysia. The reduction of agricultural land area especially in paddy field will give negative impact on rice production in future. After a thorough study of the Scopus databases, 31 articles were analyzed. This review identified five topics that had emerged and will help farmers, stakeholders and researchers seeking the driver of paddy land-use.

The country's rice sector is in critical condition and requires a new plan to become more dynamic and progressive. Malaysia will encounter rice shortages in the future if it keeps depending on imported rice. According to Adnan et al., (2020), sustainable agriculture mostly relies on the efforts and skills of farmers who make reasonable choices and take suitable action with the support of their information and practical knowledge. However, the scenario of land use conversion for paddy land use (potential areas for supply paddy production) had shown the gradual increase year by year and will threat the paddy supply among the population in the future. Evidence suggested by (Fikry et al., 2017), the most important factors for paddy land use changes is industrialization; can cause the decline in plantation area from 335,340 hectares in 1978 to 243,020 hectares in 1983

shows that industrialization has affected paddy land. Meanwhile, from 1992 and 2005, the total amount of agricultural land in Alor Setar, Kedah, decreased dramatically from 6,684.02 hectares to 2,356.83 hectares. By 2050, urbanization and industrialization will increase due to the world's population predicted to double and an increasing need for agricultural land for any type of development. The agricultural land always had competition for limited resources specially to converted paddy field to residential or industrial areas (Marzuki & Jais, 2020).

On the other hand, the factor of urbanization, rising sea levels, increasing the population, the government policy and shifting occupation give impact on paddy land use. Nurul Izzati (2023) exploring the prediction land-use changes in Kedah. Her study show that the paddy field land use decreased to 56,971.49 hectares, with a percentage of 6.34 percent. The percentage of decrease in area of paddy field land use from 2015 to 2035 was 6.26 percent (Mohd Ali, 2023). Meanwhile, paddy production is expected to drop by 990,783.16 metric tons in 2035 from 1,203,911 metric tons in 2020. The paddy reduction will increase the cost of rice import to ensure that the nation's supply of food security guarantees is always adequate in the future, the government must pay attention to the decrease in rice output and the amount of rice land use. According to Shahidan et al. (2022), Melaka's paddy production is expected to reach 24.6% by 2030, although 7,326 more hectares are needed to reach the target. Both the state of Melaka and the state of Kedah are affected by the paddy reduction issue. Paddy agricultural land utilization would be under pressure to shift to industrialization, settlement, and urbanization due to reasons including population and economic expansion (Siti Aisyah 2021).

The paddy land has a high yield per hectare despite its limited size. Paddy production depends on several factors, including soil fertility, suitable climate, climate-resistant seeds, sufficient land, competent labour, and access to technology. All these factors are essential to ensure that the rice supply is adequate yearly. Using soil fertility to ensure fertility on soil and it is important to healthy paddy growth. According Shahrina Md Nordin et al. (2014), paddy is sub-sector and develop under Agriculture NKEA under Economic Transformation Program (ETP) to give initiatives by government to promotion of new technology for increase the paddy production in the future. The Malaysian government has provided initiatives to develop unused paddy areas to increase food production for society. The government or stakeholder needs to identify any unused paddy fields and develop those areas into paddy fields with a good drainage system, high soil quality, and use of climate-resistant seeds. These newly developed rice fields should be gazetted to increase national food security for future sustainability. The Government of Japan also implemented this effort to tighten the enforcement of farmlands. To accomplish this aim, the Government of Japan purchased all agricultural lands from landlords and then rented them out to farmers at higher rates. A recent study by Shujiro Urata et al., (2023) shows that the Government of Japan has introduced a zoning scheme to protect the agricultural property, which divides the property into three principal categories: agricultural area, urban area, and the rest area.

Nowadays, technological development has increased paddy production. In the past, paddy was harvested manually. However, farmers nowadays use machinery inventions to help them with paddy harvesting which allowed large-scale cultivation and reduced manual labor costs. The development of technology and incentives is essential for farmers to increase rice productivity to meet the local demand for staple food and boost the economy of low-income farmers. For example, the use of remote sensing technologies to continuously monitor large paddy fields increases paddy production by providing the farmers with accurate information on field crop intensity and stunted paddy growth. The Malaysian government has allocated billions of Ringgits for technology in agriculture for past 50 years to increase rice production. In addition, other supports from the

government to the paddy farmers included Research and Development (R&D) in the paddy sector, credit facilities, subsidised retail prices, guaranteed minimum prices, extension support, fertiliser subsidies, and irrigation investment. The use of precision technologies in agriculture, such as Unmanned Aerial Vehicle (UAV), can be used by the government for monitoring purposes and to ensure that farmers comply with the laws by not making any changes to their paddy fields without the authority's permission. Additionally, such technology helps to increase rice production.

LIMITATION AND FUTURE DIRECTION

The current study has taken a global focus on driving forces of paddy land-use shifts with various geographical locations; it draws mainly on empirical studies conducted in the land-use of paddy. Paddy land conversion to non-agricultural or cash crop purposes creates serious risks to national food security in the future. However, it does not provide a generalizable fact that applies to all countries and cultures worldwide. This phenomenon also has a negative influence on paddy production in Malaysia. This study had several limitations, especially in terms of the method used. Firstly, we used only the Scopus as a database to search for relevant studies only. Second, selection of the relevant studies was limited only to research articles published in the English language. It also did not cover other types of literature such as conferences, proceedings, books, book series and notes. Third, the searching process and inclusion/exclusion criteria were designed based on the subject knowledge and excluded subject areas such as medical, engineering, nursing, chemistry, computer science, immunology and microbiology and chemical engineering. This study is only limited to publications that focus on the sustainability of paddy land-use shifts and environmental management based on food security. Thus, the search criteria used may not have captured all the relevant articles about paddy land-use shifts.

As recommendations, stakeholders and farmers had to protect paddy agriculture land such as gazetting the cropland area as agricultural area, and strictly on agricultural land policy to change the paddy to non-paddy. Policymakers and government must monitor paddy land-use changes by increasing the enforcement on the individual that do something to paddy land without permission. Meanwhile, the government also must implement a sharing session with farmers or developers before they have decided to change the paddy field to non-paddy or other crops. According to Rajamoorthy et al.(2015), the Malaysia Ministry of Agriculture (MOA) and agro-based industry implemented Dasar Agromakanan Negara (DAN) in 2011-2012 to ensure a sufficient supply of food. The DAN also aimed to transform the agro-based industry to become a more competitive, sustainable industry and increases the income of agricultural entrepreneurs and farmers. The Federal Agricultural Marketing Authority (FAMA) under the MOA and the agro-based industry is one of the leading agencies responsible for securing food in Malaysia.The FAMA also have effective marketing plans to help the farmers market the local rice and improve the moral values of farmers to maintain the paddy fields and earn a lucrative income. The young farmers should use this opportunity to join the agriculture industry, especially paddy plantations. Additionally, the farmers may sign a contract with FAMA to purchase crops at a reasonable price, even when the economy is unstable, and the price is fluctuating. By doing this, the farmers can minimise any potential risks associated with farming. Besides, a programme provided by FAMA has successfully reached its target of sustaining food production among local farmers and agro-entrepreneurs.

In addition, as the fourth industrial revolution (IR4.0) develops, implementing technologies such as internet network objects or "Internet of Things" (IoT) into the rice irrigation system is a strategic step to increase rice production. An efficient irrigation system can help rice farmers to increase rice production at an optimal level and reduce the problem of lack of water supply in rice fields. According to Lu'mu Taris (2022), the importance of using IoT in rice cultivation is that farmers can monitor the water demand in the rice field over a long distance whether it is sufficient or not. In addition, IoT applications can also provide information on temperature, soil quality (pH), rainfall, insect infestation and moisture in rice fields (Sethy et al., 2021). The use of technology in rice cultivation helps to increase rice production and reduce the operating costs of rice farmers. This is because rice farmers no longer have to go the paddy fields to ensure that the water supply in the paddy fields is adequate or not. According to Li-Wei Liu (2021), the use of IoT applications among rice farmers has been started to increase rice production. In this regard, the implementation of IoT in Malaysia among the rice farmers needs to be used extensively so that the problem of water scarcity can be solved as soon as possible.

The prediction of agricultural output and land-use changes plays an important role in environmental planning and land use management as it helps to evaluate agricultural output effectively (e.g., paddy production), conduct crops production system, and detect unauthorised development of paddy field. For this purpose, farmers can use the Geography Information System (GIS), a knowlegde-based information system that allows users to acquire information related to their paddy plot, seasonal production, and pest control. Thus, the use of technology (e.g., UAV, remote sensing and GIS) in monitoring paddy plantation is essential to ensure effective measures are taken to increase future rice production. However, the use of technology in agriculture also has resulted in numerous adverse environmental impacts, such as water and air pollution, biodiversity loss, and soil deterioration. For example, agrochemicals diminish soil microbial biodiversity by eliminating their nutrient recycling. In summary, the development of this technology should be taken seriously by the government to ensure the supply of sufficient water for rice crops in terms of sustainable rice cultivation.

Paddy production increases when farmers' needs and interests comply with their agricultural practice. For such reason, stakeholders such as the Department of Agriculture (DOA) should teach the farmers how to increase their paddy productivity via sustainability and market their products overseas. The knowledge can be imported by providing them with the necessary skills or training, such as the Good Agricultural Practises (MyGap) and Certificate of MyOrganic (MyOrganic) (Mohd Ali et al., 2021). Additionally, the stakeholders should encourage farmers not to convert their paddy fields to non-agricultural purposes. The farmers tend to change the function of paddy fields to non-paddy due to unfavourable paddy yields. Thus, the government needs to involve the farmers in MyGAP and MyOrganic certificates. This product has a high demand in the international market and among organic enthusiasts because of their increased awareness of food that is safe, free from poisons and supports agricultural activities towards sustainable goals. This high demand allows the farmers to develop a technique in paddy plantation activities to produce healthy and sustainable food, thus increasing their income.

Besides that, a non-profit agency in Malaysia, such as The Malaysian Agroecology Society (SRI Mas), increases rice productivity by using an agroecological technique. This technique helps farmers to produce safer and healthier foods while improving their quality of life. The collaboration between non-profit organisations (NGOs) seems to be one way of encouraging farmers to increase their incomes and strive to meet their needs for food by ensuring agricultural land availability. As discussed earlier, the reduction of paddy fields due to land-use conversion to

non-agricultural or non-paddy agricultural practices presents a significant danger to national food security in the future. There should be a committee responsible for maintaining the national food security rather than being neglected by the paddy industry.

Most paddy farmers are elderly and are still interested in agricultural work. A large number of abandoned fields due to a lack of young labourers to cultivate the paddy crops caused the land to begin being abandoned. In addition, the paddy productivity factor that began to decrease in terms of (yield and quality) also caused the old farmers to no longer be able to work intensively due to age factors. The policymaker and government must encourage young adults to join the farming industry. Working as a farmer can generate high income and increases paddy production for the young generation while achieving 100% SSL without depending on rice import. The government and private sectors should also create a new programme (e.g., mentoring youth in agriculture programme) to increase awareness and knowledge about future food supply. An increase in rice production will enhance the SSL of Malaysia, which will protect the nation from any disruptions of rice supply from rice exporting countries. In other words, to sustain and preserve the paddy industry, Malaysia needs to empower the young generation and make them innovative, especially in paddy activities.

CONCLUSION

Paddy land use issues pose a formidable challenge, especially for the farmers, developers, and stakeholders to sustain the sustainable paddy field. Therefore, the main purpose of this review was to conduct a systematic literature review on relevant studies to understand the driving factors of paddy land-use shifts and suggest future directions on paddy management. As highlighted by 31 articles, the paddy land use change is complex and driven by various factors. The land-use change will deteriorate food security in the future. It also disrupts the environment, economy, and farmers' society, who rely on paddy activities as their income source for a better quality of life. This study offers several recommendations to increase rice production and to sustain food security in Malaysia: (i) use of precision technologies in agriculture for monitoring purposes, (ii) development of unused paddy areas, (iii) increase the farmers' knowledge and skills, and (iv) strengthening and encouraging the involvement of young farmers in paddy farming. Future studies are warranted to help the stakeholders develop an effective solution to improve the nation's food security for future generations. Policymakers should focus on the competition of resources such as paddy fields where urban areas expand beyond its footprint forcing the conversion of productive agricultural land into residential, commercial, or industrial areas. Meanwhile, the farmers also need to increase awareness and knowledge to maintain the paddy fields as agricultural food production. Additionally, the sustainability of rice cultivation should be maintained to ensure that there is sufficient paddy production to meet demand and accomplish the Sustainable Development Goals (SDGs), especially the second goal, which is to zero hunger.

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