UNIVERSITI PUTRA MALAYSIA

FACTORS THAT INFLUENCE INTENTION TO ADOPT FRAGRANT RICE VARIETY AMONG RICE SUPPLY CHAIN PLAYERS IN MALAYSIA

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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January 2019

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Malaysia depends almost exclusively on imports of fragrant rice mainly Basmati type from Pakistan and India. The import of this specialty rice showed a growing trend every year with a value of RM500 million. A new rice variety namely MRQ74 or also known as Mas Wangi that has 80% similar attributes to Basmati type has been innovated by the Malaysian Agricultural Research and Development Institute (MARDI). In 2011, fragrant rice farming was introduced under a new Entry Point Project 9 (EPP 9) for non-granary areas with the introduction of MRQ74 variety to take advantage of the higher-end rice market. However, fragrant rice production requires a comprehensive workflow to guarantee the quality of fragrant rice during planting, harvesting, and milling. All those players involved in the fragrant rice production must work together to reduce uncertainty in the supply chain and ultimately to ensure success and sustainable fragrant rice industry in Malaysia. Therefore, the general objective of this study was to determine the factors that influence adoption intention of the new rice variety, MRQ74 among the players within the rice supply chain. The approach of this study was conducted through a quantitative method. The conceptual framework of the study was developed by integrating seven (7) constructs namely relative advantage, low complexity, compatibility, market demand, government support, attitude, and intention to explain the behavioral intentions among farmers, millers, and wholesalers.

The study involved four (4) different categories of rice supply chain players which represented by adopters (farmers) and non-adopters (farmers, millers, and wholesalers). The cross-sectional studies were conducted to gather data using four different sets of the questionnaire through various approaches. Face-to-face interviews were carried out to gather data from farmers, while for millers and wholesalers, data were collected through telephone, online, and postal surveys. The study involved 492 rice supply chain players, 70 adopters and 422 non-adopters that

were chosen based on cluster random sampling technique. Descriptive analysis and factor analysis were conducted to analyze the data. Finally, the research models were analyzed with partial least square estimation approach (PLS-SEM) using Smart-PLS 3.0 software to validate the measures developed and verify the potential relationship among constructs.

The predictors namely relative advantage, government support, and attitude were significantly influenced adopters' continuance intention in adopting fragrant rice farming with 67.0% of the variance in intention. The result has proved that relative advantage was the strongest determinant factor and had the largest effect size for the adopters' continuance intention in adopting fragrant rice farming. Moreover, the findings of the non-adopters (farmers) also found that government support, relative advantage, attitude, and market demand were significantly affected farmers' intention in converting to fragrant rice farming with 47.4% of the variance in intention. The two factors namely relative advantage and government support were the most critical predictors that could motivate and convince farmers to adopt fragrant rice farming. Whereas, results from millers and wholesalers were different because relative advantage did not have a significant effect on their adoption intention. The results suggested that millers and wholesalers were not interested in adopting MRQ74 variety even though the benefits of the innovation were greater compared to the existing rice varieties. Further, the constructs namely attitude, government support, and relative advantage weakly explained 31.5% of the variance in millers' intention and 28.9% of the variance in wholesalers' intention.

This study demonstrated that attitude was the primary determinant of rice supply chain players' behavior, particularly for the millers and wholesalers. Besides, the favorable attitude of the rice supply chain players towards fragrant rice farming was influenced by innovation attributes namely relative advantage, government support, and market demand. The mediating analysis revealed that adopters' attitude mediates the relationship between predictors (relative advantage, government support) and intention. Meanwhile, non-adopters (farmers) attitude mediates the relationship between predictors (market demand, government support) and intention. This study has provided further insights into the adoption intention research. Besides, this study explained the relationship between attitude and intention of adopting fragrant rice farming, as well as the relationship of other factors namely relative advantage, government support, and market demand. The results may be valuable for the policy-makers to strategize actions to enhance the participation of the rice supply chain players in fragrant rice farming such as providing substantial support and incentives in the fragrant rice industry as well as educate rice players with updated information regarding the MRQ74 variety. This is to ensure the sustainability and competitiveness of the fragrant rice industry in Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

FAKTOR-FAKTOR YANG MEMPENGARUHI NIAT UNTUK MENERIMAGUNA VARIETI BERAS WANGI DI KALANGAN PEMAIN-PEMAIN RANTAIAN BEKALAN BERAS DI MALAYSIA

Oleh

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Malaysia bergantung sepenuhnya kepada beras wangi khususnya Basmati yang diimport daripada Pakistan dan India. Data import beras istimewa ini menunjukkan pertumbuhan setiap tahun dengan nilai sebanyak RM500 juta. Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI) telah menghasilkan varieti padi baru dikenali sebagai MRQ74 atau Mas Wangi yang mempunyai 80% persamaan dengan Basmati. Pada tahun 2011, Kerajaan Malaysia telah memperkenalkan penanaman beras wangi di luar jelapang melalui Projek Permulaan (EPP 9) di bawah Bidang Ekonomi Utama Negara (NKEA) untuk pasaran beras premium. Walau bagaimanapun, pengeluaran beras wangi memerlukan aliran kerja bagi memastikan kualiti beras yang dihasilkan iaitu bermula daripada peringkat penanaman, penuaian dan pengilangan. Pemain rantaian bekalan beras yang terlibat dengan penanaman beras wangi perlu bekerjasama bagi mengurangkan ketidakpastian di sepanjang rantaian bekalan bagi memastikan kejayaan serta kemampanan industi beras wangi di Malaysia. Oleh itu, objektif umum bagi kajian ini adalah untuk mengenalpasti faktor yang mempengaruhi penerimagunaan varieti padi MRQ74 di kalangan pemain rantaian bekalan beras. Pendekatan kajian adalah dengan menggunakan kaedah kuantitatif. Sehubungan itu, kerangka kerja konseptual telah dibangunkan dengan mengintegrasi tujuh (7) konstruk iaitu kelebihan relatif, kerumitan rendah, keserasian, permintaan pasaran, sokongan kerajaan, sikap dan niat bagi menjelaskan tingkahlaku penerimagunaan di kalangan petani, pengilang dan pemborong.

Kajian melibatkan empat (4) kategori responden di kalangan pemain rantaian bekalan beras dan dikelaskan kepada penerima guna (petani) dan bukan penerima guna (petani, pengilang dan pemborong). Kajian keratan rentas telah dilaksanakan bagi pengumpulan data menggunakan empat (4) set soal selidik dengan pelbagai pendekatan. Pengumpulan data ke atas petani telah dibuat secara temubual

bersemuka, manakala data daripada pengilang dan pemborong diperolehi melalui penggunaan telefon, kajian atas talian dan secara pos. Kajian ini melibatkan 492 orang responden di mana 70 orang adalah merupakan penerima guna dan 422 orang adalah bukan penerima guna yang dipilih melalui teknik persampelan rawak kelompok. Analisis deskriptif dan analisis faktor telah dibuat bagi menganalisis data tersebut. Seterusnya, model kajian ini telah dianalisis dengan PLS-SEM menggunakan perisian Smart-PLS 3.0 untuk mengesahkan pengukur yang dibangunkan dan hubungan di antara konstruk.

Faktor seperti kelebihan relatif, sokongan kerajaan dan sikap menunjukkan terdapat hubungan yang positif dengan niat penerimagunaan petani (penerima guna) dalam penanaman beras wangi iaitu dengan varians dalam penerimagunaan sebanyak 67.0%. Keputusan ini membuktikan bahawa kelebihan relatif merupakan faktor penentu terkuat dan mempunyai saiz kesan terbesar kepada niat penerimagunaan penanaman beras wangi di kalangan penerima guna. Selain daripada itu, keputusan yang diperolehi daripada petani (bukan penerima guna) juga menunjukkan bahawa sokongan kerajaan, kelebihan relatif, sikap dan permintaan pasaran mempengaruhi niat penerimagunaan petani untuk bertukar kepada penanaman beras wangi iaitu dengan varians sebanyak 47.4%. Didapati kelebihan relatif dan sokongan kerajaan merupakan faktor penting yang dapat menyakinkan petani untuk menerima penanaman beras wangi. Manakala, keputusan bagi pengilang dan pemborong adalah berbeza kerana kelebihan relatif tidak mempengaruhi niat penerimagunaan mereka terhadap varieti MRQ74. Ini menunjukkan pengilang dan pemborong tidak berminat untuk menerimaguna varieti MRQ74 walaupun ianya mempunyai kelebihan berbanding varieti padi sediada di pasaran. Seterusnya, konstruk seperti sikap, sokongan kerajaan dan kelebihan relatif menerangkan hubungan yang lemah iaitu 31.5% daripada varians dalam niat penerimagunaan pengilang dan 28.9% daripada varians dalam niat penerimagunaan pemborong.

Kajian ini juga mendapati sikap adalah merupakan penentu utama dalam tingkahlaku pemain rantaian bekalan beras terutamanya pengilang dan pemborong. Di samping itu, sikap suka terhadap penanaman beras wangi dipengaruhi oleh kelebihan relatif, sokongan kerajaan dan permintaan pasaran. Analisis pengantara mendedahkan bahawa sikap penerima guna merupakan pengantara di antara hubungan peramal (kelebihan relatif, sokongan kerajaan) dengan niat penerimagunaan. Manakala, sikap bukan penerima guna (petani) merupakan pengantara di antara hubungan peramal (permintaan pasaran, sokongan kerajaan) dengan niat penerimagunaan. Keputusan kajian ini adalah sangat penting dalam membantu para pembuat dasar merangka tindakan bersesuaian untuk meningkatkan penyertaan pemain rantaian bekalan beras dalam industri penanaman beras wangi. Tindakan yang dapat dilaksanakan oleh pihak kerajaan adalah seperti sokongan berterusan dan penyediaan insentif bagi industri beras wangi serta mendidik pemain industri beras dengan maklumat varieti padi MRQ74 yang terkini. Ini adalah bagi memastikan kelestarian dan daya saing industri beras wangi di Malaysia.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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AMOS	Analysis of Moments Structures
ASEAN	Association of Southeast Asian Nations
BERNAS	PadiBeras Nasional Berhad
CPI	Consumer Price Index
DOA	Department of Agriculture Malaysia
DOSM	Department of Statistics Malaysia
DOI	Diffusion of Innovation
EPP	Entry Point Project
EPU	Economic Planning Unit
ETP	Economic Transformation Program
FAMA	Federal Agriculture Marketing Authority
FAO	Food and Agriculture Organisation
GABA	Gamma-aminobutyric Acid
GI	Glycemic Index
GM	Genetically Modified
GMP	Guaranteed Minimum Price
GNI	Gross National Income
IADA	Integrated Agricultural Development Area
KADA	Kemubu Agricultural Development Authority
KETARA	North Terengganu Integrated Agricultural Development
MADA	Muda Agricultural Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MEP	Minimum Export Price
MOA	Ministry of Agriculture and Agro-Based Industry

MP	Malaysia Plan
NAFP	National Agro-Food Policy
NAP	National Agriculture Policy
NAP1	First National Agriculture Policy
NAP2	Second National Agriculture Policy
NAP3	Third National Agriculture Policy
NFA	National Food Authority of the Philippines
NFSP	National Food Security Policy
NKEA	National Key Economic Areas
NPRB	National Paddy and Rice Board
PLS-SEM	Partial Least Square-Structural Equation Modeling
PPP	Public-Private Partnership
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
R&D	Research and Development
SCM	Supply Chain Management
SSL	Self-sufficiency Level
TAM	Technology Acceptance Model
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
URAA	Uruguay Round Agreement on Agriculture
USDA	United States Department of Agriculture

CHAPTER 1

INTRODUCTION

This chapter provides an overview of the paddy and rice industry in Malaysia perspective. It begins by describing the development of policies in the Malaysian paddy and rice industry, namely supply chain, cultivation and production, self-sufficiency levels, consumption, and rice importation. The fragrant rice industry in Malaysia and problem statement are presented followed by research questions and objectives and lastly the significance and scope of the study.

1.1 Malaysian Paddy and Rice Industry

In Malaysia, rice remains the staple food although there are other food types such as noodles, bread, meat, and other cereal products introduced. Importantly, rice is seen as a strategic commodity that plays a pivotal role in ensuring food security in the country. Rice cultivation in Malaysia is closely associated with the rural population, Malay races, traditional farming, ageing farmers, and is always associated with poverty. The paddy and rice sub-sector in Malaysia is highly regulated, subsidised, and has gained special treatment and attention from the government since the 1970s compared to other food sub-sectors, given the social, political, and economic importance. The relevant programs and policies unequivocally emphasised paddy production, the need to increase farmers' income and self-sufficiency levels, reasonable rice prices, stocks and imports. Notably, Malaysia is listed as one of the top 30 rice producing countries globally with an annual paddy production of 2.25 million tons in 2016, contributing 0.2% to the total global production of rice (FAO, 2018). Notwithstanding, the commodity is the third largest crop in the country, and in 2016, the entire paddy cultivated area accounted for 688,770 hectares including the regions of Sabah and Sarawak (DOA, 2017). In Malaysia, rice is grown in two primary regions; granary and non-granary areas. Granary areas refer to those areas comprising of major irrigation schemes with areas greater than 4,000 hectares. Furthermore, granary areas are recognised as the main producing areas or permanent paddy production areas with the appropriate infrastructure including irrigation and drainage facilities. While, non-granary areas or so-called non-irrigated areas, rely heavily on rainfall for irrigation purposes. Thus, the granary areas have much higher potential for productivity improvements compared to non-granary areas.

Currently, there are ten (10) granary areas located in several states in Malaysia, namely; Muda Agricultural Development Authority (MADA), Kemubu Agricultural Development Authority (KADA), Kerian Integrated Agricultural Development Area (IADA Kerian), Barat Laut Selangor Integrated Agricultural Development Area (IADA Barat Laut), Seberang Perak Integrated Agricultural Development Area (IADA Seberang Perak), Penang Integrated Agricultural Development Area (IADA Penang), North Terengganu Integrated Agricultural Development (KETARA), Kemasin Semerak Integrated Agricultural Development Area (IADA Kemasin

Semerak), Pekan Integrated Agricultural Development Area (IADA Pekan), and the Rompin Integrated Agricultural Development Area (IADA Rompin). Approximately, 72% of the paddy production comes from granary areas, and the non-granary areas contribute the remaining balance. The yield in granary areas is significantly high compared to non-granary areas due to the availability of proper drainage and irrigation infrastructure. Indeed, this affects the level of productivity, as well as providing the capability to double the cropping of rice cultivation. Unfortunately, farmers in non-granary areas are only able to cultivate paddy fields once a year due to the lack of irrigating infrastructure.

The rice sub-sector receives enormous investment in infrastructure development, including irrigation and input subsidy (fertiliser and pesticide) from the government. The government also supports the industry through extension services, guaranteed minimum pricing, price support, production incentives, as well as research and development (R&D). For example, the Department of Agriculture Malaysia (DOA) provides extension services to farmers, while the Malaysian Agricultural Research Development Institute (MARDI) has responsibility for developing new paddy varieties that are tolerant to pest and other diseases as well as provide higher yield and quality. Support by the government is crucial to ensure paddy farmers can achieve better yields and higher income, particularly for lower-income groups. Indeed, it was reported that the cost of rice production in Malaysia is the second highest in Southeast Asia following Indonesia (Harun, Suhaimee, Zaffrie, Amin, & Sulaiman, 2015). Therefore, most farmers are highly dependent on price incentives (guaranteed minimum price and production incentives) and input subsidy, as well as the intervention of government in rice marketing through Padiberas Nasional Berhad (BERNAS). BERNAS is a government-linked organisation which manages the country's rice market, including buying paddy from farmers. The food crisis that occurred in 2008 led the government to allocate subsidies of around RM928 million for the rice industry to ensure national food security given this is an issue of national policy. The government decision was to ensure paddy farmers obtained a higher price, to achieve some degree of self-sufficiency, and to provide stable rice supply and high-quality rice to consumers.

According to Norsida and Sami (2009), government support was important for the paddy and rice industry to ensure that farmer's income remains above the poverty line. The main factors leading towards poverty which plagues the local rice farming community are mainly due to the lack of productive assets and the reliance on small-scale agriculture projects. The majority of small-scale farmers involved in paddy cultivation have an average land acreage of two hectares. Moreover, the labour in this subsector is predominantly made up of aged farmers, with an average age of 60 years and most are poorly educated. Approximately 300,000 paddy farmers depend on rice cultivation as their primary source of income (Man, 2009). Nonetheless, it is apparent that a low yield of paddy production results in low income for farmers, with the average earnings of RM1,400 per month, which includes price support of RM248 per metric ton provided by the government (Kamaruddin, Ali, & Saad, 2013).

1.1.1 Policy in Paddy and the Rice Industry

In 1933, with the establishment of the Rice Commission, a paddy and rice industry policy was introduced which was before the independence era. However, due to the limited infrastructure in place, most of the investment from private or public sectors was directed towards other viable commodities such as rubber and tin. Also, during this period, there was a lack of government support regarding research and development (R&D). Therefore, the country was heavily reliant on rice imports to fulfil domestic demand due to stagnated domestic rice production. In 1965, following independence, an agency called the Federal Agriculture Marketing Authority (FAMA) was established with responsibility for marketing rice and other foods. However, in 1971 the government decided to establish the National Paddy and Rice Board (NPRB), to take over the role of rice marketing from FAMA. In 1994, the NPRB was corporatised and renamed as PadiBeras Nasional Berhad (BERNAS) with the aim to enhance the efficiency in rice processing and marketing in Malaysia. In 1996, BERNAS was privatised to reduce government involvement in commercial activities. Besides paddy procurement and processing, BERNAS is also responsible for the importation and distribution of rice, and to maintain and manage rice stockpiles, distribute paddy price subsidies to farmers on behalf of the government, and as a buyer as a last resort. The government through the Ministry of Agriculture and Agro-Based Industry (MOA) is accountable to regulate the production of rice, license, and price.

In 1961, commencing as part of the First Malaysia Plan the government introduced several policies for the development of the paddy and rice industry in Malaysia. In 1984, a formal policy on agriculture was launched known as the First National Agricultural Policy (NAP1, 1984-1991). The primary purpose of the policy was to increase the income of farmers through the efficient utilisation of resources and productivity increases. The rice self-sufficiency level (SSL) was targeted at 80-85% during NAP1. The NAP1 was reviewed before the Second National Agricultural Policy (NAP2, 1992-2010) was formulated and introduced. NAP2 emphasised on productivity, efficiency and competitiveness of the sustainable agriculture sector and linkages with the other economic sectors, mainly the manufacturing sector. The rice SSL target was revised and set at 65% during NAP2. In 1998, the Third National Agricultural Policy (NAP3) was formulated and implemented. NAP3 plays a strategic role towards ensuring national food security through several approaches such as; to increase productivity, competitiveness, linkages with another economic sector, and ventures in new areas. The government's financial burdens and decreasing export returns prompted the government to re-evaluate its self-sufficiency policy. Therefore, the construction of the irrigation scheme or so-called granaries was introduced to increase paddy production and the SSL of rice.

The National Food Security Policy (NFSP, 2008-2010) was seen as a precautionary action undertaken by the Malaysian government to address the food crisis that occurred in 2007-2008. Accordingly, the effect of the food crisis at that time, raised many fears for the government as the country relied on about 30% of rice imports at the time to fulfil demand shortages in the domestic market. As a result, the

government channelled RM3 billion towards implementing various programs in the agro-food sector to overcome the crisis. Notably, food security is an important agenda item to ensure the availability of food supply, accessibility of adequate food in the domestic market, and stability of food for Malaysian people. Various paddy and rice programs were formulated having both short and long-term perspectives for higher self-sufficiency levels as listed in Table 1.1.

Table 1.1 : Paddy and Rice Programs in the National Food Security Policy (NFSP), 2008-2010

Program	Description
Irrigation Infrastructure and Drainage Development	Increase irrigation infrastructure and drainage density to the optimum level of 50m/ha as well as develop new water sources.
Irrigation Infrastructure and Drainage Maintenance	Maintenance of irrigation and drainage in the granary and non-granary areas.
Pest and Disease Control Subsidy	Controlling pest and disease infection with RM200/ha/season.
NPK Fertiliser Subsidy	Three bags or 50 kg per bag with the value of RM400/ha.
Land Levelling	The rate of land levelling is as much as RM1,500/ha.
Lime Subsidy	The function is to improve soil fertility with RM850/ha.
Farm Mechanisation	Increase mechanisation in paddy cultivation.
Incentive and Subsidy	Incentives and subsidy for price and rice productivity.
Miller Subsidy	Encourage domestic millers to produce ST15 (Peninsular) and SS15 (Sabah and Sarawak).
Beras Nasional	Subsidized 15% broken rice and retailed at RM1.80/kg.
Research and Development (R&D)	Promote new methods of paddy cultivation to increase paddy productivity.
Rice Stockpile	Increase the level of rice stockpile from 92,000 tons to 239,000 tons.

(Source: Tey 2010)

The government undertook several actions to overcome the situation through releasing rice stock and increasing rice stockpiles to 45 days from 92,000 tons to 239,000 tons and enforced price control at the retail level. Importantly, the policy aims to increase rice production and to achieve the SSL target. The government also established the Miller Subsidy Program (RM800/ton), particularly for milling 15% of broken rice, packaged as Beras Nasional (retail price RM1.60-RM1.80/kg). This type of rice is mainly targeted at poor or low-income people in order to guarantee that the rice is affordable for people to buy. Furthermore, strategies to strengthen the paddy and rice industry in the granary and non-granary areas continues in the National Agro-Food Policy (NAFP, 2011-2020). The NAFP emphasises on paddy productivity, quality of rice, efficiency mechanisation and automation, strengthening the management of rice stockpiles, restructures the incentives and subsidy for rice, and institutional reinforcement for effective paddy and rice management. Table 1.2 lists the various production incentive schemes introduced by the government for

paddy farmers such as input subsidies, the guaranteed minimum price at RM1,200/ton, and paddy production incentives.

Table 1.2 : Production Incentives/Subsidies Schemes in the National Agro-Food Policy (NAFP), 2011-2020

Incentive/Subsidies	Description
Guaranteed Minimum Price (GMP)	The rate of GMP has increased from RM650/ton to RM1,200/ton in 2014 due to the rise in input prices and labour costs.
Price Subsidy	Increase the market price of paddy with the rate of RM248.10/ton. This subsidy is to increase farmers' income.
Input Subsidies (Fertiliser and Pesticide)	Fertiliser at 100kg/ha or 240kg/ha of compound fertiliser and 40kg/ha or 80kg/ha of urea fertiliser.
	Controlling pest and disease infection with valued at RM200/ha.
Paddy Production Incentive	Ploughing incentive of RM100/ha and inputs incentive (pesticide and fertiliser) to as much as RM140/ha.
Yield Increase Incentive	Farmers who achieve increased yield by more than 1% compared to the last season are eligible for RM750 ton/ha.

(Source: MOA 2011)

In 2011, Malaysia introduced the Economic Transformation Program (ETP) under the 10th Malaysian plan namely; Agriculture National Key Economic Areas (NKEA) that focus on selected sub-sectors having high-growth potential. There are three primary initiatives in the ETP specifically for the paddy and rice industry, namely; the Entry Point Project 9 (EPP 9) cultivation of fragrant rice varieties in non-irrigated areas (MRQ74 and MRQ76 rice variety), EPP 10 (strengthening productivity of paddy farming in MADA), and EPP 11 (increasing productivity of paddy farming in other granaries). The programs focus on transforming traditional small-scale paddy farmers towards uplifting their income and to increase self-sufficiency in rice and food security. The goals of EPP 10 and EPP 11 are to increase paddy productivity in identified granary areas, thereby increasing rice self-sufficiency to 85%. Meanwhile, the objective of EPP 9 is to produce 73,000 tons of fragrant rice in 2020 and therefore to reduce the dependency on imported fragrant rice to around 160,000 tons annually through the development of 18,200 hectares of abandoned land (ETP, 2011). As stated in the NAFP, the changes in consumer preferences towards fragrant rice as a result of higher incomes and lifestyle create opportunities for farmers to produce local fragrant rice (MOA, 2011).

1.1.2 Malaysian Rice Supply Chain

Supply chain management (SCM) is crucial for the paddy and rice industry due to the involvement of many players within the supply chain such as farmers, millers, wholesalers, retailers, and consumers. The paddy and rice supply chain involves numerous activities such as cultivating, harvesting, processing, distributing, and retailing and all need to be implemented and integrated efficiently to fulfil consumer demands. Thus, SCM is essential to improve the long-term performance of the individual entities and the entire supply chain (Mentzer, DeWitt, Keebler, Min, Nix, Smith & Zacharia, 2001). Also, SCM will assist in the integration of end-to-end business processes from the customer right through to the industry players in the supply chain and help to reduce the imbalance of information at every level along the supply chain. Figure 1.1 depicts the Malaysia rice supply chain specifically for domestic rice production that involves several players, namely; farmers, millers, wholesalers, retailers, and consumers.

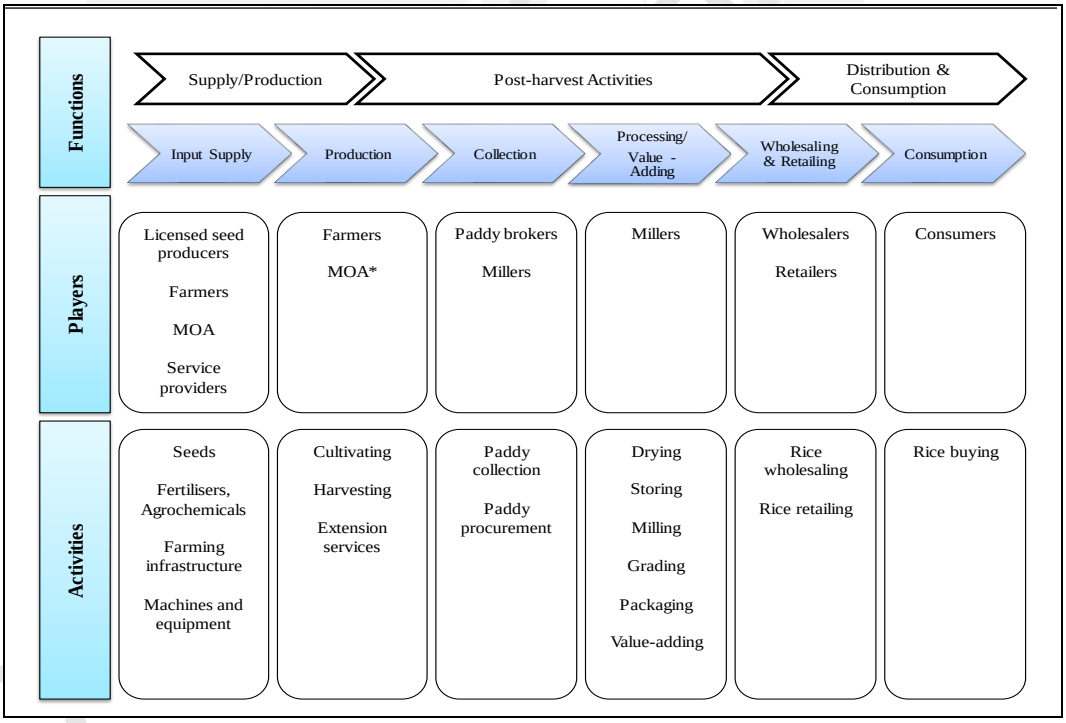

Figure 1.1 : Rice Supply Chain in Malaysia
(Source: Wong, Emrus, Bashir & Tey 2010)
Note: *Department and Agencies under MOA (DOA, MARDI, MADA, KADA, IADA, LPP)

Indeed, there are several activities in the supply chain including; production, post-harvest activities, value-adding, distribution, and consumption. Apart from rice production, there are also other businesses and activities that coexist along the supply chain, such as service providers for logistics and machinery, supplying inputs (fertilisers and pesticides), and value-added activities into vermicelli, flour, and rice bran. The supply chain begins with rice breeding research conducted by MARDI as

the producer of breeder and foundation seeds. Rice varieties such as MR219, MR220, MR220CL, and MR263 are supplied to the appointed licensed seed producers that are obligated to provide certified rice seeds to 194,931 paddy farmers at granary or non-granary areas across the country, including Sabah and Sarawak (DOA, 2017). Currently, there are nine private seed producers appointed by the MOA with responsibility for producing quality certified paddy seeds. Moreover, producing as much as 80,000 tons per year using the foundation seeds produced by MARDI. The Department of Agriculture Malaysia (DOA) plays an active role as the certifying agency to ensure the quality of the paddy seeds via field inspections, auditing the facilities and conducting sampling for seed testing. The certificate of quality paddy seed is valid only for seed that complies with the requirements and standards-based on the specification contained in the document of the Department of Agriculture Malaysia Standard: Specification for Rice Seed (*Oryza sativa*) and MS 469: 2012: Specification for Rice (*Oryza sativa*) Seeds for Planting.

Paddy farmers will cultivate the paddy and sell the harvested paddy directly to millers or through paddy brokers. There are about 665 licensed agents that function as intermediaries or middlemen between farmers and millers. To preserve the quality of rice, millers will take the immediate action to dry the harvested paddy quickly within 48-72 hours to prevent any degradation in rice quality. This step is to ensure the optimum moisture content at 14% is achieved before being stored or proceeding with rice milling. Accordingly, there are several steps in rice milling, namely husk and bran layers removal, as well as rice whitening before marketing to the consumer. In 2015, there were around 231 millers registered across Malaysia (174 in Peninsular Malaysia and 57 mills in East Malaysia). BERNAS owned and operated 31 rice mills mainly located in major granary areas. Annually, the group managed to mill about 400,000 tons of paddy with a total rice output of around 270,000 tons (BERNAS, 2017). The milled rice is then sold to licensing rice wholesalers having a responsibility to sell local and imported rice to retailers or directly to consumers. Meanwhile, the broken rice will be sold to manufacturers for use in value-added activities such as producing vermicelli and flour processing. Indeed, some millers use the rice husk to generate thermal energy for their drying facilities. BERNAS as a partner in the paddy and rice industry in Malaysia is not only involved in the procurement and processing of paddy but also functions as a rice importer, distributor, and in marketing. Moreover, BERNAS is also responsible for maintaining rice stockpile and acting as a buyer of last resort of paddy at the guaranteed minimum price as mentioned earlier.

The previous reports on the paddy and rice industry in Malaysia have highlighted that the production system (farmers) are not well integrated with post-harvest subsystems consisting of millers, wholesalers, retailers, and consumers (EPU, 2009; Marditech, 2004). Furthermore, it can be seen, if not obvious, that the government has been more focused on paddy farming compared to other subsystems because the performance of rice production is not on par with post-harvest subsystems. For instance, at the retail level, Malaysia has the most advanced and innovative rice packaging and product presentation in ASEAN, although production remains low. Accordingly, the country needs to rely on rice imports to ensure the sufficient supply

of rice to meet domestic consumption demands. In 2016, Malaysia allocated about RM1.57 billion for rice imports compared to RM1.58 billion in 2013 (DOA, 2017). Also, the yield and production of rice in Malaysia specifically in granary areas, has substantially improved due to government initiatives. However, the production in non-granary areas remains low. According to Ruttan (2000) and Harun et al. (2015), the adoption of agriculture innovation has been acknowledged as a critical component towards increasing crop productivity and economic growth. Therefore, the introduction of new technologies at non-granary areas could help to increase rice yield and ultimately, farmers' income.

1.1.3 Cultivated Area and Production

As identified by the Ministry of Agriculture and Agro-Based Industry (MOA) most farmers involved in paddy cultivation are small landholders with an average farm size of around 1.99 hectares (MOA, 2010). In 2016, a total of 194,931 farmers were engaged in paddy farming across Malaysia (include Sabah and Sarawak) with a total of 688,770 hectares of cultivated area (DOA, 2017). About 75.9% of the paddy cultivation was in the Peninsular Malaysia (522,826 hectares), while Sarawak accounted for around 18.0% (124,211 hectares) and Sabah accounted for 6.1% (41,733 hectares). The popular paddy varieties cultivated by farmers were MR219, MR220CL2, and MR263 which are normal/regular white rice. Notably, the rice varieties have different features regarding their physical characteristics, maturation period, yield, and resistance to specific pests and diseases. As an example, since 2001, MR219 has been the common rice variety cultivated by farmers in Malaysia because the variety has a high yield of about 10.7 tons per hectare (Raudah, Talib & Kadir, 2014; Suswanto, Shamshuddin, Syed Omar & Mat, 2007). Nazuri and Man (2016) discovered that rice attributes such as high-yielding variety and resistance to pests and diseases influenced the farmers' selection of a new rice variety.

In 2016, the total paddy production recorded was 2,739,606 tons (DOA, 2017). Most of the paddy production originated from ten (10) granary areas that contributed a total of 75% of paddy cultivation (2,060,318 tons) while the remaining production (25%) originated from non-granary areas with total paddy production of 679,288 tons (Table 1.3). According to the MOA (2010), paddy farmers with an average land holding size of two (2) hectares received an average of RM1,550 per month in granary areas as compared to RM835 per month in non-granary areas. The main factors contributing to the income difference were mainly due to planting intensity and the availability of infrastructure (drainage and irrigation) in granary areas.

Table 1.3 : Paddy Cultivated Area and Production

State	Granary Area	Year 2016	
		Planted Area (Ha)	Production ('000 mt)
Selangor	IADA Barat Laut Selangor	38,114	222.0
Kedah	MADA	201,239	1,063.2
Penang	IADA Penang	25,564	148.3
Perak	IADA Kerian	41,788	165.0
	IADA Seberang Perak	27,723	103.4
Kelantan	KADA	53,836	248.2
	IADA Kemasin Semerak	7,281	27.5
Terengganu	KETARA	9,752	54.8
Pahang	IADA Pekan	6,541	13.4
	IADA Rompin	5,169	14.4
Malaysia	Granary Areas	417,007	2,060.3
Malaysia	Non-Granary Areas	271,763	679.3
Malaysia (TOTAL)		**688,770**	**2,739.6**

(Source: DOA 2017)

In the year 2000, the average annual yield for paddy consistently increased from 3.2 tons/hectare to 3.9 tons/hectare in 2016. However, there was a substantial difference in yields between the granary and non-granary areas as the average yield of paddy in the granary areas was 4.9 tons/hectare compared to 2.8 tons/hectare for the non-granary areas, respectively. Furthermore, in the year 2000, the approximate average yield of paddy in granary areas increased by 32.4% from 3.7 tons/hectare to 4.9 tons/hectare in 2016. Conversely, non-granary areas were only able to produce 2.8 tons/hectare in 2016 compared to 2.7 ton/hectare in 2000, an approximate 3.7% increase (Figure 1.2).

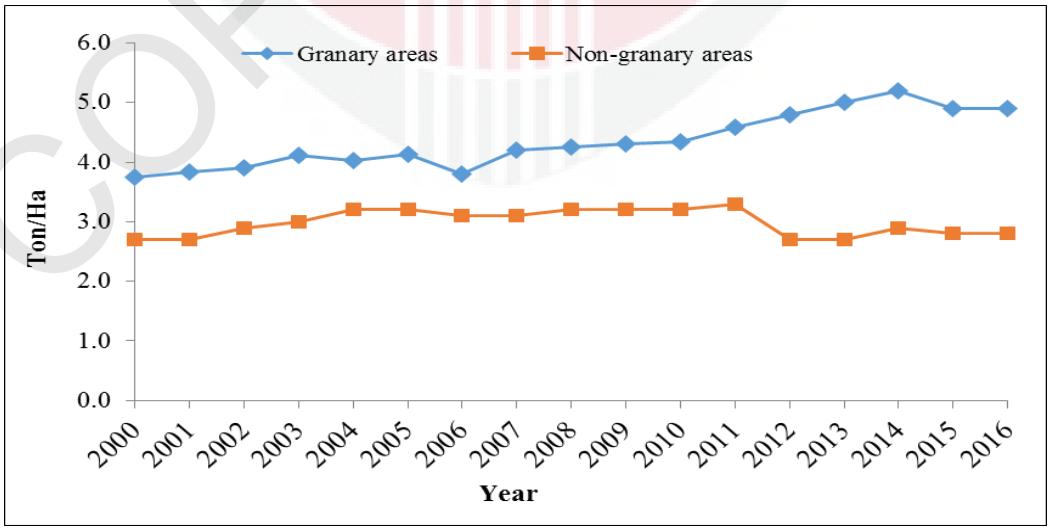

Figure 1.2 : Average Yield for Granary and Non-Granary Areas
(Source: DOA 2017)

Indeed, one of the driving factors that helped boost paddy production and yield in the granary areas was the entire irrigation system that was in place. Notwithstanding, the trend concerning the average yield in granary areas showed that IADA Barat Laut Selangor achieved the highest level of productivity with 5.83 tons/hectare in 2016, followed by IADA Penang (5.80 tons/hectare) and KETARA (5.62 tons/hectare). Meanwhile, three states in non-granary areas namely Negeri Sembilan, Johor, and Perlis obtained the highest average of paddy yield with 4.4 tons/hectare, 4.2 tons/hectare, and 3.9 tons/hectare respectively. Overall, paddy production increased from 2.141 million tons in 2000 to 2.739 million tons in 2016, an increase of 28% (Figure 1.3). However, there was only a marginal increase (12.2%) in paddy cultivated areas from 614,082 hectares in 2000 to 688,770 hectares in 2016 due to the expansion of the existing regions of Sabah and Sarawak. Despite, the paddy regions cultivated in non-the granary areas specifically in Peninsular Malaysia, these areas have decreased by 17% from 127,864 hectares in 2000 to 105,819 hectares in 2016. Notably, the paddy areas are estimated to further decline by 1.4% in 2020.

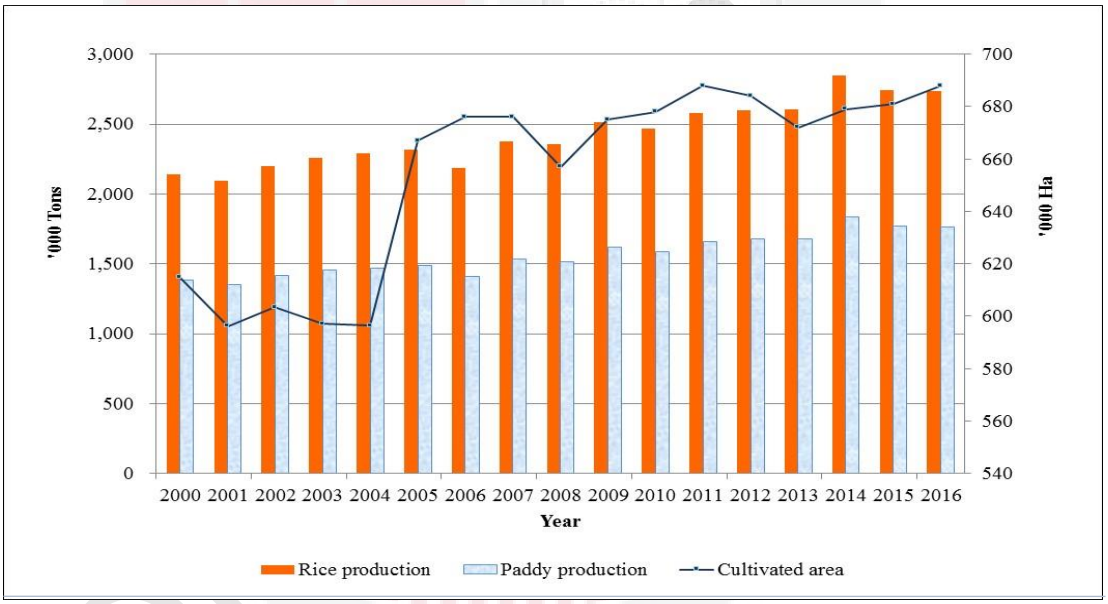

Figure 1.3 : Cultivated Area, Paddy and Rice Production
(Source: DOA 2017; MOA 2015)

Furthermore, the paddy land in Peninsular Malaysia decreased by 0.43% between 1984 and 1995 because of land competition from more profitable crops like oil palm. Also, paddy farmers are more attracted towards cultivating vegetables and fruits having much higher value compared to paddy (Khor et al., 1998). Fatimah et al. (2011) supported this fact, indicating that farmers were converting land areas into other forms of agricultural and non-agricultural activities due to the low income earned from paddy farming. Notwithstanding, the conversion of paddy areas to other agricultural activities is further due to competition to acquire land for industrialisation and urbanisation purposes (Bala, Alias, Arshad, Noh, & Hadi, 2014; Siwar, Idris, Yasar, & Morshed, 2014). Therefore, the government formulated several strategies to ensure rice security in the country such as introducing a

guaranteed minimum price (GMP), a paddy price subsidy and an input subsidy. For instance, the GMP in 2008, increased from RM750/ton to RM1,200/ton in 2014 to protect the income of paddy farmers due to rising inputs and associated labour costs. Moreover, the government intervening in rice production as mentioned, was to ensure that the farmers were protected from global price volatility and ultimately to safeguard and secure the sustainability of the rice industry in Malaysia (Amin et al., 2010). The implementation of the price support scheme by the government increased output by 65.8%, contributing to a 38.6% increase in the income of paddy farmers (Dano & Samonte, 2005). A study by Ahmed and Tawang (1999) also found that 50% of the farmers' income was attributed to allocated subsidies that directly affected farm profitability to aid small landholder paddy farmers.

1.1.4 Self-Sufficiency Level (SSL)

The commitment from all players in the food supply chain is crucial in order to guarantee food security in Malaysia. In the context of rice, the stability of a SSL is foremost as only 7% of global rice production is traded. Thus, SSL is one approach used by the government to measure the stability of food security in the country because the demand in the domestic market is expanding due to the population growth. According to the MOA (2011), the growth rate of rice consumption between 2010 and 2010, is projected to rise by 1.6% from 2.30 million tons to 2.69 million tons due to the increasing population, which will affect the SSL of rice in the country. During the 1960s and 1970s, the government committed to focus on increasing rice production by 100% through strategic initiatives such as the implementation of double cropping, investment in irrigation and drainage facilities, provision of subsidies, market intervention, extension services as well as research and development.

The rice SSL was forecasted at 65% in the National Agricultural Plan 2 (1992-2010) and the National Agricultural Plan 3 (1998-2010) because of the positive, global rice trade. The SSL of rice in the Ninth Malaysia Plan (2006-2010) was set at a target of 90% due to the presence of high yielding rice varieties, efficient technology, and through the implementation of improved farm management. Regarding the targeted SSL, Malaysia needs to increase paddy production and productivity to fulfil the demand from the growing population. Indeed, the strategy is to secure the national SSL and to reduce the deficit in the trade balance. The figure had been reviewed at the end of the Mid-Term Review of the Ninth Malaysia Plan (2006-2010) indicating an 86% decline. Further, it was reported that the SSL at the end of 2010 was 72%. Although, the trend in cultivated areas and yield increased from 2000 to 2016, the SSL in 2016 (70.3%) due to population growth was reported to be slightly lower compared to 2000 (75.5%). Hence, it is estimated that Malaysia needs to produce an additional 1.32 million tons per year in rice production to fulfil the increasing demand and to ultimately enhance the SSL of rice to 90% by 2060 (Al-Amin et al., 2011).

1.1.5 Rice Consumption

Rice production in Malaysia is only able to achieve around 70% of domestic demand. Thus, the remaining 30% need to be imported from other countries. Asian countries, apart from being the major rice producing continents, also have the highest consumption of rice globally with total caloric intake of around 40-80%. China and India are two leading countries, for example, that account for 50% of the world's total rice consumption. Also, it has been reported that countries such as Bangladesh, Cambodia, Vietnam, Myanmar, Thailand, Indonesia, and the Philippines in 2011, had the highest daily per capita rice consumption with more than 300 g per day or more than 110 kg per capita consumed (FAO, 2014). Also, growing Asian immigrants in those countries increased rice consumption and likewise in Africa and Asia where rice is a primary staple food source. Notwithstanding, government intervention in controlling the price of rice and implementing rice subsidy programs also contributed towards the increase in rice consumption in those continents (Hossain, 1997; IRRI, 2015). Figure 1.4 illustrates the trend of per capita rice consumption in Asia and the global population between 1994 and 2015. The Asian population consumes more rice compared to the world's population.

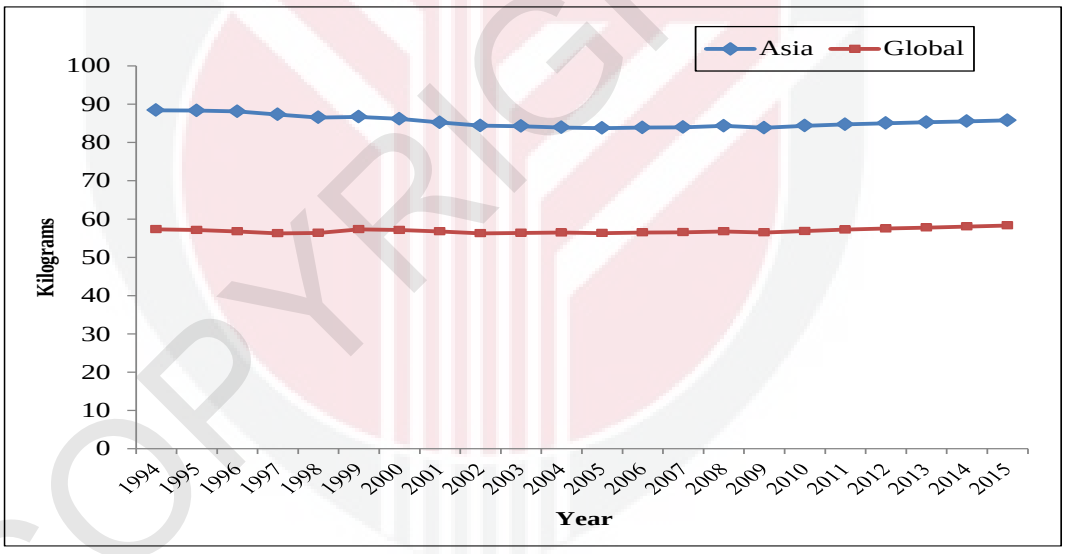

Figure 1.4 : Global and Asia per Capita Rice Consumption
(Source: FAO 2016)

Even though the per capita consumption of rice declined, this situation was expected to be offset by the growth of the Asian population due to rice demand. Furthermore, it was projected that the demand for rice in the Asian region would increase due to the growth of the population at 1.8% per year in urbanised areas. Notably, by 2025, the total global consumption of rice is forecasted to reach 481.9 million tons and 525 million tons by 2050 (Abdullah, Ito, & Adhana, 2006). Therefore, the supply of rice should be increased to fulfil the anticipated demand. The growth of total rice consumption may even exceed the population growth if the recent uptrend in per

capita consumption in China, India, and Indonesia continues. Moreover, the dependency on imported rice could also impact the importer countries if unpredicted conditions occur such as the implementation of trade restrictions or sanctions (export bans) by rice exporters or changing climatic conditions in specific growing areas. Therefore, it may result in panic buying by large importers, and accordingly, the price of rice would potentially increase at a faster pace due to the shortage of rice in the global market.

Consumer purchasing decisions for rice vary from country to country depending on the quality attributes and prices. The rice attributes such as parboiled long grain rice with medium to high amylose content and aromatics such as Basmati rice are characteristics preferred by many consumers in South Asia and Europe (Shi et al., 2008; Suwansri et al., 2002). A study by Custodio et al. (2016) indicated that consumers in Southeast Asia (Philippines, Thailand, Indonesia, Vietnam, and Cambodia) as well as in South Asia (East India, South India, Bangladesh) preferred aromatic rice. Therefore, this suggests that consumers have a high tendency to consume superior quality rice such as fragrant rice in their daily rice consumption.

Notably, the consumption of rice in Malaysia is expected to increase from 2.30 million tons in 2010 to 2.69 million tons in 2020, a growth factor of 1.6% per annum due population growth (MOA, 2011). Meanwhile, the production of paddy is expected to rise from 2.55 million tons in 2010 to 2.91 million tons in 2020 a growth factor of 1.3% per year. The population growth will continue to affect the SSL of rice in the future. Al-Amin et al. (2011) indicated that Malaysia, as a country, will require 1.320 million tons of additional rice in 2060 to meet 90% of the SSL. Figure 1.5 illustrates the trend of Malaysian per capita rice consumption between 1961 and 2016. The statistics show that the consumption of rice as a source of nutrition, especially for poor people has increased following the country's independence due to the growth of income. In contrast, it is observed from the figure, that the per capita consumption of rice started to decrease from 1982 onwards with 104.4 kg in 1961 to 79.7 kg in 2016 as the income per capita increased. Furthermore, it also was projected that this number would continue to decline to 77.0 kg in 2020 (MOA, 2010). However, the decrease in per capita rice consumption is shown to be offset by the rise in the Malaysian population.

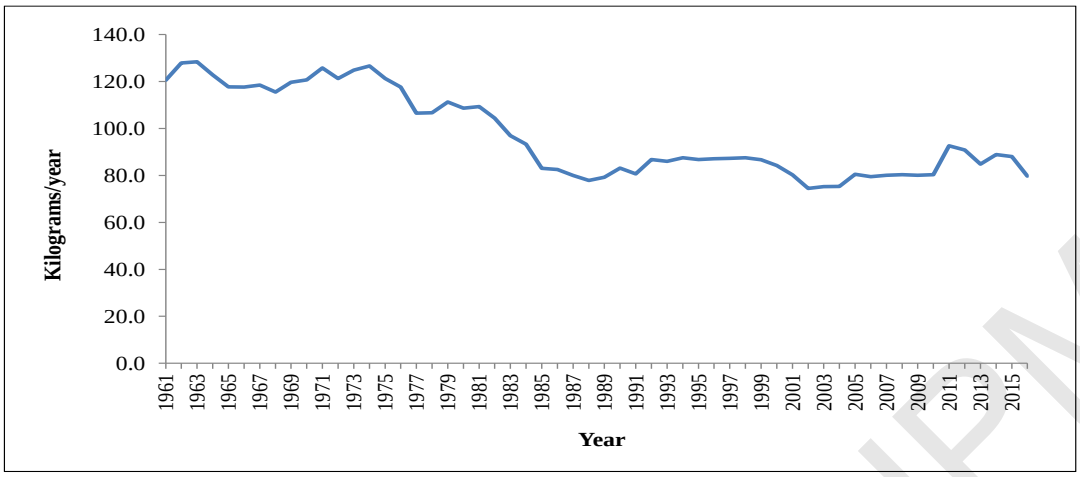

Figure 1.5 : Malaysia per Capita Rice Consumption, 1961-2016
(Source: DOA 2017; MOA 2015)

Accordingly, the increase in per capita income, changes in lifestyle, diets, and urban development are elements that will continue to affect the reduction in Malaysian rice consumption (Mad Nasir & Al-Sanoy, 2004). Moreover, the upsurge trend in imports of wheat and frozen potatoes, as well as increased consumption of other products such as bread, noodles, meat, and cereals, have also contributed to this reduction over recent years. Furthermore, the presence of different types, grades, and quality of rice in the market such as fragrant rice (Basmati and Jasmine), brown and parboiled rice are seen as a positive indication of consumer purchasing behaviour moving towards quality rice. Nowadays, health-conscious consumers are more concerned about the dietary intake of rice. The changes in living standards, income, and eating habits are the key factors that have helped to switch consumer preferences (Ahmad Hanis et al., 2012; Syahrin et al., 2008). Therefore, consumers prefer to consume high-quality rice like Basmati rice that contains less starch and helps to provide health benefits and well-being. For example, Basmati rice has a low Glycemic Index (GI) with the score of 52 compared to regular white rice (score 79). Further, the human digestive system will gradually release the carbohydrates, which in turn will help diabetic patients in controlling their blood sugar levels. The consumption of food with the high GI (above 70) will potentially lead to diabetes due to the inability of the human body to manage and control blood sugar levels (Singh, Singh, & Khush, 2000).

1.1.6 Rice Import

Since the 1970s, the rice trade has tripled in volume including consumption as a result of the Uruguay Round Agreement on Agriculture (URAA). However, rice continues to remain one of the most protected food commodities in global trade. The rice trade is forecasted to record fast-paced growth to reach 42 million tons by 2020 resulting from the steadfast import demands by Asian and African countries (IRRI, 2015). Furthermore, the expansion in rice production by major exporting countries will further increase trade growth. About 90% of global rice traded is dominated by

nine (9) countries namely India, Thailand, Vietnam, Pakistan, the United States of America, Myanmar, China, Cambodia, and Uruguay (USDA, 2018). In 2017, India was reported to be the leading exporter of rice followed by Thailand, Vietnam, and Pakistan accounting for 71% of the total rice trade in the global market. For these Asian rice-exporting countries, rice remains the most important staple and domestic food source, and therefore, the strategic reserve of this commodity is paramount. The volume of rice sold in the global market has grown from 12.4 million tons during the 1990s to 47.7 million tons in 2017.

Further, the current trade accounts for nearly 9% of global production compared with 4% during the 1980s. The expansion of rice demand is mainly from Asian and African countries including Central America and the Caribbean. The top five (5) importing countries in 2017 were China, Nigeria, Bangladesh, European Union, and Saudi Arabia. Other countries that relied on rice imports to fulfil domestic demands included Iran, Iraq, Malaysia, Philippines, South Africa, and Senegal. Notably, Asia accounted for about 42% of total world imports in 2017. The global rice trade can be divided into non-fragrant (white, parboiled, and glutinous rice) and fragrant rice (Basmati and Jasmine rice). The trading of white and parboiled rice is further divided into different percentages of broken rice such as 5%, 15%, 25%, and 100%. All leading exporters trade white rice. Several exporters dominate the trade of fragrant rice (specialty rice) namely Basmati rice including Pakistan and India, whereas Thailand and Vietnam predominately export Jasmine rice.

The trade of fragrant rice (mainly Basmati and Jasmine) accounted for around 15% to 18% of the total 7% (35 million tons) of global rice traded (Baldwin & Childs, 2011; Muthayya et al., 2014; Young & Wailes, 2003). According to Slayton and Muniroth (2011), high-quality fragrant rice is frequently exported to rich countries based on the GDP per capita. Currently, Basmati and Jasmine rice types are gaining increasing attention in Asia, Europe and the USA markets due to their superior quality characteristics (Bhattacharya, 2013). Furthermore, Basmati and Jasmine rice are not considered to be direct competitors to other types of rice, even though this type of rice operates on the same premium segment given demands are often specific from different rice importers.

In niche markets, specialty rice obtains the higher price because of its unique characteristics (McClung, 2003). The special attributes of the rice can be easily identified by its appearance, aroma, and taste which have led to its premium price resulting from the significant demand for the rice locally and globally. For instance, Basmati rice has unique attributes such as slender grains (average dimension 6.5 mm), low amylose content (19-26%), lengthwise elongation during cooking and pleasant aroma which draws upon the consumer's attention (Bhattacharjee et al., 2002). The grain quality of Basmati rice is the critical factor that sets the price apart as compared to white rice, and therefore attracts the involvement of many players in this industry. Besides, the specific characteristics of the Jasmine rice include; its softness and stickiness, low amylose content (16-18%), and pleasant aroma have also created demand in the market but cannot compete with Basmati rice regarding price.

Climate change and government intervention on rice imports (import tariffs and tariff-rate quotas) can inevitably influence and trigger the vast volumes of rice traded and the price. Usually, milled rice has higher tariffs compared with paddy rice because the government attempts to secure the milling industry. Countries in Southeast Asia such as Indonesia, Malaysia, and the Philippines have implemented high tariff rates for rice due to food security issues. In 2014, rice tariffs for Indonesia remained at 30%, 20% in Malaysia and 40% in the Philippines (Hoang & Meyers, 2015). A border tariff is also used as a restriction to protect the rice industry in those countries in order to stabilise domestic prices and self-sufficiency levels.

Due to the small volume of rice traded, the prices of rice are uncertain and can rise dramatically resulting from leading export countries such as Thailand, India, Vietnam, and Pakistan restricting rice exports to ensure sufficient domestic supplies. Also, the uncertainty surrounding climatic conditions can lead to reductions in paddy production, changes in consumption, and government policy intervention which also give rise to price volatility. Further, segmented rice trade according to rice variety (indica, japonica, or fragrant rice), milling degree (paddy, parboiled, brown or white rice), and the percentage of broken rice will likewise, affect rice prices and the volumes traded (Wailes, 2005).

Price increases have impacted the prosperity of consumers given the majority of consumers in developing countries rely on rice as their primary source of energy. Notwithstanding, rice is a strategic commodity, sensitive and well protected by most countries to ensure food security. Several regulations have been enforced by governments to protect the rice industry and trade such as tax increases and price control. In 2008, for example, Vietnam, India, and Bangladesh prohibited rice trade for several months in order to protect the country's food security (Childs & Kiawu, 2009). Moreover, at that time, India applied a minimum export price (MEP) of USD1,200/ton plus a tax of USD180/ton on all types of rice, excluding premium Basmati rice (high-quality aromatic rice). Whereas, Pakistan applied an MEP to Basmati and super Basmati rice with a value of USD1,300/tons and USD1,500/ton, respectively.

The food crisis that impacted the industry globally between 2007 and 2008 affected the upsurge of rice prices. Notably, this was the most intense spike since the global food crisis of 1973-1975. Indeed, it was reported that between November 2007 and May 2008 the price of rice globally had nearly tripled (Childs & Kiawu, 2009). Also, specialty rice (Basmati and Jasmine type) that accounted for 15% to 18% of global trade showed the highest price in the global market and increasing yearly. The global price of Basmati rice in 2013, showed the highest value at USD1,369/ton compared to Thai fragrant rice 100 % (USD1,183/ton) and white rice at USD524/ton (Figure 1.6). The global food crisis experienced in 2008 also caused the price of rice in the market to increase. The crisis triggered a lot of anguish and concern for many countries given the level of poverty and poorness of the people since most people spend about 40% of their hard-earned wages for staple food. As a result, rice importing countries took steps to overcome this worrying situation by initiating

programs to expand domestic rice production to secure rice self-sufficiency and to reduce their dependence on rice imports.

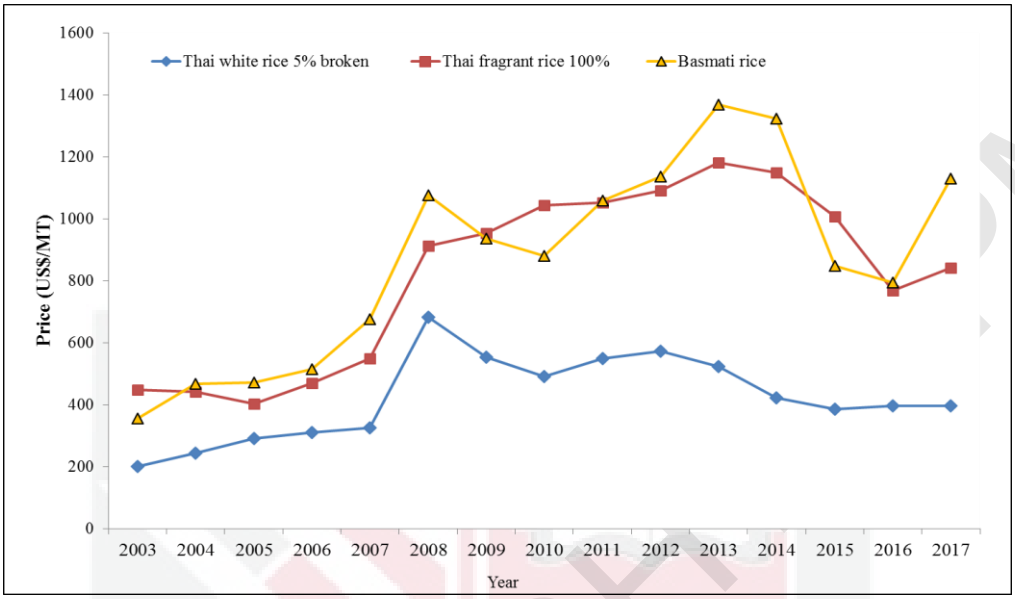

Figure 1.6 : Rice Price in Market Trade
(Source: FAO 2018)

Also, due to the global food crisis, many countries faced a sudden increase in domestic rice prices (Dawe & Morales-Opazo, 2009). The price of rice was predicted to increase due to several long-term factors, namely the rise in income of developing Asian countries, which in turn, would raise the price of other foods including fuels and fertilisers, and the elimination of rice stocks. The rise in price was also related to the actions taken by the major rice exporters, namely India, Thailand, Vietnam, and Pakistan. The entire situation began when two major rice exporting countries, Vietnam and India implemented trade restrictions in October 2007 to protect their consumers from a shortage of rice in their domestic market where the actions taken by both countries impacted the rice price.

During the following two months, the price of rice increased by 10%. Subsequently, Cambodia and Egypt also banned exporting rice that caused the global price of rice to rise. China also imposed a tax on rice exports of 10% and removed the value-added-tax rebate. A further factor that contributed towards the rising price of rice globally was due to panic buying of several large importers (predominantly the Philippines, Middle East, and Africa). Additionally, the rapid price increase was also influenced by the weak value of the US dollar that likewise increased oil prices (Slayton & Slayton, 2009). Due to the panic buying situation, many countries like Nigeria, Indonesia, and Iran adopted steps to increase rice supplies by degrading or excluding tariffs on rice imports. Prices in turn rose, not only affected by the rising price of rice but also due to the prices of other commodities increasing such as

wheat, corn, and soybean. Major exporting countries also imposed ban export, restrictions, and taxes because they wanted to ensure ready availability of rice in the domestic market and ultimately to control price and inflation rates.

Malaysia is a net importer of rice with annual imports of about 30% to 40% including specialty rice (Basmati-type and Jasmine-type) to support the nation's self-sufficiency policy to ensure food security and to fulfil consumer demand. There are several types of rice that Malaysia imports to meet consumer demand; white rice, specialty rice (Basmati and Jasmine type), and glutinous rice. The total rice consumption, production, and import between the years 2000 and 2016 are illustrated in Figure 1.7. The top four (4) rice exporters to Malaysia were Thailand, Vietnam, Pakistan, and India. Approximately, 60% of imported rice in 2016 was supplied by Thailand and Pakistan, valued at RM771.5 million and RM188.7 million respectively (DOA, 2017). The food crisis in 2008, worsened the situation in which the government had to increase rice imports dramatically. Import statistics showed that the total imports of rice (mostly milled and broken rice) significantly increased by 84% from 590,000 tons in 1996 to 1,086,000 tons in 2009 (MOA, 2015).

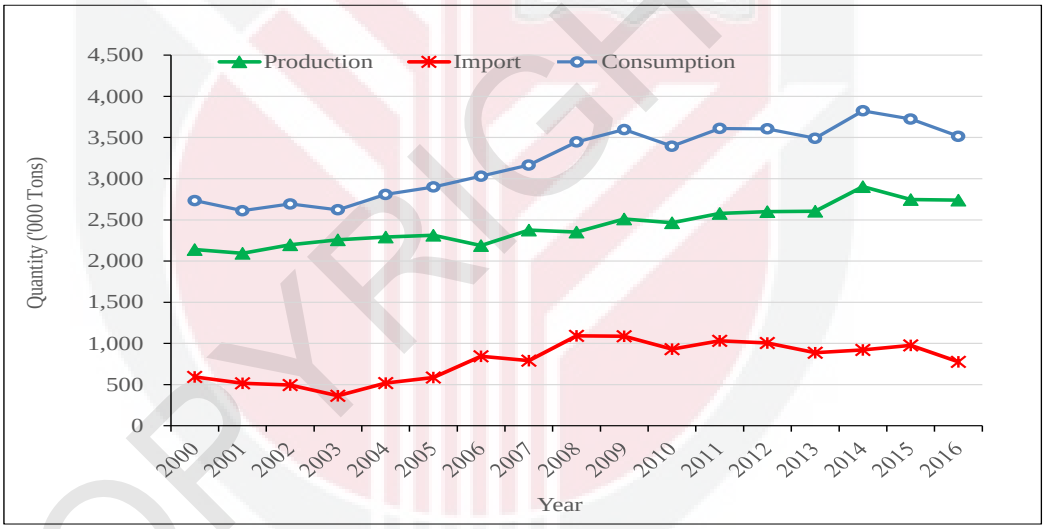

Figure 1.7 : Rice Consumption, Production and Import
(Source: DOA 2017; MOA 2015)

Regarding the food crisis, during this period, Malaysia was faced with increasing food import bills and a rising Consumer Price Index (CPI) (Fatimah & Abdel-Hameed, 2010). As reported by the Department of Statistics Malaysia (2015), an upsurge in food prices led to an increase in the CPI of rice and other cereals from 100 in 2010 to 107.2 in 2015. In 2016, Malaysia imported about 822,006 tons of rice including fragrant rice (Basmati and Jasmine type) with a value of RM1.57 billion due to the shortages of rice in the market. Indeed, the proportion of fragrant rice was approximately 20% of the total import (DOA, 2016). Malaysia heavily relies on the import of fragrant rice, with an estimated 200,000 tons per year imported with a value of RM500 million. This number has expanded markedly over the last two

decades, shifting it from a niche market to a commercially driven but attractive market. The premium price of fragrant rice has attracted the attention of rice industry players whereby competition has increased between domestic and trade markets.

The trend in consumer demand towards high-quality rice has been observed in Malaysia with the existence of a wide range of specialty rice in the market with different types, brands, grades, and prices (Abdullahi, Zainalabidin, & Ismail, 2011). Among the famous brands of specialty rice in the market are Jasmine, Faiza, Sunflower, Jati, and Floral. The brand and type of rice are factors that affect the purchasing decision of consumers (Abdullahi et al., 2011; Behrens & Heinemann, 2007; Mad Nasir & Al-Sanoy, 2004). Basmati rice is one such specialty rice that has attracted the attention of Malaysian consumers even though it is considered as one of the most expensive rice types. The attributes associated with Basmati rice are quality, taste, and flavour which influence the purchasing decision of Malaysian consumers. The demand for Basmati rice continues to grow with an average 13,241 tons per year produced with a value of USD7.1 million or RM22.5 million (MARDI, 2011). Furthermore, the import of Basmati rice has likewise dramatically increased from 10,367 tons in 2004 to 29,187 tons in 2015 with an increment of 181% as illustrated in Figure 1.8. As identified by DOSM (2008), the per capita consumption of Basmati rice in 2007 was nearly three times higher compared to 1970.

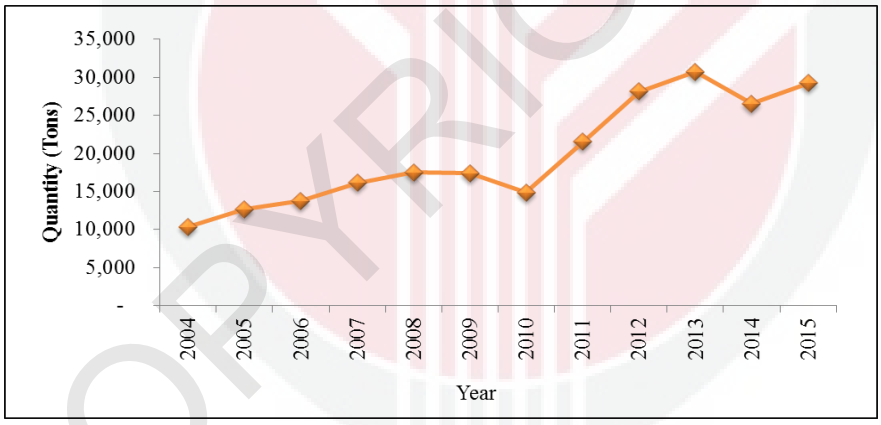

Figure 1.8 : Import of Basmati Rice, 2004-2015
(Source: DOA 2015; DOSM 2015)

Regarding the retail price of Basmati rice, this showed a significant price premium compared with other rice varieties such as local and imported white rice, brown rice, jasmine type, and glutinous rice. The premium price of rice is affected by the quality and unique characteristics of the rice (e.g., superior grain qualities and aromatics), as well as the scarcity of supply due to increasing market demand. The retail price for Basmati rice ranges from RM6.00-RM9.80/kg compared to white rice which is around RM1.60-RM2.60/kg (DOA, 2017). A study by Abdullahi et al. (2011) found that most consumers in Malaysia are willing to pay higher prices for quality products like Basmati rice. Likewise, consumers with higher income had the higher attraction and desire in buying quality rice (e.g., Basmati rice) because of the rice's

distinctiveness (e.g., aroma, texture, and visual attributes of cooked rice) and perceived nutritional value.

1.2 Fragrant Rice Industry in Malaysia

In 2005, the Malaysian Agricultural Research and Development Institute (MARDI) officially released a new rice variety; MRQ74, also known as Mas Wangi. Regarding its characteristics, this specialty rice is 80% similar to Basmati rice, such as having a long and slender grain shape, is non-sticky, and is aromatic. The distinctive features of MRQ74 rice make it a preferred rice type of Malaysian consumers, enabling it to tap into the higher-end rice market (Asfaliza, Omar, Abdullah, Baka, & Harun, 2008; Syahrin et al. 2008). The MRQ74 variety was licensed to two Constitution of Farmers Organization or Pertubuhan Peladang Kawasan (PPK) namely PPK Kangkong, Kelantan and PPK Langkawi, Kedah in 2005 that allows the PPK to plant, process, pack, and market the rice. Meanwhile, MARDI provides all the technical support and pure seeds to help to promote it through agricultural expositions and shows. Cultivation activity was contracted out to farmers in Rantau Panjang, Kelantan.

The initiative to introduce fragrant rice cultivation in non-granary (non-irrigated) areas was first proposed during the Agriculture National Key Economic Area (NKEA) Lab in 2010. The NKEA is an essential driver of economic activities that potentially and directly contribute towards economic growth, which is measurable by the Gross National Income (GNI) indicator. Indeed, the private sector plays a leading role in this project and is supported by the government. In March 2011, the Malaysian government made a concerted effort to the NKEA under the Economic Transformation Program (ETP) by announcing the Entry Point Project 9 (EPP 9) to produce fragrant rice in non-granary areas. The EPP 9 is an opportunity to introduce the specialty rice in 18,200 hectares of non-granary areas by 2020 and will potentially provide around 73,000 tons of fragrant rice to the market. Fragrant rice cultivation is acknowledged as one of the high potential industries which will positively impact national food security, tap into a new market segment, and reduce the country's dependence on imported fragrant rice (ETP, 2014). Moreover, by 2020, this project is expected to instil a Gross National Income (GNI) impact of RM133 million, reduce the volume of imports to between 20,000 to 30,000 tons, and increase farmer incomes by between 20% and 30% due to the higher selling price compared to regular white rice. Notwithstanding, it will indirectly help to reduce foreign exchange, of about USD10-27 million annually when the country is able to produce quality fragrant rice for domestic consumption. Also, it is expected to offer a reasonable price to consumers compared to imported Basmati rice. Therefore, to realise the aspiration of producing fragrant rice in large areas, it will require participation and commitment from all key players in the rice supply chain, such as farmers, millers, and wholesalers to ensure the growth and sustainability of the industry.

1.2.1 Characteristics of MRQ74 Variety

MRQ74, known as Mas Wangi is an aromatic rice variety selected from a cross between Q34, KDML 105, and Kasturi. Early generation selections were for the slender grain type with aroma, and a short, erect plant type with good panicle characteristics. MRQ74 rice has a long, slender grain shape, high amylose content, with moderately soft gel consistency and a moderate alkali spreading value. These features result in flaky, non-sticky cooked rice with an aroma (Asfaliza, 2005). Regarding the agronomic characteristic, the height of the MRQ74 plant is about 65cm and the maturity period is around 125 days. The growth time of MRQ74 variety is similar to other commercial varieties of rice. Notably, the rice yield ranges between 4.0 to 4.5 ton/hectare. The variety also requires less water and is therefore suitable to be cultivated in non-granary areas either organically or by conventional farming. The MRQ74 variety is resistant to leaf blast disease and bacterial leaf blight and the maximum rice recovery ratio for the MRQ74 variety is approximately 67.7%. However, there are several factors that will affect low graded rice recovery and high percentage of chips such as physical characteristics of the MRQ74 variety (low grain width compared to normal white rice), the condition of post-harvest grain, the level of paddy moisture content, inefficient machinery, lack of technical skills, and poor handling practices (Syahrin, Mohd Rashid, Abu Kasim, & Asfaliza, 2009). Table 1.4 shows the comparison between MRQ74 variety and MR219 variety (normal white rice variety) characteristics.

Table 1.4 : Characteristics of MRQ74 Variety and MR219 Variety

Characteristic	MR219	MRQ74
Agronomy		
Maturation (day)	105-112	125
Plant height (cm)	83.0-87.0	65.0
Panicle length (cm)	24.5	25.0
Grain		
Length (mm)	10.04	6.53
Wide (mm)	2.27	1.83
1,000 grain weight (g)	27.10	22.86
Milling Quality		
Milling Recovery (%)	65.0	67.7
Head Rice (%)	72.0	64.7
Amylose (%)	20.1	27.0

(Source: Asfaliza et al. 2008)

Figure 1.9 illustrates the MRQ74 variety grain, (a) before the milling process, (b) of the milled rice, and (c) rice packaging. Due to the unique characteristics of MRQ74, the dedicated areas and mills, therefore, need to be identified for the farming and milling of this variety to secure no contamination by the regular white rice variety and to preserve the quality of the fragrant rice during planting, harvesting, milling, and packaging.

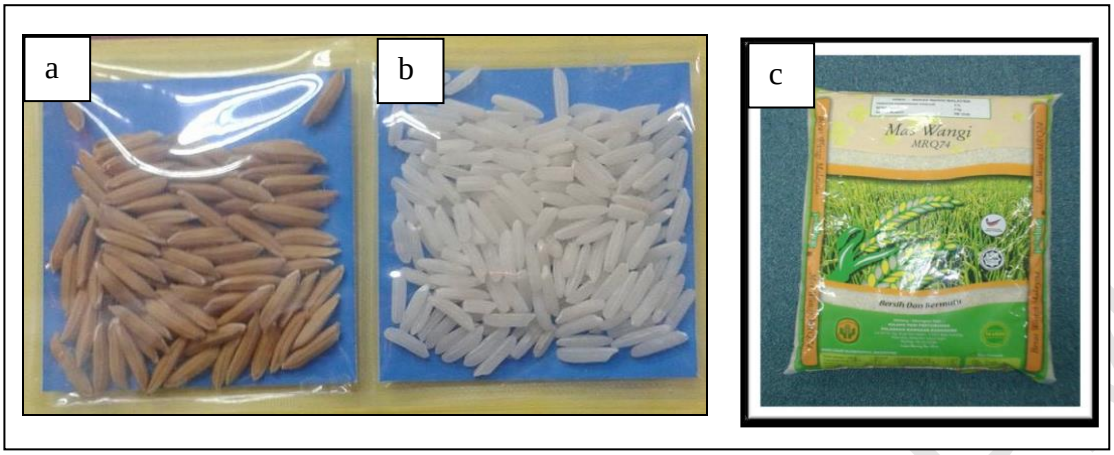

Figure 1.9 : MRQ74 Rice
Note: (a) Rice Grain before Milling; (b) Milled Rice; and (c) MRQ74 Rice Packaging.

1.2.2 Benefits of the MRQ74 Rice Variety

About 40% of the rice demand in Malaysia is for imported rice, with Basmati (from India) and Jasmine (from Thailand) rice leading sales (MOA, 2004). Although the market segment of Basmati rice is small, the demand is increasing each year with an average of 13,241 tons imported per year. Thus, MRQ74 rice can be commercialised and become a substitute for other specialty rice that is presently available in the market, which is mainly Basmati rice. A mentioned previously; the MRQ74 rice variety is high-quality rice that has 80% similarity with Basmati rice, which can offer a higher price as compared to normal white rice. Thus, the involvement of farmers in the cultivation of MRQ74 variety can increase their income by 20% to 30% compared with the existing rice varieties (ETP, 2011). Equally important, MRQ74 variety has special attributes such as resistance to blast disease which leads to a reduction by 4.6% in the use of herbicides and pesticides and low production costs compared to normal white rice variety (Asfaliza et al., 2008).

Importantly, low production costs and high-profit margins are attractive factors for industry players to commercialise MRQ74 variety in Malaysia. Moreover, this will ultimately help to reduce imports and foreign exchange implications. As identified by Syahrin et al. (2009) other players in the supply chain could also obtain optimal profits when producing MRQ74 variety. Furthermore, the study identified the profit margin for millers was around 61.1%, wholesalers (20.0%), and retailers (7.9%). Therefore, the MRQ74 rice price will need to be set higher than normal white rice to ensure that farmers will be fully committed to cultivate the rice variety and to attract other players to enter into this business.

Additionally, imported Basmati rice is sold at higher prices in the international and domestic markets as compared to other types of rice such as Jasmine and normal white rice. For instance, it was recorded that the price of Basmati rice in the retail and wholesale markets in Malaysia was higher than normal white rice, which was

about RM6.00-RM9.80/kg and RM3.90-RM7.00/kg compared to normal white rice of around RM1.60-RM2.60/kg (DOA, 2017). Based on the findings by Syahrin et al. (2008), the majority of consumers favoured the taste and non-stickiness attributes of MRQ74 rice including its long grain features. Indeed, these characteristics have also influenced many Malay consumers with small households to switch and consume MRQ74 rice. Furthermore, it also offers a lower retail price compared to other specialty rice types. As identified by Abdullahi et al. (2011) apart from rice quality features, price plays a significant role in consumer purchasing behaviour because the higher price is always associated with higher quality rice. Additionally, consumers also preferred rice that is both aromatic and white, with a recognised brand before purchasing.

Aside from the physical characteristics and cooking quality of the rice, the MRQ74 rice has also been reported to offer health benefits. Indeed, MRQ74 contains high levels of Gamma-aminobutyric acid (GABA) that can help to reduce stress levels. GABA functions as a natural calming and relaxing agent to the human brain that aids in the process of rest and reducing stress. Moreover, it also contains a low Glycemic Index (GI) that is suitable for diabetic patients and individuals who are concerned about their health (Foster-Powell, Holt, & Brand-Miller, 2002). The GI value for MRQ74 rice is low (40) compared to Basmati rice (52), normal white rice (80), and glutinous rice (100) (MARDI, 2011). Further, a low GI diet would help to slow down the conversion rate of carbohydrates into glucose that gives a positive impact on the body's health. Notably, it has been proven that low-GI food contributes towards the decreased risk of cardiovascular disease, diabetes, stroke, depression, kidney disease, and cancers such as breast, colon, prostate, and pancreas.

1.2.3 Malaysian Fragrant Rice Supply Chain

The government has also implemented a public-private partnership (PPP) approach towards introducing, producing and commercialising the MRQ74 variety. The involvement and investment from the private and public sectors are expected to trigger the growth of this project. Figure 1.10 illustrates the fragrant rice supply chain in Malaysia, depicting the Anchor Company as a spearhead in the business model. The implementation approach for this project is slightly different from that found in regular white rice cultivation. There are no subsidies and paddy production incentives offered to farmers who cultivate the new variety (MRQ74) as those subsidies and incentives are provided to the "older" rice variety farmers. The farmers who grow the MRQ74 variety are only eligible to obtain a 20% higher price compared to regular white rice (RM1,200 ton/ha) (ETP, 2011). According to Dano and Samonte (2005), the government support in the rice industry through fertilizer input and price support constitutes 58% of farmer's income.

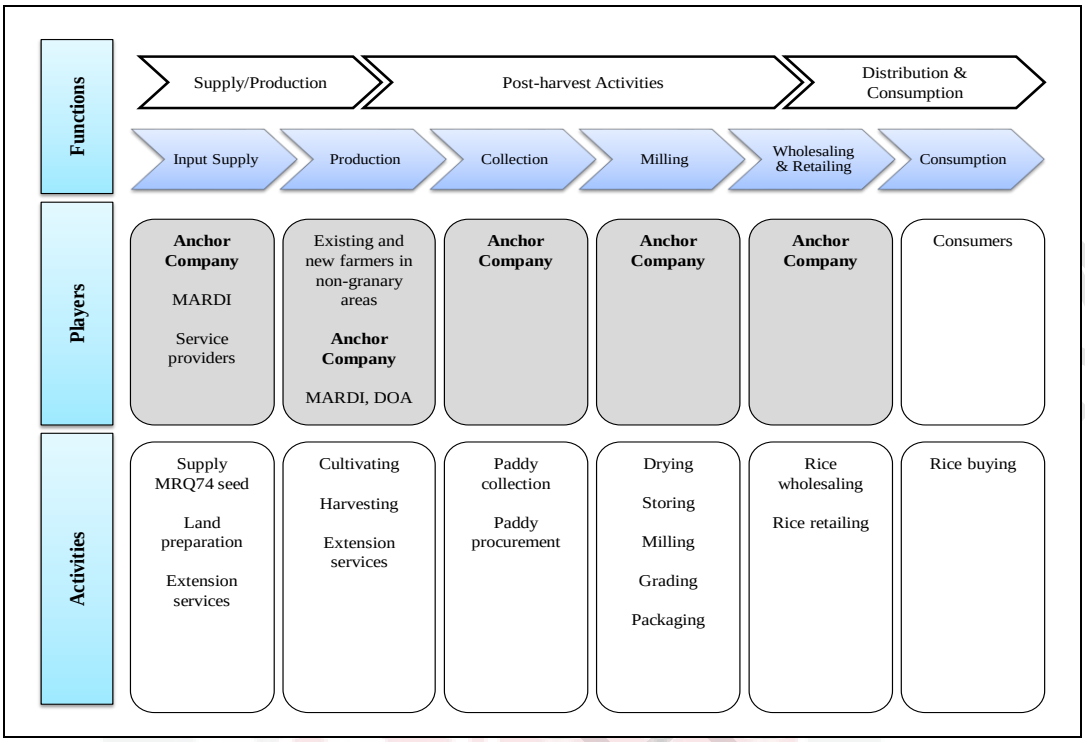

Figure 1.10 : Fragrant Rice Supply Chain in Malaysia
(Source: Compiled by the author)

Initially, three companies were appointed as Anchor Companies under the EPP 9 initiative, namely; Infoculture Sdn. Bhd., Birinbaru Enterprise Sdn. Bhd., and Sharez Amani Sdn. Bhd. While MARDI is responsible for assisting in providing technical assistance and supplying the pure MRQ74 variety seed. However, in 2014, Infoculture Sdn. Bhd., withdrew as an Anchor Company, leaving only two companies to mill and commercialise MRQ74 rice in the domestic market. Also, this initiative involved 125 farmers in non-granary areas, located in numerous states such as Kelantan, Kedah, and Johor. The participation of farmers (henceforth called adopters) in fragrant rice farming was voluntary as they were required to switch from growing and cultivating normal white rice to the MRQ74 variety.

The dedicated paddy areas were identified before cultivation to avoid contamination by the normal white rice. In 2014, the fragrant rice cultivated areas totalled 1,051 hectares with a total production of 2,026 tons, and average productivity was 1.9 ton/ha (ETP, 2014). Rice production remained unstable and needed guidance and strong support from the government to enhance the quantity and quality of the production. The previous study highlighted that the attitude of farmers' and efficient farm management were major factors contributing towards high rice production of MRQ74 variety (Syahrin et al., 2009). Also, the fragmented industry involved smaller players who affected the performance of the fragrant rice industry.

There were several challenges initially in the implementation of EPP 9 due to the low participation of farmers in fragrant rice farming (ETP, 2011). This may have resulted from their negative perception towards this innovation to produce the MRQ74 variety. Previous studies have identified various factors that have contributed towards low adoption of technology amongst farmers in Malaysia, such as perception of farmers towards innovation attributes (e.g., perceived benefits, compatibility), low education, and inadequate infrastructure (Abu Samah, Shaffril, Hassan, Abu Hassan, & Ismail, 2009; Hayrol Azril et al., 2009; Mannan, Nordin, Rafik-Galea, & Ahmad Rizal, 2017; Nazuri & Man, 2016). Further, technology consisting of complex components could also affect the adoption decision made by farmers and require further time, especially for ageing farmers. Harun et al. (2015) found that the level of technological practices for paddy production among farmers in Malaysia was still at a moderate level and could be improved via appropriate programs conducted by extension agents.

Furthermore, the government also emphasised the rice milling aspect to ensure the quality and authenticity of the fragrant rice. The low-grade rice recovery of the MRQ74 rice during the milling process has been highlighted as one of the major problems encountered by millers due to the low quality of the produced rice which will ultimately affect the profit margin. Syahrin et al. (2009) found that the average of total graded rice recovery produced for MRQ74 variety was 40.5%, broken rice 18.8%, bran 8.5% and chips 3.33%. The graded rice recovery results were differed from normal white rice variety that usually between 55-60%, with 9% for bran and 1% for chips. Poor paddy handling, inefficient machinery, inadequate farm practices and management have been identified as the central issue in the milling process due to low rice recovery ratios and high percentage of chips. Besides, MRQ74 variety has low grain width (1.83 mm) compared to normal white rice variety (e.g. MR219 grain width is 2.27 mm) that contributes to the lesser milling performance. Rice milling is a capital-intensive operation, and the practices of postharvest technology are crucial to guarantee the quantity and quality of produced rice. Inevitably, low quality MRQ74 rice could impact the domestic rice market given the difficulty of competing with imported Basmati rice.

1.3 Problem Statement

Rice is recognised as a strategic commodity that plays a pivotal role in ensuring food security in Malaysia, as the majority of Malaysians depend on rice as a staple food even though there is a broad selection of other foods in the marketplace. It is estimated that the world's population will increase to 8.9 billion by 2050, and most of the population increase will occur in Asia. Therefore, food security is a prominent feature to provide a sufficient and consistent food source, particularly rice to consumers in the event of a food crisis. The rice industry had always been given priority by the Malaysian government to ensure stable food security as well as the socio-economic considerations of farmers to overcome issues associated with poverty. While the SSL of rice is projected to be 70% in 2020, the country remains reliant on imported rice to fulfil demand from the ever-growing population. Currently, Malaysia's domestic rice production caters for only 70% of the total rice

demand, while 30% of rice as previously mentioned, is imported from other countries, namely; Thailand, Vietnam, Pakistan, and India to meet the current shortage. From the perspective of food security, it is critical for Malaysia to ensure the availability of rice as only 7% of total global rice production is traded internationally. Moreover, Malaysia highly depends on the importation of fragrant rice especially Basmati rice from Pakistan and India, often at the mercy of fluctuating and adverse foreign exchange rates each year. Notably, the demand for Basmati rice continues to expand with an average of 13,241 tons per year with a value of USD7.1 million or RM22.5 million (MARDI, 2011).

The innovation from MARDI namely the MRQ74 variety as mentioned earlier in this study is an opportunity for the country to develop the fragrant rice industry in Malaysia. The MRQ74 variety is acknowledged as being 80% similar to Basmati rice and suitable for cultivation in non-granary areas. In 2011, fragrant rice farming was introduced under a new Entry Point Project 9 (EPP 9) for non-granary areas with the introduction of the MRQ74 rice variety to take advantage of the higher-end rice market. This initiative is expected to help the country reduce its dependence on imported rice by 40% and in foreign exchange of about USD10 to USD27 million annually. Also, farmers could potentially generate much higher income due to the higher price compared with normal white rice as the buying price is 20% higher than normal white rice (RM1,200/ton as mentioned). The special attributes such as the physical appearance, higher yield (4.0-4.5 ton/hectare), resistance to leaf blast disease and bacterial leaf blight, and less usage of herbicides and pesticides could also result in lower production costs. Currently, the average yield for non-granary areas is 2.8 ton/ha which is slightly lower compared to granary areas (4.9 ton/ha). Thus, MRQ74 variety presents an ideal opportunity for farmers in non-granary areas to venture into fragrant rice farming. Besides, the high-profit-margin compared to normal white rice is an attractive factor for industry players to commercialise this MRQ74 variety. As identified by Fatimah et al. (2011) low farm income will lead to a decreased paddy area, and farmers will seek to convert their land to other agricultural and non-agricultural activities (i.e. palm oil, vegetables) to obtain higher income.

Presently, it is apparent that the progress of fragrant rice cultivation under the EPP 9 initiative is still uncertain due to several limitations such as poor participation of farmers although the project was started in 2011 with involvement of 125 farmers. The voluntary farmers who grow the MRQ74 variety are only eligible to obtain a 20% higher price compared to normal white rice (RM1,200 ton/ha) and no subsidies as well as paddy production incentives offered to them. Besides, they have to ensure that the cultivation areas are not contaminated by the normal white rice due to the special characteristics. Moreover, the MRQ74 rice production was unstable including the quality with an average yield of 1.9 ton/ha, even though the buying price is 20% higher compared to normal white rice.

Besides, the role played by the Anchor Companies to commercialise MRQ74 rice (Mas Wangi), the capability of the appointed companies need to be questioned in

order to sustain the project. For instance, as mentioned earlier, Infoculture Sdn. Bhd., one of the EPP's anchor companies, had withdrawn from this project. Thus, it may impact the success and sustainability of the project. Also, the low-grade rice recovery of the MRQ74 rice during the milling process has been highlighted as one of the major problems encountered by millers due to the low quality of the produced rice which will ultimately affect the profit margin.

To produce fragrant rice in large areas requires full participation and commitment from existing and new farmers including the various players in the supply chain such as millers and wholesalers apart from the Anchor Companies. Farmers are required to switch crops from normal white rice to MRQ74 variety; millers have to agree to mill the rice, and wholesalers have to accept MRQ74 rice for marketing. Production of MRQ74 variety requires a comprehensive workflow to guarantee the authenticity of the rice seeds, as well as the quality of the fragrant rice during the process of cultivating, harvesting, and milling. Also, dedicated farms need to be identified for the cultivation of this variety to ensure no contamination by the normal white rice variety, and specialised mills have to be chosen to avoid contamination with other growers' rice and in order to preserve the products' brand identity in the consumer market. Few aspects such as capital and technology need to be considered by the millers during rice milling operations to ensure the optimum rice recovery ratio and quality of the rice produced. Thus, capital investments in advanced machinery and compatible equipment are essential aspects that need to be addressed if they accept to participate in this new rice variety. All rice mills in Malaysia operate under price controls, so there is limited leverage for them when they deal with undesired changes in paddy purchases, paddy prices, and rice recovery ratios (Chung, Arshad, Noh, & Sidique, 2016). Low paddy quality results from inadequate farm practices and management have been identified as the central issue in the milling process due to low rice recovery ratios. Therefore, the economic sustainability of the milling operations, in the longer term is questionable as for whether the industry can be competitive.

In the distribution chain, the role of wholesalers in marketing channels is paramount to visibly market the product to retailers before the product reaches consumers. Currently, rice marketing is conducted by the Anchor Companies to infiltrate the local fragrant rice market. However, competition with existing imported Basmati rice players in the industry and inconsistency regarding the quality of the rice may hinder the acceptance of the wholesalers towards this new rice variety. Moreover, wholesalers will need to develop and implement an appropriate marketing strategy which could entail additional costs to the company. Therefore, the role of the wholesaler in the rice supply chain is not merely one of passing-product-through, as the efficiency of this link will impact other players such as farmers, retailers, and consumers.

Thus, the intention to adoption of fragrant rice farming within the entire supply chain and its players is questionable. For instance, "Are they willing to adopt MRQ74 variety for the long term?" The behaviour within a complex system, such as the

fragrant rice industry will not be entirely understood by a segregated analysis of its constituent parts. Thus, it is crucial to understand the behaviour of the main players within the rice supply chain regarding this innovation and the MRQ74 variety. Importantly, the adoption intention of the new MRQ74 variety is necessary to ensure the efficient, competitive, and sustainability of the fragrant rice industry in Malaysia. Currently, little is understood regarding the behaviour of the supply chain players towards the new rice variety from a Malaysian perspective. Notably, the adoption of agricultural innovation is a critical and necessary component in the development of the industry, agricultural and its associated activities while ensuring the players in this field receive the benefit from the innovative approach, its adoption and ultimately the economic growth.

1.4 Research Questions

Several research questions have been developed to address some of the issues previously mentioned in this section to understand the key factors that influence adoption intention of the new rice variety, MRQ74 among the players within the rice supply chain. Accordingly, the following questions are posed:

i. What are the factors that influence the farmers' continuance intention in adopting fragrant rice farming?
ii. What are the factors that influence the farmers' intention in converting to fragrant rice farming?
iii. What are the factors that affect millers' and wholesalers' adoption intention towards the MRQ74 variety?
iv. Is attitude the main determinant of adoption intention of the players within the rice supply chain?
v. Does attitude mediate the relationship between the factors and the intention to adopt fragrant rice farming?

1.5 Research Objectives

This study aims to determine the factors that influence adoption intention of the new rice variety, MRQ74 among the players within the rice supply chain. The specific objectives of this study are:

i. To investigate factors that influence the farmers' continuance intention towards adopting fragrant rice farming.
ii. To investigate the factors that influence the farmers' adoption intention in converting to fragrant rice farming.
iii. To investigate the factors that influence the millers' and wholesalers' adoption intention towards the MRQ74 variety.
iv. To evaluate the attitude of the players within the rice supply chain towards fragrant rice farming.

v. To determine the mediating role of attitude in the relationship between the factors and the intention to adopt MRQ74 variety.

1.6 Significance of the Study

For many years, researchers have attempted to investigate and clarify the adoption of agricultural innovation technology. Innovation is considered to be an essential requirement in an ever-changing environment even though it incorporates a certain level of risk, and the outcomes are not always guaranteed. Factors that influence acceptance towards innovation can be explored through technology adoption research. Innovation adoption in organisations is multidimensional and is influenced by several factors referred to as innovation attributes. The observations and findings of this study are important in order to evaluate the factors affecting the adoption decision of adopters, as well as to measure the non-adopters (farmers, millers, and wholesalers) intention to adopt the new MRQ74 variety. The identification of the determinants will contribute towards understanding the process of adoption that will further assist policy-makers in designing and implementing policies to accelerate the adoption of the MRQ74 variety. Indeed, this is to ensure the effectiveness and successful implementation of fragrant rice farming in Malaysia. Additionally, this study will contribute towards the existing body of knowledge by focusing on how the factors influence the adoption intention towards fragrant rice farming among the different groups of rice players.

1.7 The Scope of the Study

There is a growing need for Malaysia to become more self-sufficient in rice production and to ensure food security, as rice continues to be sustained as a staple food source. Innovation is critical in agriculture because the adoption of new technology offers great opportunities, especially to players within the rice industry and to increase farm production and income. Currently, Malaysia is heavily reliant on imports to meet its specialty rice demand requirements, particularly for fragrant rice. The commercialisation of a new rice variety, namely MRQ74 variety will help to reduce rice imports and import bills. Fragrant rice production in non-granary areas involves numerous players in the supply chain such as farmers, millers, and wholesalers apart from the Anchor Companies. The new rice variety has tremendous potential for commercialisation not only for domestic consumption but also in the global market. Thus, the primary objective of this research is to determine the factors that influence the adoption intention of the new rice variety, MRQ74 among the players within the rice supply chain. There are presently, three main players in the rice industry, namely; farmers in the non-granary areas, millers, and wholesalers identified to investigate in this study. The players within the rice supply chain are separated into two categories; the adopters and non-adopters. The sample population of farmers has been provided by the Department of Agriculture Malaysia (DOA) while the list of registered millers and wholesalers have been provided by the Ministry of Agriculture and Agro-Based Industry (MOA).

Furthermore, classified as a cross-sectional study, the study involved sampling and data collection between April 2013 and July 2014, over a 18-month period. The determination of the behaviour towards the new rice variety, MRQ74 is essential because the adoption intention of a new variety is crucial to ensure the efficient, competitive, and sustainability of the fragrant rice industry. Therefore, the best approach to understand intention-behaviour for each of the industry players is to examine the entire system, namely; the farmers, millers, and wholesalers. Most of the innovation researchers have tended to examine the experiences associated with innovation at specific points along the value chain, particularly at the farm level. Additionally, most studies were undertaken from a socioeconomic viewpoint such as household income, access to extension services, and credit which in combination do not entirely explain the behaviours towards agricultural innovation.

1.8 Organisation of the Thesis

The thesis is organised into five chapters, namely the introduction, literature review, methodology, results and discussion, and conclusion and recommendations.

Chapter One: The introductory chapter presents an overview of the paddy and rice industry in Malaysia as well as the fragrant rice industry and the major players involved in the rice supply chain. The problem statement, research questions, research objectives, significance and scope of the study are further presented in this chapter.

Chapter Two: The literature review discusses and evaluates the main theories and technology acceptance models such as the Diffusion of Innovation Theory (DOI), the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), and the Theory of Planned Behaviour (TPB). The chapter further discusses the determinants of agriculture technology adoption. The chapter details most of the constructs related to the development of the conceptual framework used in this study mainly on the adoption of technology.

Chapter Three: The methodology in this chapter describes the research design such as philosophical base research, sampling frame, instrument development, data collection methods, and statistical tools for data analysis. Additionally, the results of the factor analysis for each set of questionnaires based on the pilot study are also deliberated. Moreover, the development of the conceptual framework and hypotheses are discussed and explained in this chapter.

Chapter Four: The results and discussion presented in this chapter describe the respondents' profiles as adopters and non-adopters (farmers, millers, and wholesalers). The results of the Partial Least Square-Structural Equation Modelling (PLS-SEM) are additionally discussed based on the hypotheses testing of four (4) models related to the farmers, millers, and wholesalers.

Chapter Five: In this chapter, the summary and conclusion are presented, incorporating the findings, policy implications, and limitations of the study. This section concludes with recommendations for future research particularly for the fragrant rice industry in Malaysia.

1.9 Summary

The chapter introduced the development and performance of the paddy and rice industry in Malaysia. Also, the chapter summarised the problem statement in the Malaysian Fragrant Rice Industry. Finally, research questions and objectives, significance of the study as well as the scope of the study, are presented.

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LIST OF PUBLICATIONS

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