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PRODUCTION RISK AND TECHNICAL INEFFICIENCY OF PADDY FARMS IN MADA GRANARY AREA, MALAYSIA

KAKA YAHAYA

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By

KAKA YAHAYA

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

November 2016

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DEDICATION

Specifically dedicated to my beloved

Parents,
Late Alhaji Ibrahim Kaka
and
Late Khadiza Ibrahim

Wife,
Fatima Yusuf

Children,
Adamu Yahaya
Ummulkhairi Yahaya
Khadiza Yahaya
Aishatu (Ihsan) Yahaya
Ikram Yahaya

And

Nephew and Niece
Wasila Adamu & Mubarak Adamu

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Doctor of Philosophy

PRODUCTION RISK AND TECHNICAL INEFFICIENCY OF PADDY FARMS IN MADA GRANARY AREA, MALAYSIA

By

KAKA YAHAYA

November 2016

Chairman : Professor Mad Nasir b Shamsudin, PhD
Faculty : Agriculture

This study models technical inefficiency with production risk in inputs as two possible sources of the production variability that characterized Malaysian Paddy Production. Data from a total of 397 Paddy farms randomly sampled from MADA granary area were used for the analysis. The data for the study was sourced from the survey conducted for the period of 2014 farming season. The study employed a trans-log stochastic frontier production function model with flexible risk specification. The empirical estimates revealed that the mean output is positively influenced by seed, fertilizer, agrochemicals and labour. Fertilizer and agrochemicals are found to be risk-reducing inputs, while seed and labour is revealed to be risk-increasing inputs. This by implication means that an average risk-averse producer is expected to use more of fertilizer and agrochemicals and less of seed and labour compared to risk-neutral producer in the study area. Several characteristics of farm operators such as age, education, marital status, household size, farming experience, extension visit, credit access, farm location, cultivation technology, MR219 and MR220CL2 seed variety, planting technology, broadcasting technology, agrochemicals use and harvesting technology were found to have significant effects on the technical inefficiency of paddy production in the study area. It was also revealed that extension visit, credit access, MR219 seed variety, MR220CL2 seed variety, method of broadcasting and harvesting technology significantly reduces the technical inefficiency of producers. The estimated technical efficiency indicates that the efficiency score is overstated when the production technology of the paddy farms is modelled without flexible risk component (87.1 percent) while it was found when estimated with risk component to be 83.6 percent. Profit efficiency of paddy farmers in the study area was also estimated. The model revealed that MADA farmers do not operate on the profit frontier. The average profit efficiency of 73.2 percent implies that, although farmers in the study area are relatively profit efficient, there are clear opportunities that exist for increasing their profit efficiency by almost an average of 27% through improving their technical and allocative efficiency.

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

RISIKO PENGELUARAN DAN KETIDAKCEKAPAN TEKNIKAL DI SAWAH PADI DALAM KAWASAN JELAPANG PADI MADA, MALAYSIA

Oleh

KAKA YAHAYA

November 2016

Pengerusi : Profesor Mad Nasir b Shamsudin, PhD
Fakulti : Pertanian

Kajian ini memodelkan ketidakcekapan teknikal dan risiko pengeluaran dalam input-input sebagai dua kemungkinan sumber pengeluaran yang menggambarkan Pengeluaran Padi Malaysia. Data daripada sejumlah 397 sawah padi yang disampel secara rawak daripada kawasan jelapang padi MADA telah digunakan untuk analisis. Data untuk kajian ini diperoleh daripada kajian yang dijalankan bagi tempoh 2014 pertanian musim. Kajian ini menggunakan model spesifikasi fungsi pengeluaran *trans-log stochastic* dengan risiko fleksibel. Anggaran empirikal menunjukkan bahawa purata output secara positifnya dipengaruhi oleh benih, baja, bahan kimia pertanian dan buruh. Baja dan bahan kimia pertanian dikenalpasti menjadi input penurunan risiko, sementara benih dan buruh dikenalpasti sebagai input peningkatan risiko. Ini secara implikasinya bermakna purata pengeluar mengelak-risiko dijangka menggunakan lebih baja dan bahan kimia pertanian, dan kurang benih dan buruh berbanding dengan pengeluar risiko-neutral di kawasan kajian. Beberapa ciri-ciri pengendali ladang seperti umur, pendidikan, status perkahwinan, saiz isi rumah, pengalaman pertanian, lawatan pengembangan, akses kredit, lokasi ladan, teknologi penanaman, benih MR219 dan MR220CL2, teknologi penanaman, teknologi penyebaran, penggunaan bahah agrokimia dan teknologi penuaian adalah didapati mempunyai kesan yang besar ke atas keidakcekapan teknikal pengeluaran padi di kawasan kajian. Ia juga mendedahkan bahawa lawatan pengembangan, akses kredit, benih MR219, benih MR220CL2, kaedah sebaran dan teknologi penuaian secara signifikan mengurangkan ketidakcekapan teknikal pengeluar. Anggaran kecekapan teknikal menunjukkan bahawa skor kecekapan adalah terlebihanggar apabila teknologi pengeluaran daripada sawah-sawah padi dimodelkan tanpa komponen risiko fleksibel (87.1 peratus), manakala didapati apabila dianggarkan dengan komponen risiko menjadi 83.6 peratus. Kecekapan keuntungan pesawah padi di kawasan kajian juga dianggarkan. Model juga mendedahkan petani MADA tidak beroperasi pada tahap untung. Purata kecekapan keuntungan sebanyak 73.2 peratus menunjukkan walaupun petani di kawasan kajian secara relatifnya adalah berada pada tahap keuntungan cekap, terdapat peluang jelas untuk meningkatkan kecekapan keuntungan

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

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Paddy farming is one of the most important activities in Malaysian Agriculture sector. Paddy (rice) is a crucial part of everyday Malaysian diet. Thus according to Mohd & Shah, (2013), Paddy enterprise was recently identified as the most important food crop for ensuring the nation`s food security.

Paddy is the most important cultivated crops, besides oil palm and rubber in the country, covering a total land area of about 684,545 ha in 2012 (MOA & AI, 2014). About 75% of the paddy farm land (510,606 ha) is located in Peninsular Malaysia while Sabah and Sarawak constitute 6% (44,902 ha) and 19% (129,037 ha) respectively. It is a main staple crop which account for about 86% of the country's food grain production and is considered strategically important crop for food security in the country. Paddy development can be traced back in the 60's when many newly independent nations like Malaysia, considered the improvement of agricultural systems a priority in their planning for the rural development (Terano et al, 2013). One of the early developments in the green revolution was the improvement of paddy farming technologies in Peninsular Malaysia. By the 70's Malaysia was comparatively advanced in paddy sector among the Southeast Asian countries through the introduction of modern technologies. High Yield Varieties (HYV) and corresponding modern rice technologies have increased paddy productivity over the years. However, the introduction of the HYV required a proper farm management especially in the application of fertilizer, water, weedicide and pesticide to ensure that a potential yield from the HYV could be achieved (Terano et al, 2013). In 1970's the Malaysian government introduced a newly initiated irrigation scheme that permitted double-cropping in a controlled environment. During 1970's, there were 131,700 hectares of paddy land in Peninsular Malaysia which were improved through irrigation facilities, of which 110,563 were provided in double-cropping areas.

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Table 1.1 : Paddy planted area, average yield and total production in Malaysia 1965 – 2015

Year	Planted area (ha)	Yield (kg/ha)	Production (tons)
1965	581,904	2,158	1,255,610
1970	704,767	2,386	1,681,420
1975	750,339	2,662	1,997,000
1980	716,873	2,852	2,044,604
1985	656,375	2,975	1,952,914
1990	680,647	2,769	1,884,984
1995	672,787	3,162	2,127,271
2000	698,702	3,064	2,140,904
2005	666,781	3,471	2,314,378
2010	677,884	3,636	2,464,831
2015	690,000	4,036	2,785,000

Source : World Rice Statistics Online query facility, (IRRI, 2016)

As observed in table 1.1, the area under paddy plantation has been steadily increasing from 581,904 hectares in 1965 to 690,000 hectares in 2015. Hence with the increase in the productivity leading to higher yields the production of paddy is also showing an increasing trend over that period. Through the green revolution, paddy yield has increased from 2,158 kg per hectare in 1965 to 4,036 kg per hectare in 2015. According to statistics for rice production presented on the web database of the International Rice Research Institute (IRRI, 2016), there was a drastic increase in yield among Southeast Asian countries from 1963 to 2007 such as from 2.14 ton/ha to 4.99 ton/ha in Vietnam, 1.87 ton/ha to 3.01 ton/ha in Thailand, from 1.24 ton/ha to 3.80 in the Philippine and from 1.72 ton/ha to 4.71 ton/ha in Indonesia. Thus it was inevitable for the Malaysian paddy production to increase alongside the surrounding countries and for the green revolution to have positively impacted the paddy sector and paddy farming systems in Malaysia.

Paddy is mostly cultivated in the designated eight major producing areas called Granary Areas. Granary areas refer to major irrigation schemes and are recognised by government in the national agriculture policy as the main paddy producing areas. The granary areas which cover over 200,000 hectares of the irrigated paddy land are found in Peninsular Malaysia. The mini granary areas with irrigation facilities totally about 28,000 hectares are also found all over the country. These granary areas are Muda Agricultural Development Authority, (MADA); Kemubu Agricultural Development Authority, (KADA); Barat Laut Selangor Integrated Agricultural Development Authority, (IADA Barat Laut Selangor); North Terengganu Integrated Agricultural Development Authority, (IADA Ketara); Krian/Sg. Manik Integrated Agricultural

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Development Authority, (IADA Kerian Sg. Manik); Seberang Perak Integrated Development Authority (IADA Seberang Perak); Pulau Pinang Integrated Development Authority (IADA Pulau Pinang); and, Kemasin/ Semerak Integrated Agricultural Development Authority, (IADA Kemansin Semarak) (figure 1.1). The Granary Areas, which support both main-season and off-season paddy productions, provide about 72% of the rice production in the country (Najim et al, 2007).

Distribution of paddy land areas among eight Granaries (table 1.2) shows that MADA has the highest allocation (96,558 hectares) which constitute 48% of the total Granary Areas (200,505 hectares) in the country. The paddy land allocated to other Granary Areas and their proportions of the total areas are: KADA, 29,450 hectares (15%); IADA Kerian Sg. Manik, 21,108 hectares (11%); IADA Barat Laut Selangor, 19,021 hectares (9%); IADA P. Pinang, 10,305 hectares (5%); IADA Seberang Perak, 14,140 hectares (7%); IADA Kemasin/Semerak, 4,876 hectares (2%); and IADA Ketara, 5,047 hectares (3%).

1. Muda Agricultural Development Authority
2. IADA Palau Pinang
3. IADA Kerian Sg. Manik
4. IADA Seberang Perak
5. IADA Barat Laut Selangor
6. Kemubu Agricultural Development Authority
7. IADA Kemasin Semarak
8. IADA Ketara

Figure 1.1 : Eight Major Paddy Growing Areas in Malaysia
Source : Chee-Wan and Meng-Chang, 2012

The mini Granary Areas are characterized by small and medium scale irrigation infrastructure with different capacities for double cropping as their paddy land area differs. About 80% of the mini Granary Areas is also found in the Peninsular Malaysia, and together with major ones, they constitute about 85% of total paddy cultivated areas. The non-Granary Areas are the non-irrigated rice areas which depend mostly on precipitation include rain fed paddy Sabah and Sarawak (Ahmad et al, 1999). In these areas, singled-cropped paddy cultivation is commonly practiced and with low productivity.

Table 1.2 : Distribution of paddy land areas in hectares among granaries in peninsular Malaysia in 2013

Granary	Cultivated Areas (Ha)	% of Total Cultivated Areas
MADA	96,558	48
KADA	29,450	15
IADA Kemubu	21,108	11
AIDA Barat L. Selangor	19,021	9
AIDA P. Pinang	10,305	5
AIDA Seberang Perak	14,140	7
IADA Kemasin Semarak	4,876	2
AIDA Ketara	5,047	3
Total	**200,505**	**100**

Source : Department of Agriculture Peninsular Malaysia, (MOA & AI, 2014)

1.2 Paddy Planting and Production Trends

There are more than 200,000 paddy farmers who rely on paddy production as the main source of income. The number of paddy farmers is on decrease because of ageing and lack of fresh hands to take over from aged farmers. There are mostly small holder farmers with an average farm size of about 1.5 hectares, and they dominate rice production sector which is highly regulated and subsidized. The areas under paddy production have witnessed an average annual growth rate of 2.6 percent from 680,647 hectares in 1990 to 698,702 hectares in 2000 (figure 1.2). This later declined by 3% to 679,315 hectares in 2014 for all-season paddy production (MOA & AI, 2015). Much of the land area reduction under paddy rice production happened in Peninsular Malaysia under main-season production. A total of 427,356 hectares (that is 63% of total land area under paddy production in the country) were planted for paddy in the main season as against 246,976 hectares planted in the off-season in 2013. Both main and off seasons' paddy are planted in the eight designated Granary Areas which depends largely on irrigation. However, main season paddy is also cultivated in non-Granary Areas under rainfall.

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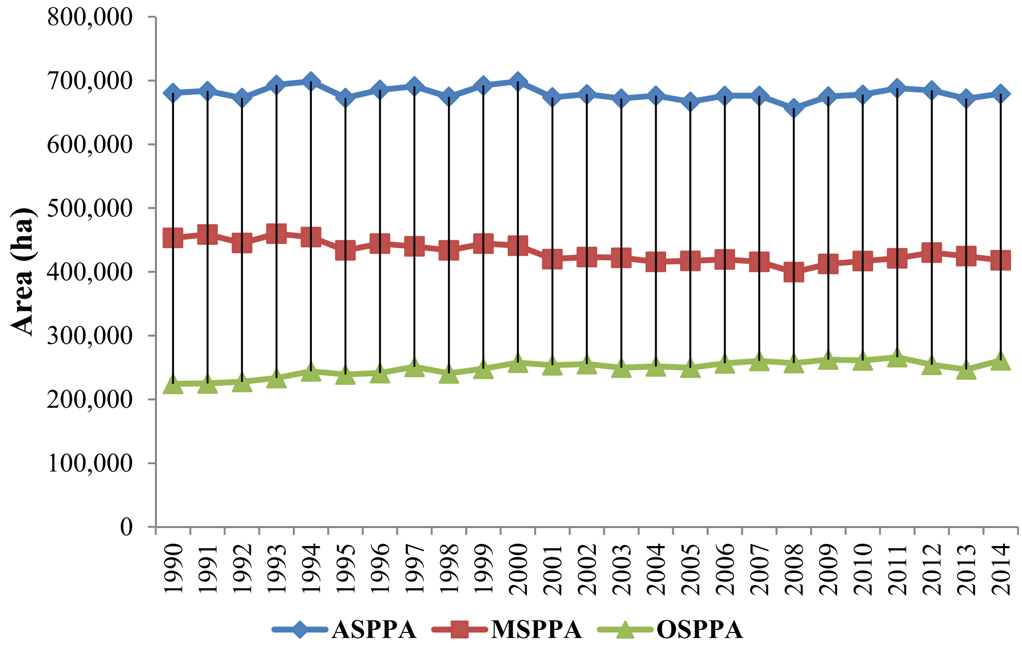

Figure 1.2 : Total Planted Area (ha) for Paddy by Season in Malaysia (1990-2014)
Sources : Paddy Statistics Unit, Malaysian (MOA & AI, 2015). Note: ASPPA (All-Season Paddy Planted Area); MSPPA (Main-Season Paddy Planted Area); and, OSPPA (Off-Season Paddy Planted Area).

According to Malaysian Ministry of Agriculture and Agro-based Industry, Agriculture Statistical (MOA & AI, 2015), main-season paddy production has a commencement month of planting between August to February of the following year, while the off-season paddy cultivation fall between April and June of the same year. All-season paddy refers to yearly summation of data reported in the man-season and off-season paddy production in terms of area planted, area harvested, production and average yield.

Malaysia's paddy production has witnessed an increasing trend in the last two decades (figure 1.3). There was 14% increase in paddy national output from 1.9 million tonnes in 1990 to 2.1 million tonnes in 2000 and further increased by 25% to 2.8 million tonnes in 2014 for all-season. The off season paddy production has shown a steady increase in output (35%) over the years from 785,813 million tonnes in 1990 to 1,222,206 million tonnes in 2014. Within the same period, main season paddy production also witnessed an irregular increase of 24% from 1,230,256 million tonnes in 1990 to 1,626,646 million tonnes in 2014.

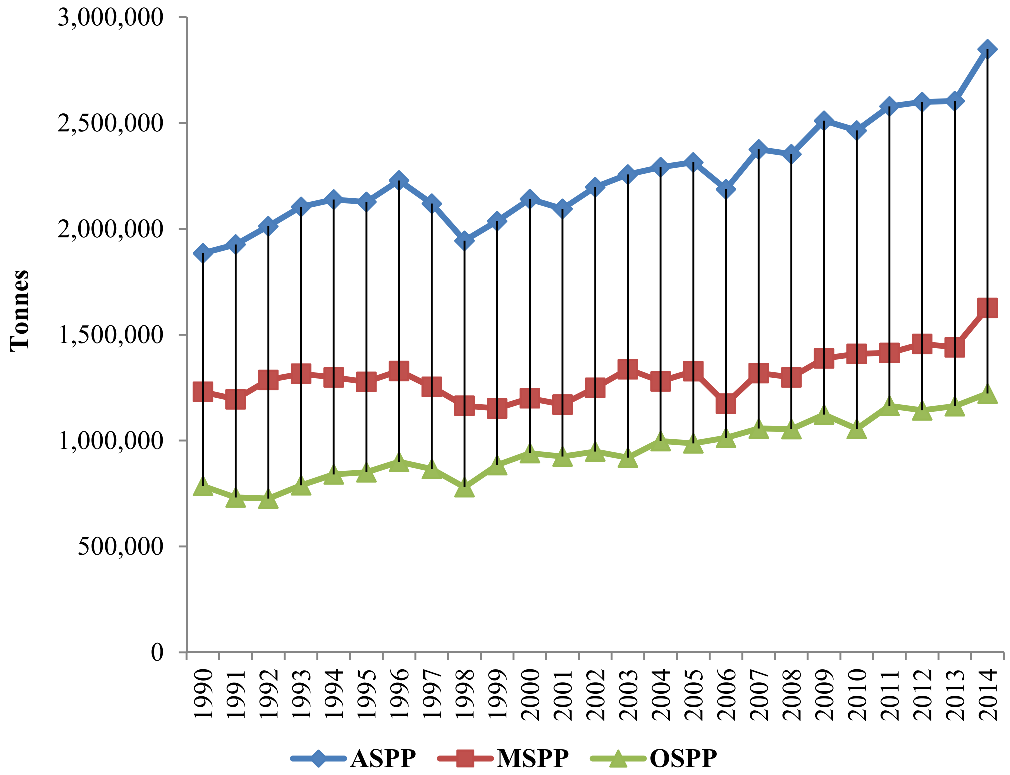

Figure 1.3 : Paddy Production by Season in Malaysia, 1990-2014
Sources : Paddy Statistics Unit, Malaysian MOA & AI, (2015). Note: ARP (All-season Rice); MRP (Main-season Rice Production); and, ORP (Off-season Rice Production).

Paddy yield recorded an increase on the average from 2.7 tonnes / ha to 4.2 tonnes / ha within 1990- 2014 period (figure 1.4). The off-season paddy recorded an increased in yield from 3.5 tonnes / ha to 4.7 tonnes / ha within 1990-2014. The main-season yield increased from 2.7 tonnes / ha to 3.9 tonnes / ha within the same period. The national average yield is lower at about 3.642 tonnes / ha in the main season compare to 4.065 tonnes / ha in the off season.

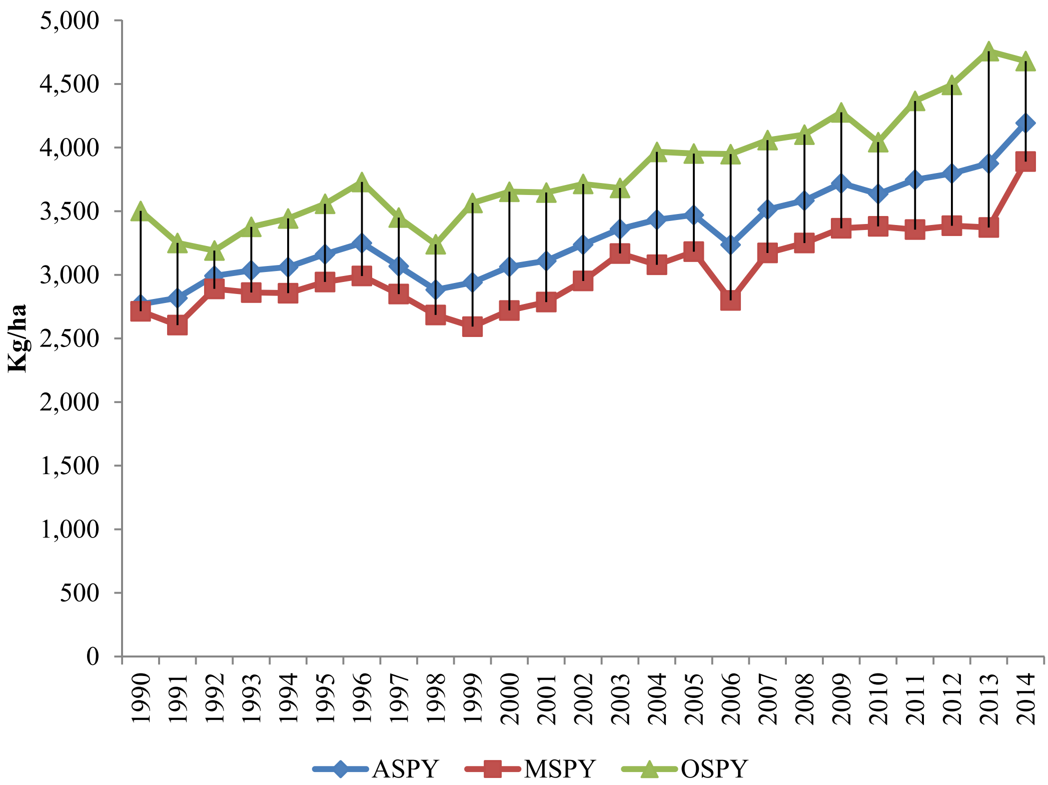

Figure 1.4 : Average Yield of Paddy in Malaysia 1990 to 2014
Sources : Paddy Statistics Unit, Malaysian MOA & AI, (2015). Note: APYD (All-season Paddy Yield); MPYD (Main-season Paddy Yield); and, OPYD (Off-season Paddy Yield).

The estimated paddy production for all States in 2013 according to Department of Agriculture, Malaysia was 2,615,845 tonnes. The production from Peninsular Malaysia contributed 85% (2,243,206 tonnes) to the overall national paddy production while Sabah and Sarawak contributed (15%) 372, 639 tonnes (figure 1.5). As revealed in figure 1.5, Kedah State recorded highest production (889,167 tonnes) followed by Perak (360,135 tonnes) and the lowest state was N. Sembilan with 8,425 tonnes.

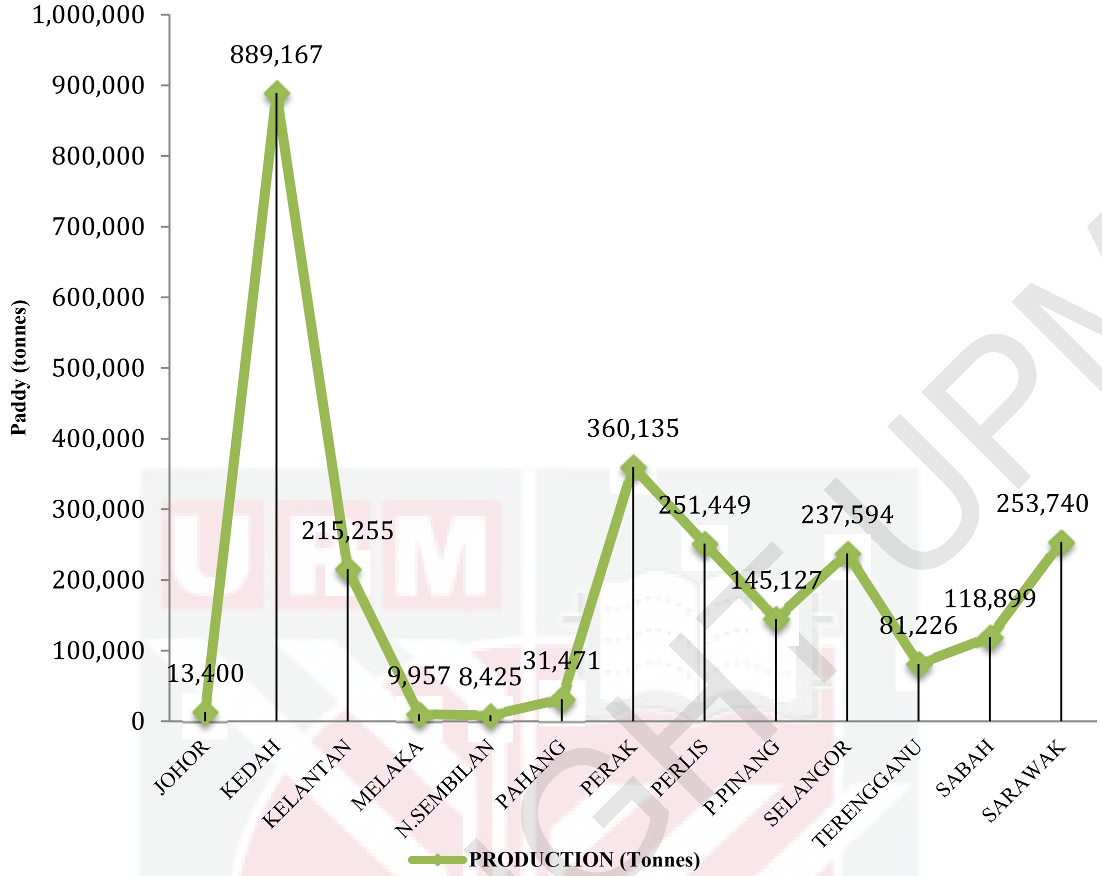

Figure 1.5 : All Season Paddy Production by State, Malaysia 2013
Source : Department of Agriculture, (2013). Note: Total Paddy production is 2,615,845 tonnes

The contribution by granary areas was 82% (1,847,208 tonnes) of the total paddy production in Peninsular Malaysia (figure 1.7). MADA granary was the highest contributor among the eight granary areas contributing 51% (941,889 tonnes) of the total production in the granary areas. This was followed by IADA BLS which contribute 12% (237,594 tonnes) and lastly the lowest contributor IADA Kemansin Semarak contributing only 1% (18,815 tonnes) of the total production in the granary areas. The distributions of paddy planted area for All-Season paddy production over the period of 2013 by States are presented in figure 1.6. From the figure, Kedah has the highest paddy planted area accounting for 31% (210,327 ha) of the national paddy planted area (674,332 ha). This was followed by Sarawak with 20% (134,260 ha) of the national paddy planted area while the least among the States was Melaka with 0.4% (2,783 ha) contribution in the total national paddy planted area.

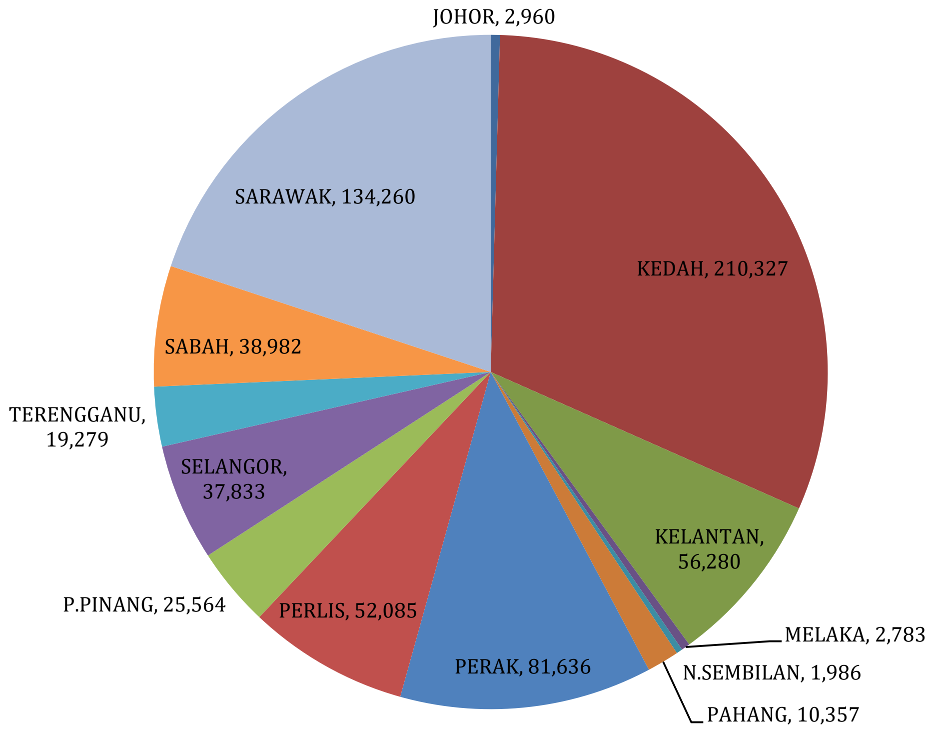

Figure 1.6 : All-Season Paddy Planted Area by State, 2013
Source : Department of Agriculture, (2013). Note: Total Paddy Planted Area is 674,332 Hectares

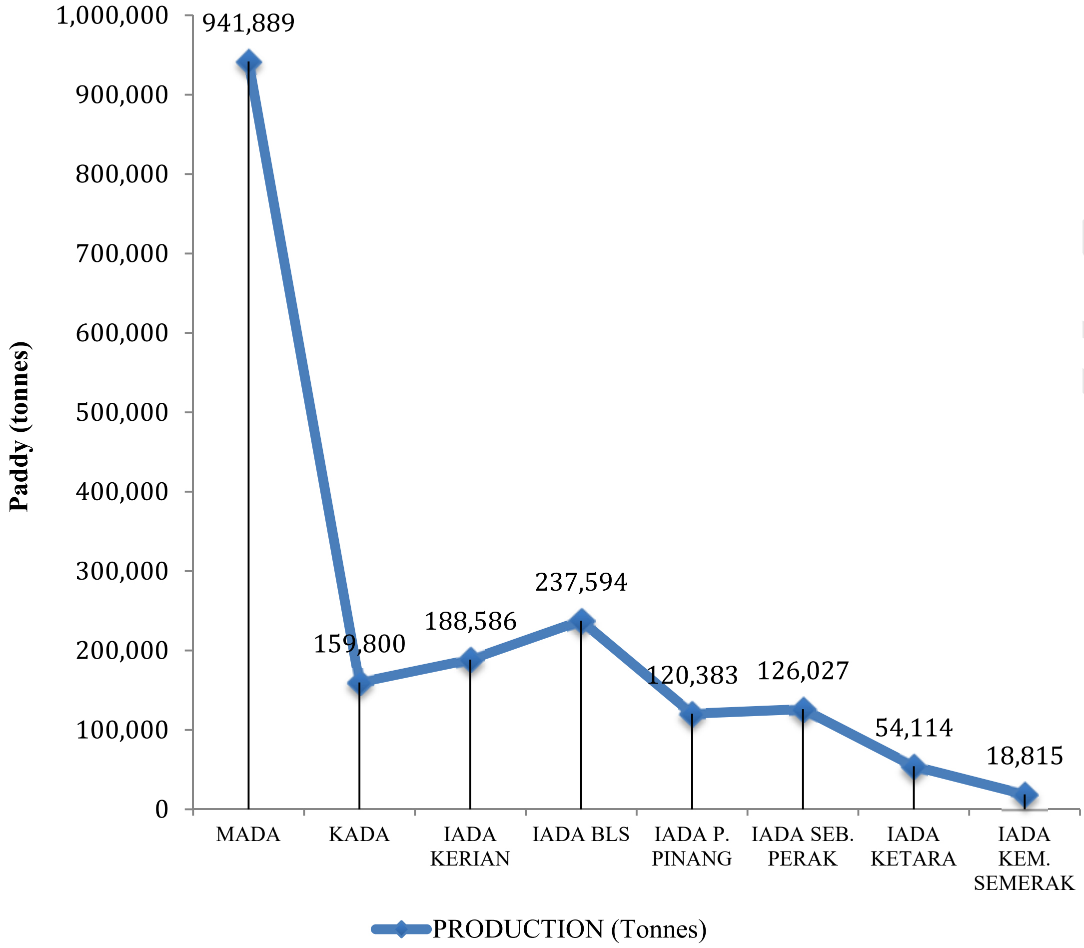

Figure 1.7 : All-Season Paddy Production by Granary Area, 2013
Source : Department of Agriculture, (2013). Note: Total Paddy production is 1,847,208 tonnes

The paddy production estimates of 2013 also shows that the States of Selangor, P. Pinnang and Perlis recorded the highest average yield of 6,280 Kg/ha, 5,677 Kg/ha and 4,828 Kg/ha respectively followed by Johor with an average yield of 4,527 Kg/ha while the state with lowest average yield was Sarawak having 1,890 Kg/ha (figure 1.8).

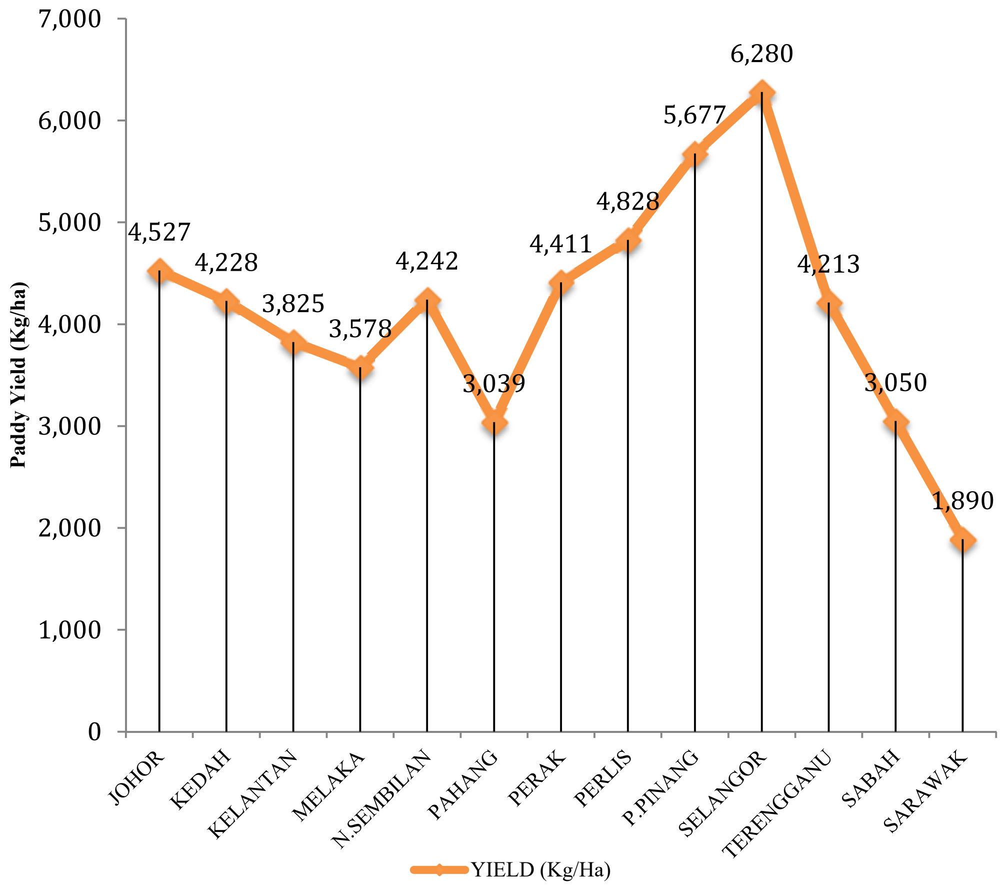

Figure 1.8 : All-Season Paddy Yield by State for 2013
Source : Department of Agriculture, (2013). Note: Average Paddy Yield is 3,879 kg/ha

1.3 Rice Consumption and Imports Trend

The total rice consumption in the country shows an increase of 43% from 1.6 million tonnes in 1990 to 2.8 million tonnes in 2014 (figure 1.9). Within a decade of 1990 and 2000, the national rice consumption increased from 1.6 million tonnes to 1.97 million tonnes (representing an increase of 18%). There is further increase of total consumption by 26% between 2000 and 2014. However, rice consumption per capita is showing a downward trend from about 90 kg in 1990 to about 82 kg in 2012 (Figure 1.10). This implies a reduction in consumption per capita of about 9%. The reduction of rice consumption per capita is attributed to changes in dietary habit, income level and population increase (Fahmi et al, 2013). Even though the domestic rice production increase by 38% from 1.2 million tonnes in 1990 to 1.8 million tonnes in 2014, such increment still creates a deficit of 42% of the national rice consumption by 2014 (figure 1.9). As a result of shortfall in meeting the national rice consumption, rice importation has increased by over 66% from 330,340 thousand tonnes in 1990 to 1 million tonnes in 2014 as depicted in Figure 1.9. The rice importation is necessary to bridge supply-demand gap.

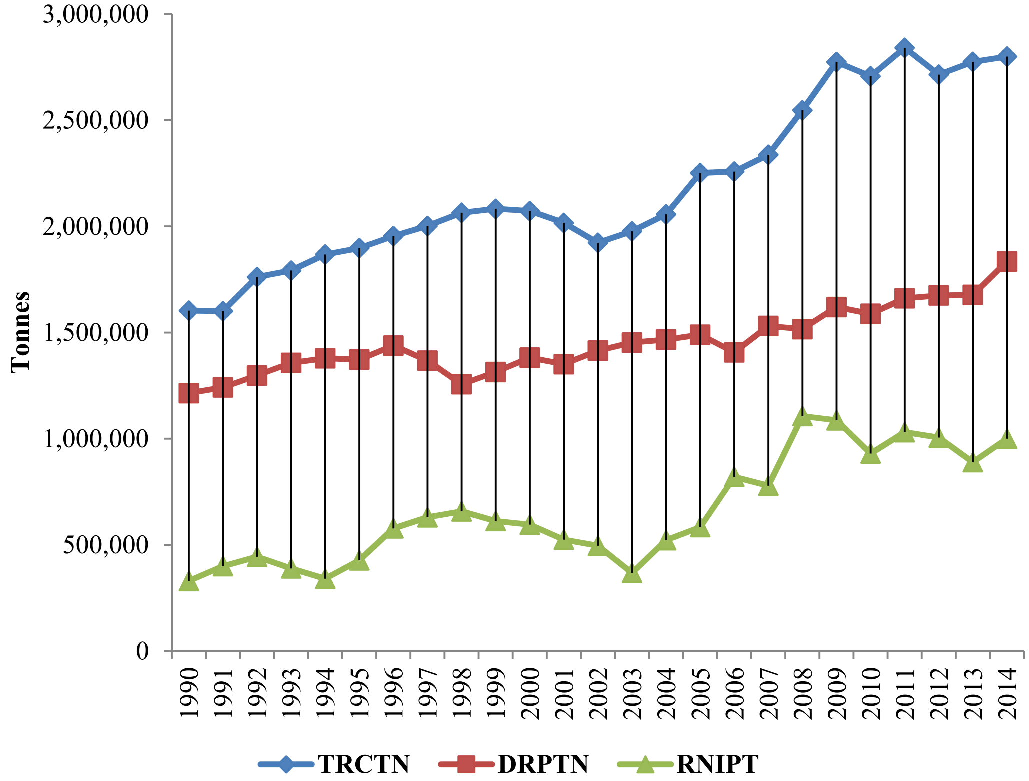

Figure 1.9 : Rice Consumption, Domestic Production and Net Import 1990-2014
Sources : MOA & AI, (2015). Note: TRCN (Total Rice Consumption); DRP (Domestic Rice Production); and, RIM (Rice Net Import).

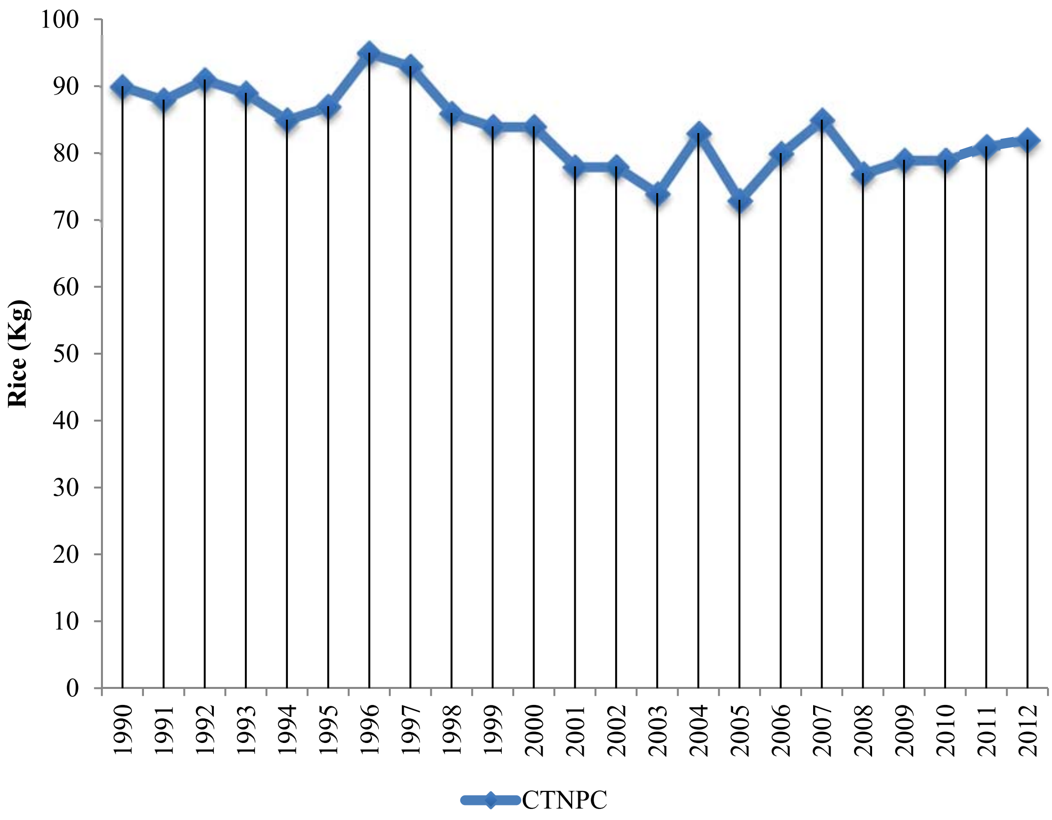

Figure 1.10 : Rice Consumption per Capita in Malaysia 1990 to 2012
Source : Department of Agriculture, (2013). Note: CTNPC (Rice Consumption Per Capita)

The rice import bill has increased astronomically over the last two decades in the country (figure 1.11). The value of rice import increase by over 400% from US$99,739,000 in 1990 to $503,580,000 in 2013. There was increased of about 81% from 1990's value to US$181, 585,000 in 2000. Between 2000 and 2013, the value of rice import into the country increased by over 300%. The highest import value incurred Vietnam has been the first major rice exporter to Malaysia since 2009. In 2011, Vietnam had about 55% of the Malaysian import Market (GRAIN, 2012) Global Agricultural Information Network Report. Thailand (19.3%) which has been the first major rice exporter before taken over by Vietnam (54.1%), is now ranked as the second major rice exporter to Malaysia in 2013 (figure 1.12).

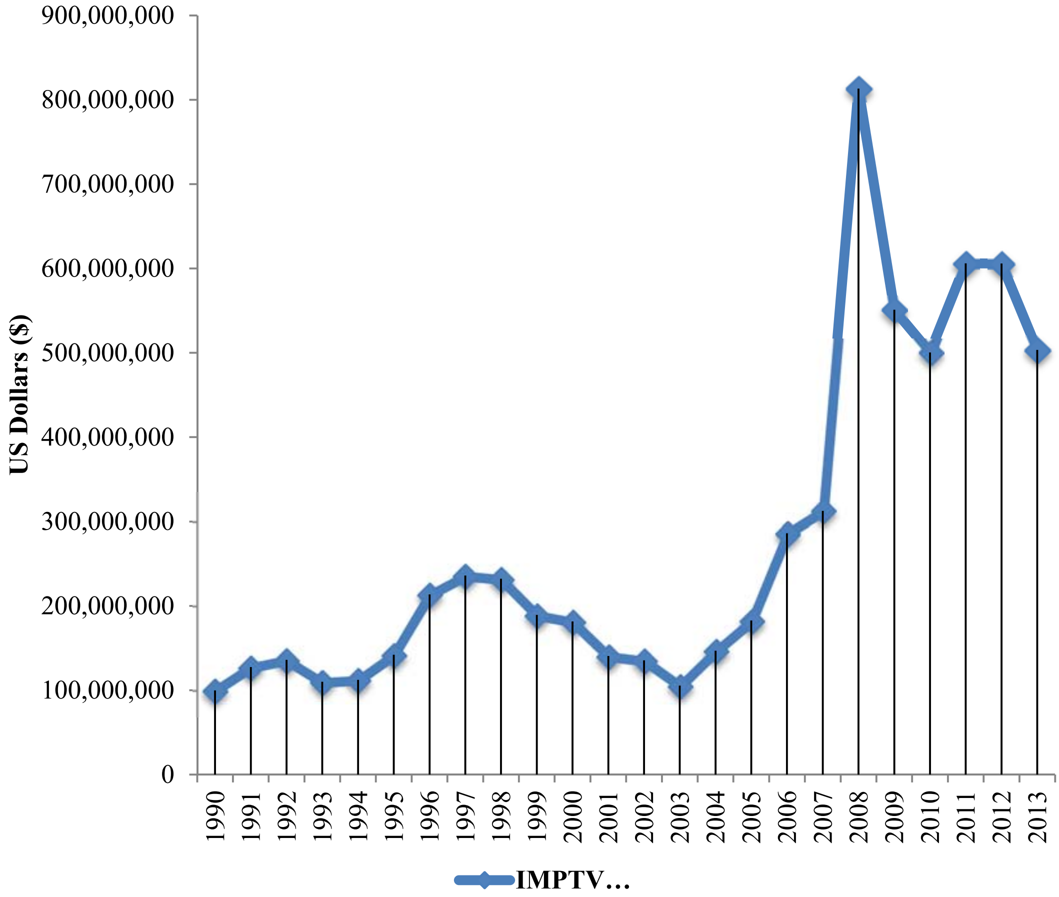

Figure 1.11 : Value of Rice Net Import ($) in Malaysia 1990 to 2013
Sources : MOA & AI, (2015). Note: IMPTV (Value of Rice Import in USD)

The other significant supplier is Pakistan (12.6%), followed by Cambodia (9.5%) and India (3.6%). Malaysian rice import from U.S. was about 9,400 tonnes in 2012, which is mainly short-grain rice variety consumed by Japanese and Korean expatriates (GRAIN, 2013).

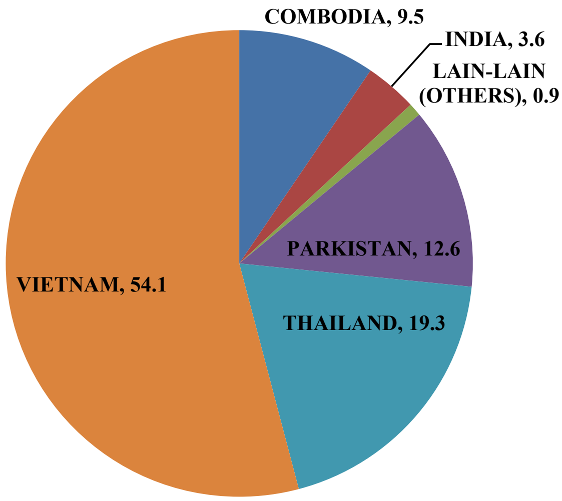

Figure 1.12 : Import of Rice by Country Malaysia in percentage, 2013
Source : Department of Agriculture, (2013). Note: Total import of Rice is 1,583.8 thousand tonnes

In 2011, given the policy of import quota, *Padiberas Nasional Bhd (BERNAS),* a state owned company with the sole right of rice import, was given a 10-year extended mandate of sole importer of rice until 2021. The government has also granted an import duty exemption to *BERNAS,* which allows the imported rice price to be marginally above the local rice price (Vengedassalam, 2013). In an attempt to protect the local rice farmers and in line with the import quota policy, *BERNAS* merely import rice just to cover the shortfalls of demand after ensuring the local rice production finds its way to the market.

Malaysia has a long history of government intervention in rice sector. The global instability in rice prices experienced in early 1970, middle of 1980 and recently in 2008 reinforced the necessity for the state intervention. Three main objectives for the formulation and implementation of various policies on rice through the decades by the government included: (i) ensuring food security; (ii) raising farm income and productivity; and, (iii) ensuring food supply to consumers at reasonable cost. The government supports for the rice sector has been consistently maintained and reflected in both National Agricultural Policy (NAPs) and Malaysia Plans. In 1980s, the government intervention in rice market was strengthened through different policies like monopoly on imports, Guaranteed Minimum Price (GMP) for paddy, fertilizer subsidy, and controlled price at milling. The government also provides investments in building drainage and irrigation facilities and funded research and development in rice. The identification of suitable areas in the states of Sabah and Sarawak for large scale commercial paddy production by the private sector is another strategy adopted by government to ensure rice food security and sufficiency. In terms of production incentives, government has introduced Guaranteed Minimum Price (GMP), paddy price subsidy and input subsidy.

Guaranteed Minimum Price (GMP) and paddy price support production incentives. The GMP was first introduced in 1949. This policy is implemented to ensure paddy farmers receive a reasonable minimum farm income and at the same time reduce poverty incidence. As a price floor policy, however, the GMP is no longer effective because since 1990, the paddy farm price has remained above the GMP at RM700 per tonnes. Similarly, in early 1980s, the price subsidy was introduced. Price subsidy is a price support to increase income of paddy farmers by providing paddy farmers with subsidy at the rate of RM33 per tonnes of paddy produced in 1980s. The rate was later increased to RM167 per tonnes in 1982 (Ahmad et al, 1999). In 1990, a further increased in the paddy price support was recorded to the current amount of RM248.10 per tonnes of paddy produced. The aggregate amount increased unsteadily from about RM468 million in 1990 to about RM531 million in 2000. The amount further increased to about RM 645 million in 2012. In addition, all paddy farmers enjoy a subsidy of RM25 per 100 kg of paddy delivered to a licensed mill or drying facility (GRAIN, 2013). However, recently the government has revised this policy and increased the GMP rate to RM1, 200.00 per ton in 2014. The revision was carried out due to partly the increase in input prices and labour costs.

Malaysia is a high-cost producer of rice and for this reason, government give input subsidies to paddy farmers. The fertilizer subsidy scheme of the government involves granting 240 kg/ha of compound fertilizer (12 bags of 20 kg compound fertilizer per ha) and 100 kg/ha of urea fertilizer (5 bags of 20 kg of urea fertilizer per ha). The aggregate amount of fertilizer subsidy per annum has been hovering unsteadily around RM 140 million and RM146 million between 1990 and 2000. This amount later decreased by about 3% (compare to 2000 value) to about RM 141 million between 2003 and 2009. In 2010, the total amount of fertilizer subsidy increased by 13% to RM 165 million over 2009 amount. It further increased by 6% to about RM 175 million in 2012. Besides to reduce the cost of production, this incentive is also meant to encourage farmers to use fertilizers properly according to the recommendation by government institutions such as the Department of Agriculture or MARDI. Farmers also receive a coupon for chemical inputs valued at RM200 per hectare for buying weeds and pest control.

Over the years, the public interventions in rice industry have earned different levels of self-sufficiency in rice production (table 1.3). Since 1966, the highest self-sufficiency level (SSL) achieved in rice production was 92%. This accomplishment was achieved during the implementation of 3rd Malaysia Plan of 1976-1980.

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Table 1.3 : National self-sufficiency level (SSL) for paddy production in percentage 1966 -2010 in Malaysia

Malaysian Plan/ (NAP)	Period	SSL Targeted (%)	SSL Achieved (%)
1st Malaysia Plan	1966-1970	na	80
2nd Malaysia Plan	1971-1975	na	87
3rd Malaysia Plan	1976-1980	90	92
NAP 1	1984-1991	65	75.9
4th Malaysia Plan	1981-1985	65	76.5
5th Malaysia Plan	1986-1990	65	75
6th Malaysia Plan	1991-1995	65	76.3
NAP 2	1992-2010	65	65
7th Malaysia Plan	1996-2000	65	71
NAP 3	1998-2010	65	71
8th Malaysia Plan	2001-2005	65	71
9th Malaysia Plan	2006-2010	65	72
National Food Security Policy	2008	80 by 2010	72
New Economic Model	2010	85 by 2020	na
National Agro-Food Policy (or NAP 4)	2011-2020	70 by 2012	na

Source : Fatimah and Abdu-Hameed, (2010). **Note**: na (Not available)

The period was characterized by rehabilitation of idle land for agricultural purpose and developing drainage for agriculture and food crops including rice production. The next highest level of self- sufficiency achieved was in the period of implementation of 4th Malaysia Plan (1981-1985). In this period, 76.5% SSL was achieved only next to 92% earlier mentioned. The period also witnessed the implementation first National Agricultural Policy. Food import substitution policy was emphasized during the period aimed at reducing high import bill of about RM4-5 billion annually (Daño & Samonte, 2005). Since 1985, the country self- sufficiency levels in rice production has been fluctuating between 75% and 72% and in all cases overshot the projected level in the master plan. The Ministry of Agriculture and Agro-based Industry, in an attempt to achieve higher self-sufficiency level and food security, adopted 4th National Agricultural Policy, which is now called the National Agro-food Policy 2011-2020 (table 1.3). This policy is targeting at making the country to attain 85% self – sufficiency level in rice production by developing large scale rice farming in Sabah and Sarawak through private sector investment and sector modernization.

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1.4 Risk in Agricultural Production

Agricultural production is generally a risky process. Agricultural risk is associated with negative outcomes streaming from imperfectly predictable biological, climatic and price variables. This variables include natural adversities (pests and diseases), climatic variables not within the control of agricultural producers and adverse changes in both input and output prices (Wanda, 2009).

The stochastic nature of agricultural production is in most cases major sources of risk. Antle (1983) asserted that variability in yield is not only explained by factors outside the farmer`s control such as input and output prices, but also by controllable factors such as varying levels of inputs. A risk-averse farmer therefore, uses less (more) of a risk increasing (reducing) factor than a risk neutral farmer (Pope & Kramer, 1979). Thus, neglecting risk-averse behaviour in agricultural models can lead to important overestimates of the output levels of risky enterprises (Hazell, 1982).

Output risk is an inherent part of the production process of most primary industries e.g. Agriculture, mining and oil extraction (Asche & Tveterås, 1999). Even more so in developing countries where subsistence agriculture predominates, production risk is an issue of great concern. Any production related activity or event that is uncertain is characterized as production risk. Agricultural production implies an expected outcome or yield. Variability in outcomes from those expected yield creates risks to the producer`s ability to achieve financial goals. Reducing variability in expected yields has been a major focus of farm managers.

The conventional stochastic frontier model in the equation 2.3 above proposes the same effect of an input on mean output and variance output. Implying that if an input influences output positively, that input is expected to influence output variance positively and vice versa (Coelli et al, 2005). However, the (Just and Pope (1978) production function proposes a separate effect of the inputs on the mean output and the variance of output or output risk. The factors of production can positively contribute to output but relate negatively to output variance. For example, pesticides, irrigation and disease-resistant seed varieties can reduce output variance and simultaneously, contribute positively to output in a given production process. These inputs are categorized as risk reducing inputs. On the other hand, inputs that influence output variance positively are termed as risk increasing inputs. Just and Pope concluded that the effect of an input on output variance should not be tied prior to output variance but the risk effect of an input depend on empirical studies (Just and Pope, 1978).

The production environment is uncertain and producers input use decisions, as well as environmental factors ultimately affects output. The variability in output as a result of certain input decisions is the risk associated with input use. In countries where subsistence agriculture predominates, production risk is an issue of great concern. One very important characteristic of a risky production process is the observance of random production shocks after certain inputs decisions have been made. With respect to

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relative input uses, a source of deviation from competitive levels is the inputs marginal contribution to the level of output risk (Asche & Tveterås, 1999). Some inputs may reduce the level of output risk, while others may increase risk (Asche & Tveterås, 1999). Production uncertainty is therefore one of the most important ingredients in the formulation of government policy in the inputs decision making of producers (Just and Pope (1978).

Agricultural risk can be categorized into two main types namely, production risk which is characterized by high variability of production outcomes and price risk resulting from volatility of the prices of agricultural output and inputs. The effect of risk and uncertainty is more significant in developing countries due to market imperfections, asymmetric information and poor communication networks (Fufa & Hassan, 2003; Wanda, 2009). The stochastic nature of agricultural production is in most cases a major source of risk, because, variability in yield is not only explained by factors outside the control of the farmer such as input and output prices, but also by controllable factors such as varying the levels of inputs (Antle, 1983). A risk-averse farmer thus uses more of a risk reducing factor than a risk neutral farmer (Pope & Kramer, 1979). Some inputs may reduce the level of output risk (e.g. pesticides) while others may increase risk (Asche & Tveterås, 1999).

The first attempt to separate the effect of the inputs on the mean output and the variance of output or output risk was by Just and Pope (1978). The Just and Pope (1978) production function is represented as shown below:

$$y_i = h(x_i; \alpha) + exp\, g(x_i;\ \Psi) v_i \qquad (1.1)$$

$g(x_i; \Psi)v_i$ Represent the idiosyncratic component of production risk as a result of farm specific factors. Given the mean output function is $E(y_i) = h(\chi_i)$ and the variance of output is $v = g^2(x_i)$. The marginal production risk which measures the effect of input on the production risk is given as:

$$\frac{\partial var(y_i)}{\partial \chi_i} = 2g(\chi_i; \Psi) g_i(\chi_i; \Psi) \qquad (1.2)$$

Marginal risk can be positive as well as negative depending on the signs of $g(\chi_i; \Psi)$ and $g_i(\chi_i; \Psi)$. where the later is the partial derivative of g with respect to the input i. A positive marginal risk means the input has an increasing effect on the output risk and a negative value means that the input has a decreasing effect on the output risk Just and Pope (1978). Therefore estimating efficiency to account for production risk depends on the input levels. A lot of work has been done in attempt to provide empirical evidence on how risk influences the nature of decisions in agricultural production.

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These attempts can be categorized into two groups of studies. The first group aimed at estimating producer's attitude towards risk that influences their input allocation and output supply decisions. These studies have employed either the experimental or econometric approaches to bring out risk attitudes of individual producers. The experimental approach is based on hypothetical questionnaires regarding risky alternatives or risky games with or without real payments (Wik et al, 2004). Among the studies that have employed this approach include; (Binswanger, 1981) that used risky games with real payments to measure Peasant's risk preferences in an experiment in India. The econometric approach is based on individuals" actual behaviour assuming expected utility maximization. Studies that have used this approach to elicit producer's risk attitudes include; Antle (1983), Love & Buccola, (1991), Pope & Just, (1991). However, the econometric approach has been criticized for confounding risks behaviour with other factors such as resource constraints faced by individual decision makers (Wik et al., 2004). This is particularly important in developing countries where market imperfections are prominent and production and consumption decisions are non-separable (Sadoulet and de Janvry, 1995).

The second group of studies has attempted to investigate the influence of risk on agricultural production by directly incorporating a measure of risk in the traditional production functions. Such studies include work by Just and Pope (1979) that focused on production risk, measuring it by variance of output. They also suggested the use of the production function specifications satisfying some desirable properties. The main focus in their specification is to allow inputs to be either risk increasing or risk decreasing. The Just-Pope framework, however, does not take into account producer's attitude towards risk (Kumbhakar, 2002). Love & Buccola (1991) extended the Just-Pope function to consider producer's risk preferences in a joint analysis of input allocation and output supply decisions. Wan & Battese (1992) proposed an alternative stochastic frontier production function which permits the estimation of technical efficiency to account for production risk. This study belongs to the second group of studies where the influence of production risk is investigated by directly incorporating a measure of risk in the traditional production function.

Efficiency represents the degree of success which producers achieve in allocating the available inputs and the outputs they produce, in order to achieve their goals which is to attain a high degree of efficiency in cost, revenue or profit. The production frontier is therefore the maximum output attainable by a given set of inputs and existing production technologies. In estimating stochastic production technology, the model adopted must account for, production risk and technical inefficiency (Just and Pope 1978; Kumbhakar, 2002). Technical efficiency (TE) of i-th farmer is defined by the ratio of the mean production for i-th farmer given the values of the inputs and its technical inefficiency effect (u_i) to the corresponding mean production if there were no technical inefficiency of production (eqn 3.5). According to Kumbhakar, (2002), technical inefficiency (TI) depends positively upon the production risk function and negatively on the mean output if there were no inefficiencies (eqn. 3.6). This means that technical efficiency (TE) is also dependent upon production risk because mathematically, $TE_i = 1 - TI_i$. Therefore important to incorporate production risk in the stochastic frontier estimation. Allocative efficiency (AE) refers to the ability of a firm to produce at a given level of output using the cost minimizing input ratios. It reflects the ability of a firm to use inputs in optimal proportions, given their respective prices. The economic (profit) efficiency is measured by the global economic performance of the firm, that is, by its ability to make its operations profitable. According to Farrell (1957), economic (profit) efficiency is the product of technical efficiency and the allocative efficiency. According to his definition, it appears that a firm cannot be 100% efficient economically if it is not 100% efficient technically and at the same time 100% efficient allocativelly.

1.5 Problem Statement

Paddy farming in Malaysia is inherently operated with risk emanating from weeds, pests and diseases, inadequate supply of quality seed, extension support and intensive management practices. Others include limited opportunities for credit and the presence of technical inefficiency, which was identified by previous studies (Alias & Ismail, 1996; Ghee-Thean et al, 2012 and Mailena et al, 2014) focusing on this sector as indispensable for sustainable paddy production. Despite the importance of paddy in the nation`s farming system, actual paddy yield in MADA was low (4.5 t/ha) when compared to potential yield of 10 t/ha in the country reported by Ghee-Thean et al, (2012) and continue to fluctuate due to increasing diseases, pests and soil fertility decline. However, studies have shown that the effects of these uncertainties on production can be investigated through the choice of inputs on the output variance, otherwise known as production risk in inputs. The realization of output is uncertain and the ability of farmers to obtain maximum yields given a set of input factors is often influenced by their input decisions as well as environmental factors. Certain input factors may contribute positively to the realization of output whiles others may not. Environmental factors such as the incidence of pests and diseases, drought and floods ultimately affect the ability of farmers to obtain high yields.

Every farmer`s goal is to employ input factors in such a way as to obtain the maximum achievable yield. Large variations between observed yields and maximum achievable yields are therefore undesirable. Farmers input choices tends to affect the extent of output variability observed. The employment of certain input factors in the production process may result in the observance of high fluctuations in yield and others may not. The nature of the input factors with regards to how they affect output variability (risk) is therefore necessary for input allocation decisions. The variability of output with respect to input use is the risk associated with the production process.

Given the fact that risk considerations may be a factor when choosing between production plans as it might influence observed production output, it is necessary to take it into account when assessing the performance of the paddy production industry. In assessing the paddy production industry, certain socioeconomic and managerial factors that may boost production should also be identified. Not accounting for production risk with respect to input use, results in biased estimates of technical efficiency. These biased estimates may be misleading to policy makers.

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Presently, government provides input subsidy at 240kg/ha mixed fertilizer and 80kg/ha for organic fertilizer as well as RM 200/ha/season subsidy for pesticides control. The price support is currently at RM 248.1/ton with guaranteed minimum price of RM750/ton. In addition government provides the yield increase incentive of RM 650 for increasing level compare to previous year and production increase incentive in form of ploughing expenses at a maximum of RM 100/ha and additional fertilizer of RM140/ha/season (Mailena et al, 2014). Even though there have been many continuous effort on paddy farms, however, there was no significant improvement in the yield. The average yield at 3.9t/ha (DOS, 2013) is lower than the actual paddy farm yields in Malaysia which vary from 3 to 5t/ha and it was below than the neighbouring countries such as Indonesia and Vietnam at 5.13t/ha and 5.75t/ha respectively (FAOSTAT, 2012). Moreover, recent result generated from World Rice Statistics Online Query Facility (IRRI, 2016) website revealed variation in yield obtained from Malaysian paddy production. According to the data, 3.72t/ha, 3.64t/ha, 3.88t/ha and 3.84t/ha was realized in 2009, 2010, 2013 and 2014 respectively.

Those conditions conceive that the difficulties on improving the yield is potentially cause by un-intensive use of inputs due to the un-efficient management on paddy farms. Thus, the improvement on the efficiency of input used and farm efficiency will be fundamental and the measurement of the existing farms efficiency including risk properties of inputs therefore much more useful. Several studies on efficiency aspect of paddy production conducted applied stochastic production frontier in measuring paddy technical efficiency yet, the production risk of inputs that provide the information on which input(s) is risk decreasing or risk increasing did not receive the special attention on those studies. In view of this development, this study therefore models the technical efficiency of paddy farms with production risk indicated by the effects of inputs use on output variance with a view to support the creation of efficiency improving policies that will raise the productivity of paddy farms to meet efficient utilization of resources towards achieving self-sufficiency level.

1.6 Objectives of the Study

The general objective of the study is to investigate production risk and technical inefficiency as two possible sources of production variability of Malaysian Paddy farms. The specific objectives of the study are:

a. To measure production behaviour and risk with respect to farmer's technological inputs;
b. To measure the existing condition of paddy farms by estimating the technical efficiency levels and identifying the determinants of technical inefficiency levels; and
c. To estimate profit efficiency levels and factors influencing profit inefficiency levels.

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1.7 Significance of the Study

Agricultural producers make decisions in a risky environment resulting from production uncertainty (weather, pests, diseases etc.), market and price (input and output), and financial (interest rates). How farmers manage these risk is greatly influenced by their attitudes towards or willingness to take risk. There is strong evidence that farmers are universally risk averse and that they seek to avoid risk through various institutional and managerial mechanisms.

Productivity estimates of technological input factors to Paddy output will provide insight on the relationship of the various technological input factors to output and the extent to which output will change if the input factors are changed. The estimated scale elasticity of production also gives an indication of the change in output if all the factor inputs are varied by the same proportion. These estimates help to inform policy on the right input mix which will result in increased output. The findings from the production risk component will give insight into how the individual technological inputs affect variations in output. Some technological input factors may tend to increase output variance while others may not. This information is necessary for input allocation decisions.

The technical efficiency levels will also give an indication of the extent of utilization of the present technology employed in the production process and the potential for improvement. There is uncertainty associated with input use in every production process which should be accounted for when accounting for technical efficiency. Relevant factors that can improve technical efficiency in Paddy production process in MADA Granary Area will be identified. This knowledge will provide useful information for all stakeholders that are involved in the design and implementation of programs and policies aimed at improving Paddy production in Malaysia. An improvement in technical efficiency of production will evidently result in increased output which will also ultimately go a long way to affect the income of the famer and also improve their standard of living. The outcome of this study will also contribute to literature on the improvement of technical efficiency of Paddy production industry and also the mitigation of risk in Malaysia Paddy production process.

1.8 Organization of the Thesis

The thesis is organized into five chapters. Chapter one deals with Background of the study, Problem statement, Objectives and Significance of the study. Chapter two presents the literature review of the various approaches for efficiency measurements: non-parametric and parametric (deterministic and stochastic frontier approaches), production risk, the incorporation of production risk in the stochastic frontier model as well as the empirical applications of the various approaches. Chapter three outlines the methodology employed for the study which comprises information about the method of analysis such as conceptual framework, theoretical framework, empirical analysis for estimating technical efficiency and production risk and the hypothesis test. It also outlines the data and sampling technique employed and information about the study area. Chapter four presents the results and discussion of the study with respect

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to each specific objective, summary statistics of the output and input variables, description of Socio-economic characteristics of the respondents, results of the various hypotheses tested, the estimates of the marginal output risk and the inefficiency model estimates and estimates of profit function model. Finally chapter five presents summary, policy implications and conclusion of the study.

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LIST OF PUBLICATIONS

Yahaya Kaka, Mad Nasir Shamsudin, Alias Radam and Ismail Abd. Latif (2016**).** Profit Efficiency among Paddy Farmers: A Cobb Douglass Frontier Production Function Analysis. *Journal of Asian Scientific Research 6(4): 66-75.*

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