UNIVERSITI PUTRA MALAYSIA

SYSTEM DYNAMICS ANALYSIS OF THE PADDY DEDUCTION SYSTEM IN THE MADA GRANARY AREA IN MALAYSIA

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By

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

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Prof. Datin Paduka Fatimah Mohamed Arshad, PhD
Faculty : Institute of Agricultural and Food Policy Studies

Paddy deduction rate refers to the ratio of bad paddy to the total paddy produce sold to the buyers including millers and other intermediaries. It is important to ensure good quality of paddy before processing it to rice. However, the determination of paddy deduction rate often goes above the deduction rate recommended by the government. Therefore, this study examines the decision making process in deriving the paddy deduction rate that mutually agreed both by the farmers and millers in the MADA area which is the largest granary area in the country. A system dynamics methodology is used to capture the complexity of decision making of the major actors at the farm level market. The complexity characteristics include: feedback relationship or circular causality between decisions made by sellers and buyers, delays and non-linearity behavior. A system dynamics model representing such decision making was developed and assessed by simulating three different scenarios. They are: (i) maximizing good farm practices, (ii) increasing the capacity of combine harvester and (iii) adjustment by the government on the domestic paddy price and retail prices. Their impacts on deduction rate, moisture content, farmers' income and millers' profitability were subsequently investigated. This study revealed that maximizing farm practices, increasing the capacity of combine harvester machine, adjustment by the government in the domestic paddy price and retail price have significant impacts on the determination of the desired paddy deduction rate between the farmers and millers in the MADA granary area. The simulation results suggested that the Scenario Three (S3), which comprised the changes in the farm practices, machine harvester efficiency, domestic paddy price and retail price rice, produced the most significant impacts on the paddy deduction rate imposed on the farmers and changes in the miller's profitability. Therefore this study suggests that there is a need for the farmers to maximize their farm practices in order to achieve the lower paddy deduction rate.

The better farm practices adopted by the farmers, the lower the paddy deduction will be.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

ANALISIS SISTEM DINAMIK KE ATAS SISTEM PEMUTUAN PADI DI KAWASAN MADA DI MALAYSIA

Oleh

RAWAIDA RUSLI

April 2018

Pengerusi : Prof. Datin Paduka Fatimah Mohamed Arshad, PhD
Fakulti : Institut Kajian Dasar Pertanian dan Makanan

Kadar pemutuan padi ditafsirkan sebagai nisbah padi yang kurang bermutu kepada jumlah padi yang sedia ada untuk dijual kepada pembeli termasuk pengilang dan perantara lain. Adalah penting untuk memastikan kualiti padi berada pada tahap yang terbaik sebelum diproses menjadi beras. Walau bagaimanapun, kadar pemutuan padi yang sebenar yang dicapai adalah melebihi kadar pemutuan yang ditetapkan oleh kerajaan. Oleh itu, kajian ini dijalankan untuk mengkaji proses pembuatan keputusan bagi mencapai kadar pemutuan padi yang dipersetujui oleh para petani dan pengilang di kawasan MADA yang merupakan kawasan pengeluaran padi terbesar di negara ini. Pendekatan sistem dinamik telah digunakan untuk merungkai pembuatan keputusan yang kompleks di antara pemain utama di peringkat ladang. Ciri-ciri yang menggambarkan sifat yang kompleks adalah: hubungan dan perkaitan pembuat keputusan antara penjual dan pembeli padi, jeda dan gelagat yang tidak linear. Sistem dinamik model telah dibangunkan dan dinilai dengan menjalankan simulasi ke atas tiga senario yang berbeza. Senario tersebut adalah (i) memaksimakan amalan perladangan yang baik, (ii) peningkatan kapasiti mesin lepas tuai, dan (iii) pengubahsuaian oleh kerajaan ke atas harga padi dan runcit beras. Kesan senario ini ke atas pemutuan padi, lembapan basah, keuntungan petani dan keuntungan pengilang telah dianggarkan. Kajian ini menunjukkan bahawa memaksimumkan amalan perladangan, peningkatan kapasiti dalam mesin penuai padi, pelarasan kerajaan terhadap harga padi runcit beras memberi kesan yang bererti terhadap penentuan kadar pemutuan padi yang diingini antara para petani dan pengilang di kawasan MADA. Keputusan simulasi mencadangkan bahawa Senario Tiga (S3) iaitu perubahan di dalam amalan perladangan, kecekapan kapasiti mesin lepas tuai, harga padi dan harga runcit beras menunjukkan impak yang bermakna ke atas kadar pemutuan padi ke atas petani dan juga perubahan di dalam keuntungan

pengilang. Oleh itu, kajian ini mencadangkan, adalah perlu untuk petani memaksimumkan amalan perladangan di dalam mencapai kadar pemutuan yang dikehendaki. Semakin baik amalan perladangan yang dilaksanakan, semakin berkurangan kadar pemutuan padi yang dikenakan.

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

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LIST OF ABBREVIATIONS

ASEAN	Association of Southeast Asian Nations
B	Balancing
BAU	Business as Usual
BERNAS	PadiBeras Nasional
BULOG	Badan Urusan Logistik (Logistics Bureau)
CGE	Computable General Equilibrium
CLD	Causal Loop Diagram
CU	Capacity Utilization
Dmnl	Dimensionless
EPU	Economic Planning Unit
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GMP	Guaranteed Minimum Price
Ha	Hectare
IADA	Integrated Agriculture Development Area
IO	Input-Output
IoT	Internet of Things
KADA	Kemubu Agricultural Development Authority
Kg	Kilogram
MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MC	Moisture Content

MSE	Mean Square Error
MT	Metric tonne
MoA	Ministry of Agriculture
NAFAS	National Farmers Organization
PPSS	Paddy Price Subsidy Scheme
R	Reinforcing
R&D	Research and Development
RM	Ringgit Malaysia
RMSPE	Root Mean Square Percent Error
S1	Scenario 1
S2	Scenario 2
S3	Scenario 3
SD	System Dynamics
SFD	Stock and Flow Diagram
SSL	Self-Sufficiency Level
THB	Thai Baht
Ton/t	Tonne
TSCC	Total Supply Chain Cost

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces the background of paddy and rice industry followed by a brief discussion on government intervention with emphasis on the paddy deduction rate in MADA granary area. The scope of the study, its significance, and organization of the policy study are delineated towards the end of the chapter.

1.2 Background of Paddy and Rice Industry in MADA Granary Area

Muda Agriculture Development Authority (MADA) is located in the northern Malaysia, which is also one of the prime Malaysian granary areas. The Malaysian granary areas consists of ten granary areas which are, MADA, Kemubu Agricultural Development Authority (KADA), Integrated Agriculture Development Area (IADA) Kerian, IADA Barat Laut Selangor, IADA Pulau Pinang, IADA Seberang Perak, IADA KETARA, IADA Kemasin Semerak, IADA Pekan and IADA Rompin. MADA contributes the highest to the paddy production from the granary area in Malaysia (Figure 1). Overall the granary aarea has contributed almost 70 percent of its paddy production to the total paddy production in Malaysian since 2015 (Figure 1.2).

Figure 1.1 and 1.2 shows the significant increase in the paddy production in the MADA granary area as well as Malaysia as a result of major intervention by the Malaysian government in the paddy and rice industry as part of the five year Malaysian Plans. The Malaysian paddy and rice industry is crucial to the nation for food security reason since 1960s. The Government has allocated huge amount of resources for the industry in order to achieve the objectives – (1) to safeguard national food security; (2) to improve farmer's income; (3) and to ensure stable rice price level for the consumers.

In addition, the Government has also embarked on interventionist policy to insulate the industry from the market vagaries, such as price volatility and unstable supply. Figure 1.3 summarizes the government interventions in the paddy and rice supply chain starting from input, production, milling and trading.

The Government intervenes in the production sector by offering subsidies of seeds, fertilizers, pesticides, irrigation, cash incentives and Guaranteed Minimum Price (GMP), which was started since 1957 as the floor price to protect the farmers from the unstable international price market as well as to increase the farmer's income (Tengku Mohd Ariff & Ariffin, 1989). The GMP continuously served until the mid-2014 in which the GMP was no longer imposed as the paddy price has been fixed at RM 1,200 per tonne.

In the trading sector, PadiBeras Nasional (BERNAS) has been granted with the import monopoly and purchasing licence to import the rice. Meanwhile, for the milling sector, the government imposed the price control to assure reasonable prices for the consumers. For the distribution sector, the rice price is controlled by the government.

Despite the massive government intervention along the paddy and rice supply chain, the sector has also experienced higher degree of market intervention in comparison with other agricultural commodities due to the food security and socioeconomics reasons (Tengku Mohd Ariff & Ariffin, 1999).

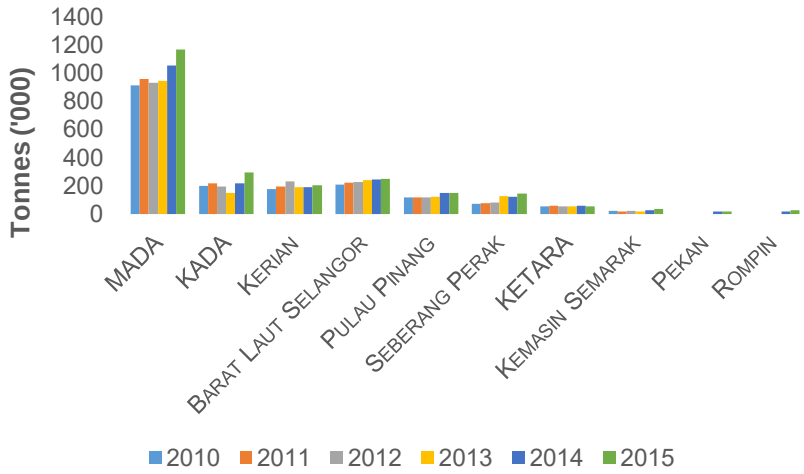

Figure 1.1 : Contribution of Paddy Production in Various Granary Areas in Malaysia ('000 tonnes), 2010-2015
Source : Department of Agriculture (2015)

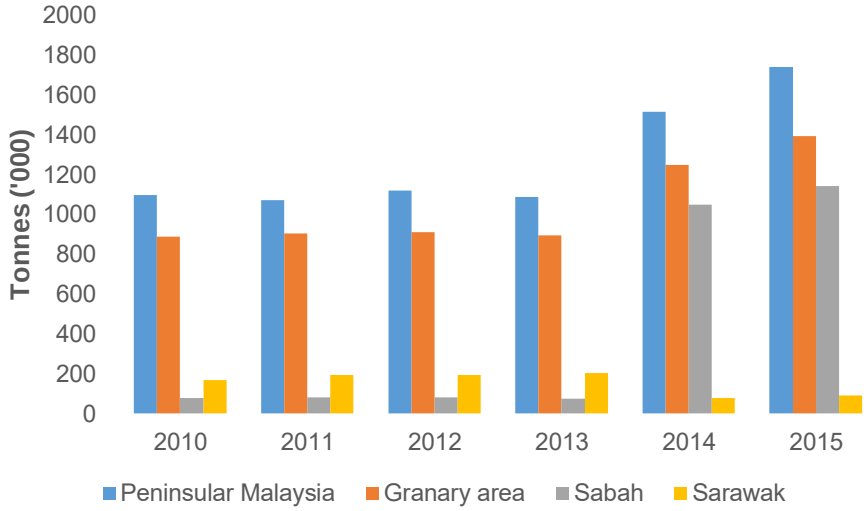

Figure 1.2 : Contribution of Granary Areas in Paddy Production in Malaysia ('000 tonnes), 2010-2015
Source : Department of Agriculture (2015)

SECTOR	MARKET INTERVENTIONS	INDUSTRY PLAYERS
INPUTS	Subsidies on petroleum, centralized input distribution system by NAFAS	INPUT SUPPLIERS
PRODUCTION	Subsidized Seeds, Fertilizers, Pesticides, Irrigation, Cash Incentives, Extension Services, GMP	PADDY FARMERS
TRADING	Import Monopoly & Purchasing Licence	RICE IMPORT (BERNAS); PADDY TRADERS (BROKERS & AGENT)
PROCESSING	Miller Subsidy for ST 15 (up to 2015), Energy Subsidy, Milling Licence	BERNAS RICE MILLS; PRIVATE RICE MILLERS
DISTRIBUTION	Fixed price for ST15 (RM1.65-1.8 per Kg), Ceiling Price (RM 2.40/Kg) for SST10 & RM 2.60/Kg for SST 5), Distribution Licence	BERNAS WAREHOUSE → BERNAS WHOLESALERS; PRIVATE WHOLESALERS; RETAILERS
CONSUMPTION	Ceiling Price for Rice	CONSUMERS

Figure 1.3 : Paddy and rice supply chain in Malaysia
Source : Fatimah (2011)

Based on Figure 1.3, the market interventions are quite extensive, affecting farmers, millers, traders and consumers. However, the intervention has undesirably caused market distortion proven in many parts of the world.

In the case of Malaysia, the market distortion is observed in terms of prices that the GMP and ceiling prices are set above the border price. Other symptoms of market distortion include; arbitration activity or active rice smuggling at the country's border, adulteration of rice qualities, static milling rate and slow progress of value added activities as shown in Figure 1.4. The production sub-sector is plaque with several issues, such as poor paddy quality, and slow progress in the drying and milling sub-sector and rice supply chain.

In view of the issues and problem across the sub-sectors, various policy strategies have been implemented across the supply chain. The policies set include the GMP, the Paddy Price Subsidy Scheme (PPSS) for the farmers, the miller's subsidy for the millers to produce more ST15 (Peninsular) and SS 15 (Sabah and Sarawak), and zoning subsidies for the lower grade rice. However, the millers' subsidy was withdrawn in 2015. By strategy, these policies are meant to increase the paddy and rice productions levels.

The flat-rate paddy deduction had been since 1979 along with the introduction of paddy price subsidy scheme to increase the farmer's income although the actual rate deducted was around 24 to 25 per cent for the dry season and around 26 to 27 per cent for the rainy season (Salman, 2010). Therefore, these data indicate high moisture content of paddy sold to the millers for processing. Consequently, the millers have to incur the higher drying and operating costs for paddy with higher moisture content.

In the mid-2014, the flat rate deduction had been changed to the "actual" paddy deduction, to reflect the actual quality of paddy sent to the mills. However, the paddy deduction remains high, which affected the net price paid to the farmers. On the miller's side, the paddy deduction rate can be higher due to the negotiation made at the mills. Besides, the millers use the deduction rate as a means to increase their profit margin which is being squeezed due to fixed retail and wholesale prices.

The above deliberation indicate a complex interaction between the farmers and millers. Each side's decision is determined by a number of factors or variables in the paddy and rice market system. The agreed deduction rate is the product of interaction of the two parties. Clearly there is a feedback communication between the two between the circular causality in that each in responding to the other party's decision. Taking into account factors that matter to them. In view of

the complexity of the deduction rate negotiation, this study attempts to examine the decision making process of the actors (farmers and millers) in deriving the desired paddy deduction rate.

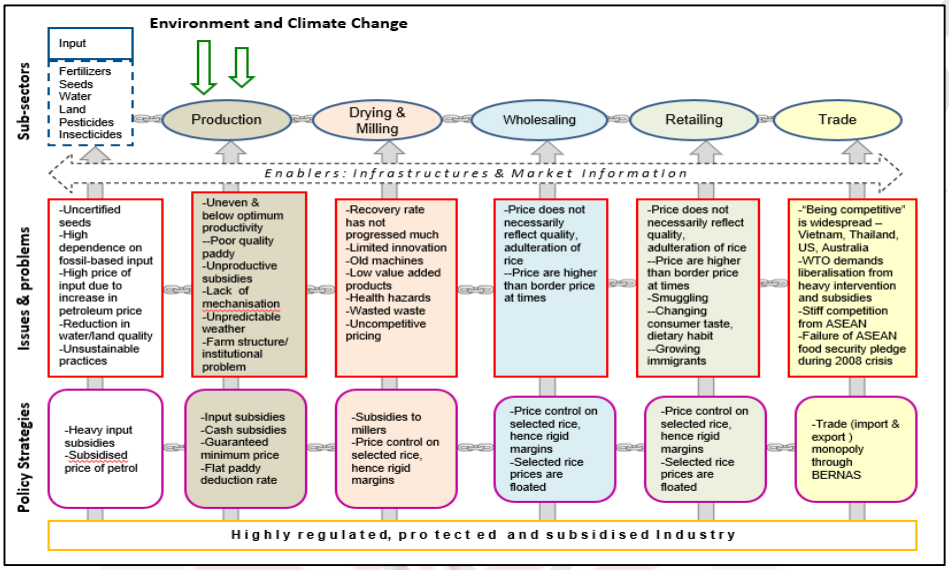

Figure 1.4 : Issues, Policy and Strategies in Paddy and Rice Supply Chain
Source : Fatimah and Ahmad (2013)[1]

1.3 Problem Statement

Paddy deduction rate is a rate imposed upon the wet paddy sent to the mills for the determination of effective price paid to the farmers. The determination of paddy deduction rate is a result of negotiation between the farmers and millers. However, the determination of paddy deduction rate during the negotiation is flawed. The deduction rate often goes off the schedule during the negotiation.

Figure 1.5 illustrates the average paddy deduction rate in MADA (1960-2016). The figure indicates (i) there are three phases of rates, they are phase I (1960-1974) with a rate of 15 percent, phase II (1974-2014), and phase III (>2014), (ii) unlike in Thailand where the rates vary in accordance to quality. The rate for

[1] Presentation at Workshop on R&D Roadmap for Rice Security, Charting Research Agenda for Rice Paddy and Rice Industry in Malaysia: A Supply Chain Approach 2nd July 2013

Malaysia is a “flat” one, determined by the government until 2014 when “actual rate” policy was implemented, (iii) the rate has increased from 14 percent during phase I to 22 percent in phase II and until 25 percent in the phase III. The paddy is normally deducted above 25 percent until 45 percent in the MADA granary area (Syahrin et al., 2016), Figure 1.5. This high rates clearly reduces the farmer’s income and the millers’ profit. The farmers normally negotiate for lower deduction rate to maintain higher net price, thereby increasing their income. For the millers, higher deduction rate is favourable so as to increase their profit margin.

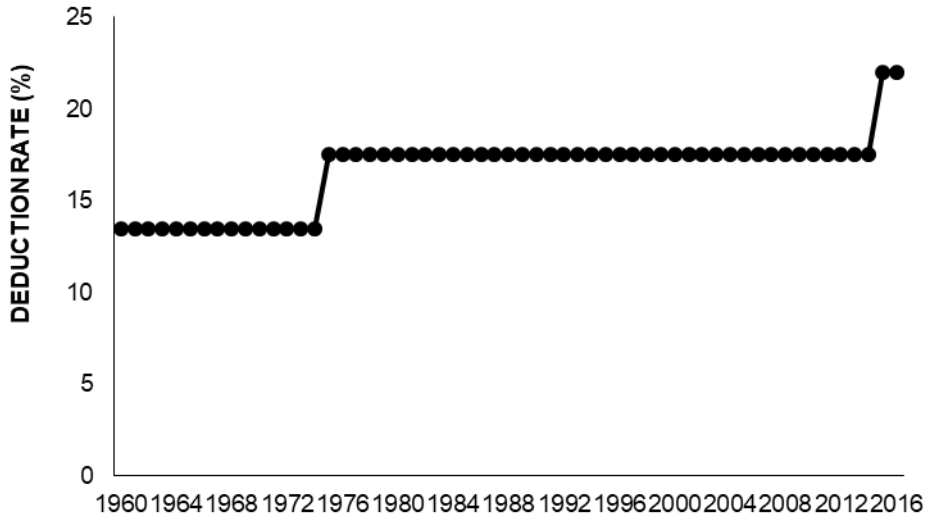

Figure 1.5 : Paddy Deduction Rate in MADA Granary Area (%), 1960-2016
Source: Fatimah (1982); Paddy Production Report (1980-2014)

There are a number of factors that contribute to the high deduction rate. First, poor farm practices by the farmers contribute to the higher deduction rate imposed on their paddy. According to Mohamad Zainal et al. (2016), there were about 80 percent of the farmers in MADA granary area practice unsustainable paddy farming. In addition, Rosnani et al. (2015) also revealed that almost 65 percent of the farmers in Malaysia compared to Vietnam where 60 percent of their farmers adopt the best farm practices. 83 percent of the farmers in Australia believed that the Rice Check is useful in producing high yield (FAO, 2005). In MADA area, Rice Check has introduced to guide farmers towards the best farm practices (MADA Statistical Handbook, 2014). Figures 1.6 to 1.7 shows the average wet paddy and actual moisture content which recorded the increasing trend for the both seasons in 1990 until 2012. These data revealed the farmers “adopted” average farm practices.

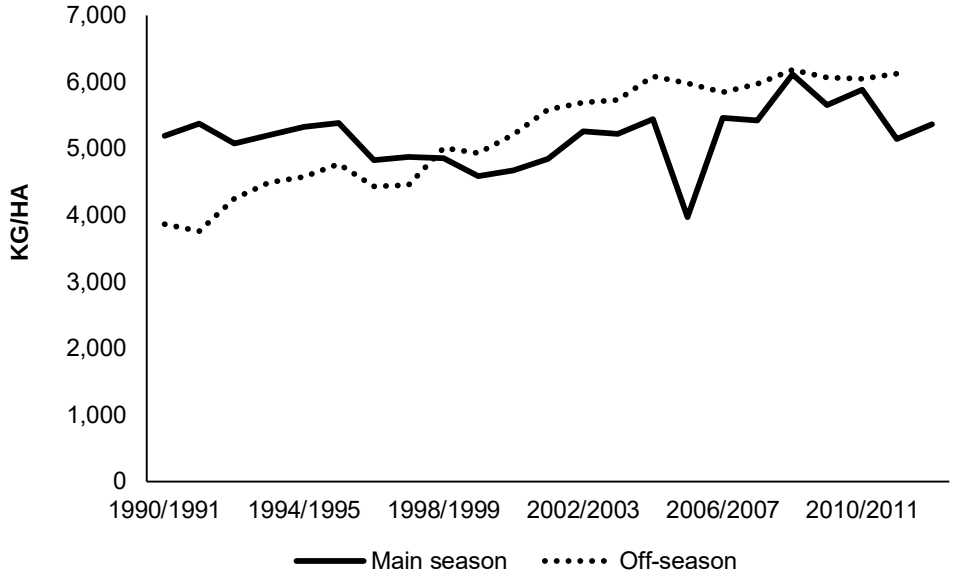

Figure 1.6 : Average Wet paddy of Main and Off Season in MADA Granary Area (kg/ha), 1990-2012

Source: Paddy Production Survey Report, Department of Agriculture (1990-2013)

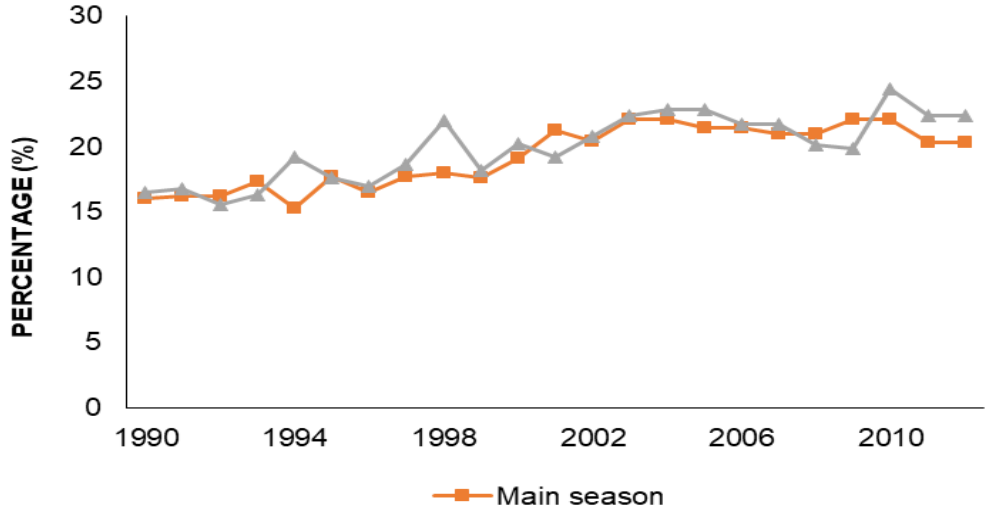

Figure 1.7 : Actual Moisture Content in MADA Granary Area (%), 1990-2012

Source : Paddy Production Survey Report, Department of Agriculture (1990-2012)

Second, beside poor farm practices, the use of combine harvester also influences the deduction rate imposed. In the MADA granary area, almost 100 percent of the farmers used combine harvester to harvest their paddy (MADA

Statistical Handbook, 2014). The combine harvester had been applied since 1970 due to labour shortage and high harvesting cost (Kameoka & Hoki, 1990). However, the total number of combine harvesters in the MADA granary area are only limited to 493 harvester machines. The harvester normally operates on average 0.16906 hectare per day[2] (MADA Statistical Handbook, 2014). Abu Hassan and Mohd Zainal (2010) stated that the desired capacity for the harvester is 4 hectares per day. Therefore, the limitation in the capacity of harvester and limited number of combine harvester lead to the delay in harvesting, which also affect the quality of the paddy sent to the mill.

Third, almost 90 percent of the farmers in the MADA granary area rely heavily on the brokers to harvest. The brokers will decide the time of paddy to be harvested. In some cases, the brokers decide the paddy be harvested earlier than usual. This situation leads to the increase in paddy impurities. The farmers have no other options than accepting the broker's decision which would otherwise cause their paddy harvesting being delayed one week later. Thus, the broker's decision to harvest also contributes to the mixing of all paddy varieties which finally lead to the higher rate of paddy deduction.

The millers, on the other hand, have to accept the mixed paddy from the farmers to sustain their milling operations. In this regard, the millers have to incur high operating costs to address of higher moisture content in the wet paddy delivered to their mills, thereby shrinking their profit margin. In order to compensate the lower profit margin, they unfairly penalize the farmers by imposing higher deduction rate. Figure 1.8 presents the percentage of rice recovery ratio which shows an unchanged trend from 1988 to 2016. According to Wahid et al. (2010), the rice recovery ratio of high rice quality should be at 68 percent.

[2] Personal communication with the farmers in the MADA area

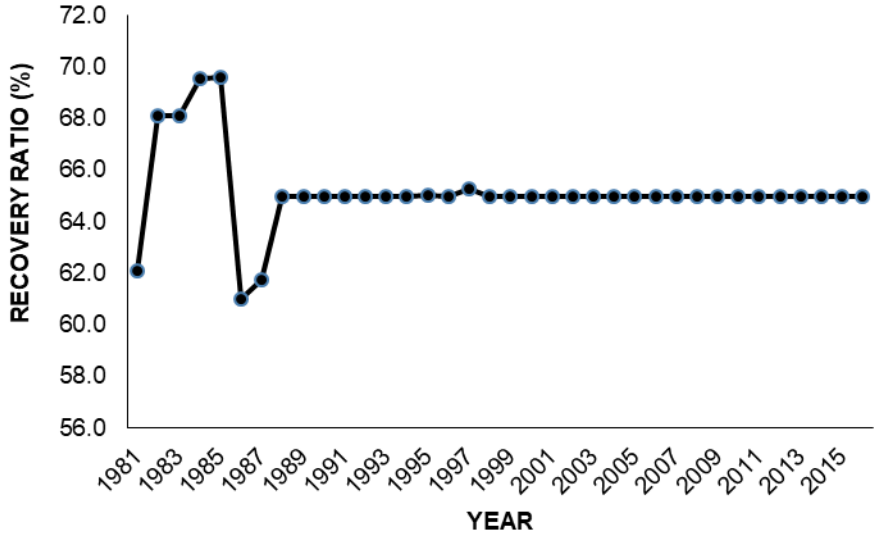

Figure 1.8 : MADA Rice Recovery Ratio (%), 1980-2016
Source : MADA Statistical Handbook (2014), Crop Statistical Handbook (2016)

Forth, other than higher operating costs faced by the millers, the rice price control also contributes to the higher deduction rate due to lower margin received by the millers. Mohd Ghazali et al. (1988) stated that the price control has suppressed the growth of the private milling sector. The millers use the deduction rate as a tool to increase their profit margin. For the millers, they need to expand their profit margin due to higher operating costs. According to Syahrin et al. (2016) and Salman (2017), there is a need to rectify the market structure situation by improving the market competition through liberalisation. That means no price control imposed on the retail rice price.

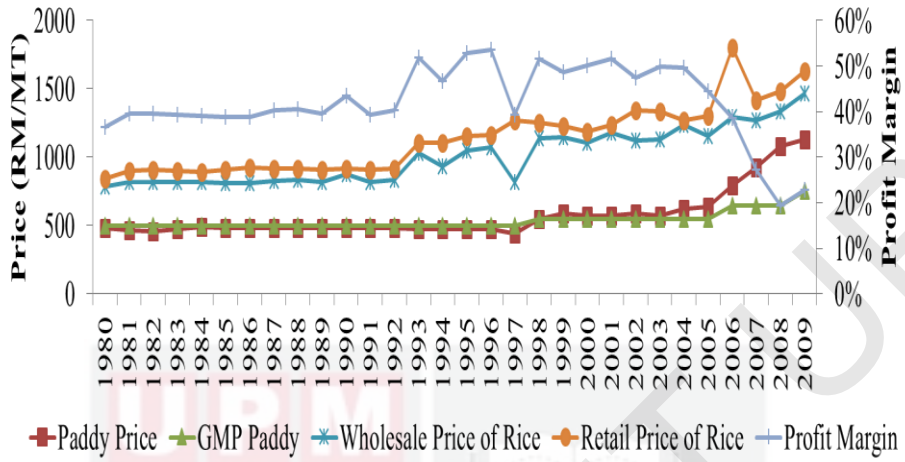

Figure 1.9 : Retail Price of Rice and Profit Margin (RM/MT), 1990-2008
Source: Department of Statistics (2011)

In view of the above deliberations, this study intend to answer the following research questions:

1. What is the desired paddy deduction rate that mutually satisfies both Farmers' and millers in the MADA granary area?
2. In what way factors such as farm practices, harvester's efficiency and changes in paddy and rice prices affect deduction rate?
3. Similarly, what are the impact of the factors mentioned in (2) on moisture content, farmers' income and millers' profitability?

1.4 Research Objectives

The general objective of the study is to examine the decision making process towards achieving the desired paddy deduction rate that mutually favours both farmers and millers in the MADA granary area. The specific objectives of the study are:

1. To develop a system dynamics model that describes the decision making process which mutually satisfies both farmers and millers;
2. To examine the desired deduction rate that mutually satisfies both farmers and millers;

3. To simulate various scenarios and examine their impacts on selected key variables. (The scenarios include; changes in farm practices, harvester's efficiency and paddy and rice price. The key variables are; deduction rate, moisture content, farmers' income and millers' profitability).

1.5 Significance of the Study

This study contributes to the empirical knowledge of the study by capitalising on the system dynamics methodology in understanding the determination of desired paddy deduction rate for both the farmers and millers in the MADA granary area. The findings from this study are useful for the key industry players as well as policy makers. The study is useful in examining the impact of policy changes in affecting the deduction rate on farmers' income and millers' profit.

1.6 Organization of the Study

This study is structured as follows. Chapter 1 begins with a brief discussion on the government role and intervention in the paddy and rice supply chain in

Malaysia. The chapter goes on by describing the problem, research questions, research objectives and significance of the study.

Next, Chapter 2 deliberates on the paddy deduction system in the MADA granary area. Procedures of deduction practices in the granary area are also highlighted. Several deduction practices in the neighboring countries (e.g. Thailand, Viet Nam, Indonesia, Philippines) are also discussed.

Chapter 3 ensues by highlighting the literature on the system dynamics methodology and reviewing empirical studies related to the paddy and rice sector. The advantages of system dynamics modeling and comparison between the system dynamics approach and other methodologies are also presented.

Chapter 4 discusses the research methodology and describes how this study utilizes the system dynamics in accordance with the recommended steps in the SD modelling. This chapter subsequently illustrates the resulting models i.e. causal loop and stock-and-flow diagrams for each sub-sector under study, followed by the description of loop in each sub-model. Key variables and parameters are reported together for each sub-model.

Then, Chapter 5 discusses the results, which are obtained based on the number of simulations of selected scenarios. The simulation results are disaggregated in two i.e. model validation and model testing for different key variables. Each simulation is illustrated by graphs of simulated and actual outputs based on the different scenarios. The discussion on the findings are successively presented.

Finally, Chapter 6 concludes the study by presenting summary of the study, general conclusions, recommendations for policy makers and industry stakeholders, and recommendations for future research.

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