



**UNIVERSITI PUTRA MALAYSIA**

***A SYSTEM DYNAMICS ANALYSIS TO IMPROVE SELF-SUFFICIENCY  
LEVEL FOR RICE SECURITY POLICY IN MALAYSIA***

**EMMY FARHA BINTI ALIAS**

**IKDPM 2013 2**





**A SYSTEM DYNAMICS ANALYSIS TO  
IMPROVE SELF-SUFFICIENCY LEVEL FOR  
RICE SECURITY POLICY IN MALAYSIA**

By

**EMMY FARHA BINTI ALIAS**

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

**October 2013**



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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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**October 2013**

**Chairperson: Fatimah Mohamed Arshad, PhD**

**Institute : Institute of Agricultural and Food Policy Studies**

The production of paddy in Malaysia showed a relatively higher rate of growth during the Green Revolution era and began to decline in the 1990s and beyond, indicating a logistic growth between 1970 and 2010. The annual paddy productivity growth has declined to 0.59% in 2012 compared to 3.6% in the 1970s. This non-linear rice production behaviour over time implies a structural change that has occurred in the industry. By the late 1990s, these high growth rates were not maintained due to the reduction in the productivity growth. The productivity was not sustained due to a number of factors. These include; limited area expansion due to urbanisation, outflow of resources due to the pull from the lucrative non-agricultural sectors,



limited improvement in value-added, unsustainable farm practices, lack of infrastructures and limited technological advancement.

The general objective of this study is to examine the food security of paddy and rice industry in Malaysia under a changing macro-economic environment. The specific objectives are (i) to understand the structure and behavior of paddy and rice industry; (ii) to develop a system dynamics model for paddy and rice sector; (iii) to simulate a number of scenarios and their impacts on the sustainability on food security i.e., self sufficiency level (SSL) targets; and (iv) to recommend alternative policies towards a sustainable food security in Malaysia.

A paddy and rice system dynamics model was developed to study and understand the behavior of the paddy and rice industry. The model was divided into two sub models; (i) paddy production (paddy area, productivity and input); and (ii) consumption (income and consumption). The study also identified four policy framework; (i) land management to regulate conversion of paddy area to other agricultural and non-agricultural activities; (ii) physical loss during post-harvest period; (iii) promoted organic fertilizers to improve soil structure and fertility; and (iv) structural change in determining the desired paddy productivity.



The study simulated six scenarios; Scenario 2 represents the withdrawal of subsidies, Scenario 3 adds the effect of post-harvest losses, Scenario 4 includes paddy land conversion, Scenario 5 examines implementation of organic farming, and lastly Scenario 6 incorporates structural change in determining the desired paddy productivity.

The simulation exercise suggests that Malaysia is able to achieve SSL of 62% in Scenarios 2 and 3 and 67% in Scenarios 4 and 5. However, under Scenario 6, SSL achieved is estimated at 80% by 2050. This is largely due to the higher growth in domestic rice production as a result of the combination of policies implemented (withdrawal of subsidies, post-harvest losses technology, land management, organic farming and structural change in determining the desired paddy productivity).



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

**ANALISIS SISTEM DINAMIK UNTUK  
MENINGKATKAN TAHAP SARA DIRI BAGI  
DASAR SEKURITI BERAS DI MALAYSIA:**

Oleh

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Pengeluaran padi di Malaysia menunjukkan kadar pertumbuhan yang lebih tinggi dalam era Revolusi Hijau dan mula menurun pada tahun 1990-an dan seterusnya, menampilkan keluk pertumbuhan logistik di antara tahun 1970 dan 2010. Kadar pertumbuhan tahunan produktiviti padi telah berkurangan kepada 0.59% pada tahun 2012 berbanding dengan 3.6% pada tahun 1970-an. Gelagat pengeluaran beras yang tidak linear dari masa ke semasa menunjukkan wujud perubahan struktur yang telah berlaku dalam industri ini. Pada akhir tahun 1990-an, kadar pertumbuhan yang tinggi tidak dapat dikekalkan kerana pertumbuhan produktiviti yang semakin menurun. Pertumbuhan ini tidak dapat dikekalkan disebabkan oleh beberapa faktor.



Ini termasuk; pengembangan kawasan yang terhad kerana pembandaran, aliran keluar sumber kepada sektor bukan pertanian yang menguntungkan, peningkatan nilai tambah yang terhad, amalan perladangan yang tidak mapan, kekurangan infrastruktur dan teknologi yang terhad.

Objektif umum kajian ini adalah untuk mengkaji sekuriti makanan untuk industri padi dan beras di Malaysia dalam persekitaran makro-ekonomi yang berubah. Objektif khusus adalah (i) untuk memahami struktur dan gelagat industri padi dan beras; (ii) untuk membangunkan satu model sistem dinamik bagi sektor padi dan beras; (iii) untuk membuat simulasi bagi beberapa senario dan kesannya ke atas kemapanan pada sekuriti makanan iaitu, sasaran SSL; dan (iv) untuk mencadangkan polisi alternatif untuk kemapanan sekuriti makanan di Malaysia.

Model sistem dinamik padi dan beras telah dibangunkan untuk mengkaji dan memahami gelagat industri padi dan beras. Model ini dibahagikan kepada dua sub model iaitu (i) pengeluaran padi (kawasan padi, produktiviti dan input); dan (ii) penggunaan (pendapatan dan penggunaan). Kajian ini juga mengenalpasti empat kerangka polisi iaitu (i) pengurusan tanah untuk mengawal penukaran kawasan padi kepada aktiviti pertanian yang lain dan bukan pertanian; (ii) kerugian fizikal semasa tempoh lepas tuai; (iii) mempromosi penggunaan baja organik untuk memperbaiki



struktur dan kesuburan tanah; dan (iv) perubahan struktur dalam menentukan produktiviti padi yang dikehendaki.

Kajian ini telah menjalankan enam simulasi; Senario 2 mewakili rasionalisasi subsidi, Senario 3 menambah kesan kerugian lepas tuai, Senario 4 memasukkan penukaran tanah padi, Senario 5 mengkaji pelaksanaan pertanian organik dan akhir sekali Senario 6 adalah perubahan struktur dalam menentukan produktiviti padi yang dikehendaki.

Simulasi senario menunjukkan bahawa Malaysia mampu mencapai SSL sebanyak 62% dalam Senario 2 dan 3, dan 67% dalam Senario 4 dan 5. Walau bagaimanapun, di bawah Senario 6, SSL yang dicapai dianggarkan sebanyak 80% pada tahun 2050. Pencapaian SSL yang lebih tinggi boleh dicapai dalam Senario 6 kerana pertumbuhan yang tinggi dalam pengeluaran beras dalam negara hasil dari gabungan kesemua polisi yang dilaksanakan (rasionalisasi subsidi, teknologi kerugian lepas tuai, pengurusan tanah, pertanian organik dan perubahan struktur dalam menentukan produktiviti padi yang dikehendaki).



## ACKNOWLEDGEMENTS

To HIM, I pledge my love and devotion, now and hereafter.

First and foremost, I wish to thank and record my sincere gratitude to my supervisor Prof. Dr. Fatimah Mohamed Arshad for her continuous support to my Master's thesis and research, for her patience, motivation, enthusiasm, and sharing her immense knowledge with me. I am truly indebted to Assoc. Prof. Kusairi Mohd Noh for introducing me this wonderful methodology, i.e., system dynamics which I used in this thesis. His insights and continuous challenge on me have been inspiring. It's him that brought me deeper into the world of system dynamics which will be my area of focus for my future career.

I owe my deepest gratitude to Ir. Muhammad Tasrif (Pak Tasrif) from Institut Teknologi Bandung (ITB) for all his guidance, patience and his deep commitment in shaping up my thesis from the beginning until the end. My sincere thanks and deep appreciation to Pak Tasrif, Ibu Nunuk, Nurul, Naufal, Lia and their family for taking me into their family during my stay in Bandung. I shall never forget their warmth, kindness and forever caring me as part of their family. I would also like to thank Dr. Setyo Pertiwi for giving



me input to my study. I am very lucky indeed to have such a highly competent supervisory committee to steer me through my thesis completion.

I cannot find the words to express my gratitude to *allahyarham* dad (*papa*), Alias Othman, my mom (*mami*), Zainun Ab Latif, grandpa (*ayah*), Ab. Latif Jusoh, grandma (*mek*), Adawiah Abdullah for their unconditional love and support. My deep appreciation goes to my mother and father in law (Rohana Daud and Nasikin Jasman) for their support and kindness. My deepest gratitude goes to my beloved husband, Mohd Erwan Nasikin and my son, Amirul Mukminin Mohd Erwan for their patience, sacrifice, love and support. I love you all with all my heart. This degree is as much an accomplishment for them as it is for me.

I also would like to dedicate this thesis to my dad, who passed away in 2011. He was the most loving person I have ever known. He taught me about life and survival. I know deep in his heart, he wanted me to finish my Master degree and be successful in life. Even though he is not around to share my happiness and success, I know he is watching me from heaven and he is proud of the kind of person I have grown up to be.

I would like to acknowledge the Ministry of Higher Education (MOHE) for providing the research fund under the Long Term Research Grant Scheme



(LRGS) for a project titled “The Economic Efficiency and Sustainability of Paddy and Rice Industry in Malaysia” under the research programme titled “Food Security: Enhancing Sustainable Rice Production Through Innovative Research” (2011-2016).

Finally, I would like to thank my best friends (Rasyidah Mohammad and Wan Noor Hasyaniti Wan Ahmed), Aswani Farhana Mohd Noh and ITB staffs for their help and support.

Thank You.



I certify that a Thesis Examination Committee has met on 25 October 2013 to conduct the final examination of Emmy Farha binti Alias on her thesis entitled "A System Dynamics Analysis to Improve Self-Sufficiency Level for Rice Security Policy in Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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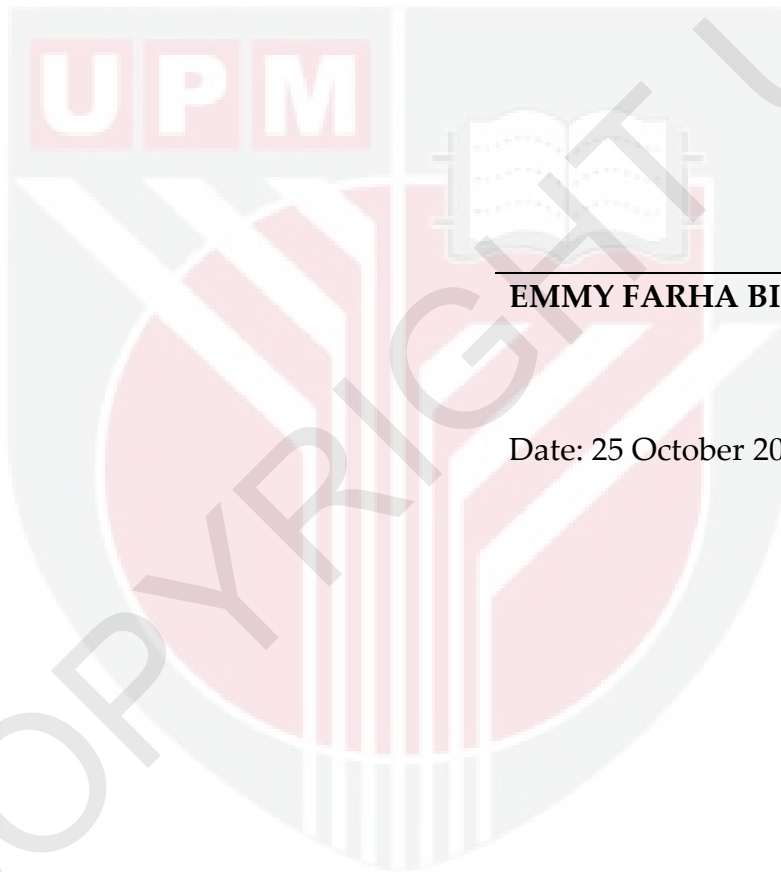
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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**EMMY FARHA BINTI ALIAS**

Date: 25 October 2013



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## LIST OF ABBREVIATIONS AND ACRONYMS

AFTA	Asean Free Trade Agreement
AoA	Agriculture Agreement
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
ATIGA	ASEAN Trade in Good Agreement
B	Balancing loop
BAU	Business as usual
BERNAS	Padiberas Nasional Berhad
BPM	Bank Pertanian Malaysia
CGE	Computable general equilibrium
DAN	<i>Dasar Agromakanan Negara</i>
DoA	Department of Agriculture
DoS	Department of Statistics
EPU	Economic Planning Unit
ETP	Economic Transformation Programme
et al.	Et alii
FAMA	Federal Agricultural Marketing Authority
FAO	Food and Agriculture Organisation
FFF	Fund for food
FOA	Farmers Organisation Authority



GAP	Good agricultural practices
GDP	Gross domestic product
GMP	Guaranteed minimum price
HYV	High yielding variety
IADA	Integrated Agricultural Development Area
IADP	Integrated Agricultural Development Project
IO	Input-output
IPP	<i>Insentif Pengeluaran Padi</i>
ITB	Institut Teknologi Bandung
MADA	Muda Agricultural Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MIER	Malaysia Institute Economic Research
MoA	Ministry of Agriculture and Agro-based Industries
MSE	Mean square error
NAP	National Agricultural Policy
NPC	Nominal protection coefficient
NPK	Nitrogen, Phosphorous and Potassium
NPRA	National Paddy and Rice Authority
NPRB	National Paddy and Rice Board
OPP	Outline Perspective Plan



PSE	Producer subsidy equivalent
R	Reinforcing loop
R&D	Research and development
RM9	Ninth Malaysia Plan
RM10	Tenth Malaysia Plan
RMSPE	Root mean square percent error
SD	System dynamics
SPS	Sanitary and phytosanitary
SSL	Self-sufficiency level
ST	Super Tempatan
USAID	United States Agency for International Development
WTO	World Trade Organization



# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

Food security has always been an important agenda for Malaysia since independence in 1957. The country has gone through a number of development phases in ensuring food availability, accessibility and stability. It started with the Green Revolution in the late 1960s to induce growth in the production of rice, followed by continuous investment in infrastructures and a wide range of market interventions to protect producers and consumers alike. After five decades of development, food security status of the country continues to receive new initiatives particularly after the world food crisis in 2008. The sustainability of the country's food security in a highly dynamic market environment is questionable, an issue which this thesis attempts to examine. This chapter provides a brief overview of the paddy and rice industry in Malaysia and the problem statement of the study. The next section lists the objectives of the study, and this is followed by a brief discussion on the importance of the study. The final section outlines the structure of the thesis.

### 1.2 Overview of the Paddy and Rice Industry in Malaysia

Paddy is a strategic crop in terms of food security and other socio-economic and political concerns. Rice is a staple food for majority of its population and paddy production provides livelihood for more than 200,000 small paddy farmers (Amin, 2011). The incidence of poverty is relatively high among paddy farmers. Despite the reduction of per capita rice consumption due to increase in income and change in lifestyle, the total rice consumed has generally increased. Despite the growing demand, the local production has not caught up. This was partly due to the self-sufficiency level policy which was set at about 65%-70% in the last three decades as well as economic factors. The sector does not have a clear competitive advantage due to high cost of production and the pull of resources out of the sector to the non-agricultural sectors. Besides, rice imports are available at cheaper rates. To fulfill the local demand, Malaysia imports rice at about 30% of the local requirement from countries such as Thailand and Vietnam.

The world rice market is highly volatile, particularly price and supply. A number of crises have hit the market. The biggest ones were in 1973 and the latest one in 2008. The volatility is mainly due to frequent shifts of supply and demand. On the supply side, production is highly unstable as paddy crop is highly susceptible to weather changes. Majority of paddy farms in the producing countries in Asia, are small in size with low productivity. Most of the production are consumed locally which result in a very thin exportable



surplus. The demand may be inelastic but is increasing with time as rice eating population growing market, a shock in the system cause a violent swing of prices both ways.

In view of its importance to food security and to continuous instability and uncertainty of the world rice market, the Malaysian government has instituted a protective policy towards the industry. To ensure food availability to its people, Malaysia has set a self-sufficiency target which is defined as ratio of domestic production to total consumption. Based on this calculation, a “desired productivity” is determined as a guidance for the policy makers to channel resources to achieve the target. This approach implicitly assumed that the productivity to be achieved is based on an established relationship between input and output which may change as time progresses. This conventional approach needs rationalisation by setting an explicit target so that resources may be planned to achieve the set target.

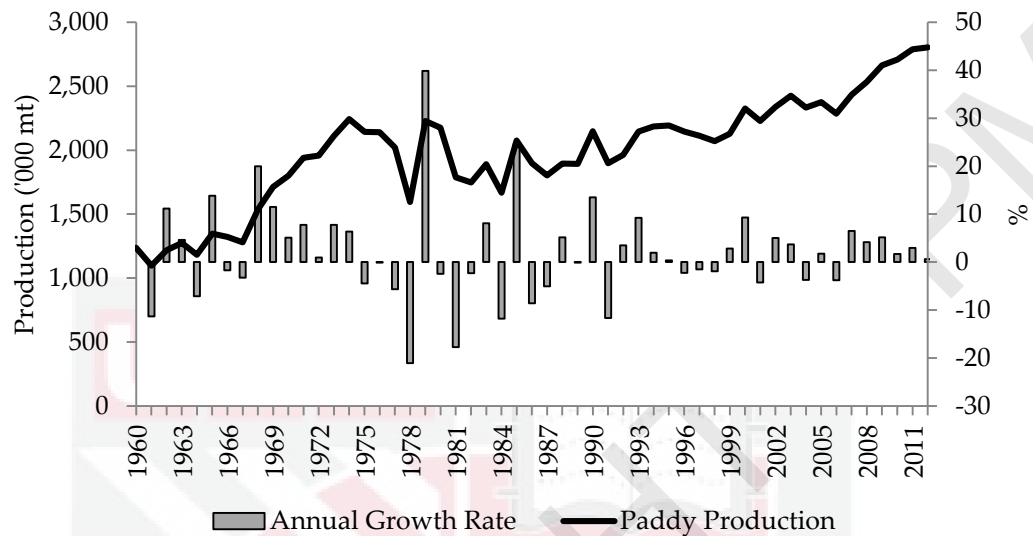
Under the Ninth Malaysia Plan (RM9) (2006-2010), the target for self sufficiency of rice was set at 65% while under Tenth Malaysia Plan (RM10) (2011-2015) and Agro-food Policy (DAN or *Dasar Agromakanan Negara*) (2011-2020), it has been revised to 70%. The self-sufficiency level is an overarching policy that dictates the strategies and instruments to attain the target. The other important policy objectives include; to ensure a high price to producers and high quality and stable rice price to consumers.

In order to achieve the said objectives, Malaysia has adopted an “interventionist regime” since 1960 to insulate the industry from the vagaries of the world market and hence ensuring prices are high to producers and consumers are protected. To induce production, the following measures were implemented. These include; input subsidies (fertilizers and pesticides), cheaper credits, irrigation rates and research and development (R&D). To ensure that consumers are protected, the government has fixed paddy floor price (Guaranteed Minimum Price (GMP)) for producers and ceiling prices for selected rice to consumers. Import of rice is monopolised by Padiberas Nasional Berhad or BERNAS (a government linked company entrusted with the import and distribution of rice). And; a number of regulatory measures were implemented such as licensing and zoning.

The production of paddy showed a relatively higher rate of growth during the Green Revolution era and began to decline in the 1990s and beyond, indicating a logistic growth between 1970 and 2012 (Figure 1.1). The annual paddy productivity growth has decreased to 0.59% in 2012 compared to 3.6% in the 1970s. This non-linear rice production behaviour over time implies a structural change that has occurred in the industry. The production grew



rapidly in the 1970s induced by the introduction of high yielding variety (HYV) as well as the development of drainage and irrigation infrastructures. However, by the late 1990s and beyond these high growth rates were not maintained due to the reduction in the productivity growth.



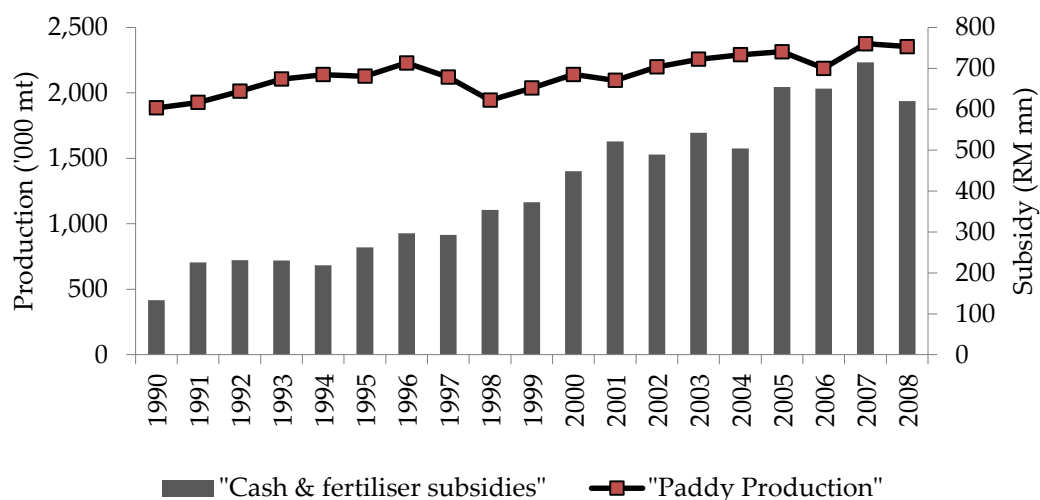
**Figure 1.1: Paddy Production ('000 mt) and Annual Growth Rate (%) in Malaysia, 1960-2012**

(Source: Index Mundi, 2012)

The production curve in the later years clearly suggests a “saturation” behavior despite the continuous support both financially and institutionally. There is a combination of factors that lead to the slowing down of the productivity growth after the Green Revolution era. These include; limited area expansion due to urbanisation, outflow of resources due to the pull from the lucrative non-agricultural sectors, limited improvement in value-added, poor farm practices, lack of infrastructures and limited technological advancement and market distortion effects.

As proven in many parts of the world, market interventions or distortions are costly, financially as well as in terms of resources allocation efficiency. Over time, the depth of the intervention went deeper together with the budgetary burden to the government. The allocation of input and cash subsidies increased from RM133.02 million in 1990 to RM619.95 million in 2008 (Figure 1.2). Despite the steep increase in the budgetary allocation, productivity and production of rice has not increased accordingly.





**Figure 1.2: Paddy Production ('000 mt) and Amount of Fertilizer and Cash Subsidies in Malaysia (RM million), 1990-2008**

(Source: DoS, 2010; NAFAS, 2009; BERNAS, 2009)

The policy objectives have been met as proven by the achievement of the SSL, farmers received a relatively higher income and consumers are insulated from the vagaries of the world market. While these intended outcomes are satisfactory, the unintended consequences are showing symptoms of inefficiencies which may contribute partly to the slowing down of the productivity growth in the later years. These include; heavy input subsidies (petroleum based fertiliser) results in reduction in soil fertility and water quality. This in turn leads to more usage of this input to replenish the soil and hence continuous dependency on the fertiliser. While this strategy is effective in the short term, its long term effect has been proven to be damaging. The recent increase in petroleum price pushes the input cost by more than 70%. The government has responded to these problems by adding more fertiliser subsidies to help farmers with the soil problem as well as to cushion the impact of price hikes of inputs. The flat rate of paddy deduction system disincentivise producers to produce high quality of rice as no premium is paid for high quality paddy. As a result, the paddy sold to the milling sector is of low quality which in turn affects milling efficiency and rice quality. Post-harvest losses are estimated at 7.2% during harvesting due to inefficient practices (Jafni et al., 2010). Similarly, the rigid price control is not conducive to innovation particularly in the drying and milling sector. The implied "fixed margin" under a rigid price regime encourages mixing of rice grades by the traders to maximise profits.

In the international arena, there is a growing demand for liberalization policy particularly from the World Trade Organization (WTO) and Asean Free Trade Agreement (AFTA). Under the Agriculture Agreement (AoA), like in



other countries, Malaysia will have to remove all domestic policies that have direct effect on production and trade of its commodities, including rice. Judging from its extensive interventions thus far, this demand requires a big shift in the current policy paradigm. Malaysia has attempted a liberalisation move in early 1990s, but the progress has been slow. Malaysia started to liberalise the rice market by floating the price of high quality rice in line with the market while continuing the price support to low quality rice for the poor. The government's National Paddy and Rice Authority has been corporatised through the formation of BERNAS which is a government linked company to take over the import and distribution function of rice.

As a response to the food crisis in 2008, Malaysia has increased further the provision of more input subsidies to producers, a bid to reduce their production cost and hence to increase paddy production. The GMP of paddy was further raised from RM650 per tonne to RM750 per tonne. To ensure enough rice production for the poor, the government has introduced a milling subsidy of RM800 per tonne to millers (including BERNAS's millers).

### **1.3 Problem Statement**

The above discussions describe the "food security" strategy of Malaysia which is largely focused on the country's staple crop that is rice. It is clear that the industry has to compete for resources with other lucrative sectors such as manufacturing and services. It is perceived that under a "free market" the country may not be able to grow rice due to high cost of production and the threat of cheaper imports. Coupled with the continuous volatility of the rice market in the world, these developments caused the government to implement a number of market interventions aimed at inducing production (to achieve self-sufficiency level (SSL) of rice) and to insulate the local market (to protect the consumers).

The intervention package is rather comprehensive and getting costly over time. The SSL has been used as a proxy for the food security situation of the country which is set at 65% under RM9 and RM10 and DAN (70%). Each intervention is impacting the sector differently producing both intended and unintended consequences. Although, the policy objectives are largely met but the sector is showing symptoms of market inefficiencies and the budgetary burden to the government's coffer is growing.

The slow growth in productivity is responsible for the lack of progress in the sector. The slow improvement in yield in the last decades was largely due to limited investment either in R&D as well as infrastructures. Area expansion on the other hand has been constrained by rapid urbanization and industrialization particularly in Peninsular Malaysia. The conversion to



activities other than paddy is inevitable due to the pull of better returns to factors. Collectively, they have produced the production behaviour as shown in Figure 1.1 which mimicks a logistic shaped growth curve which starts at a rapid rate and later plateaus due to decline in the rate of growth. The earlier behaviour was “reinforcing” in nature driven by the Green Revolution technology while the later years manifest a “balancing” effect due to partly market distortion policies which dampens the earlier exponential growth. This in turn creates a logistic curve which is one of the major archetypes available in system dynamics literature (Sterman, 2004).

Like Malaysia, most of ASEAN countries give special treatment and protection for paddy and rice industry. Between 1990 and 2010, ASEAN region shows a slow growth in paddy production with an average annual growth rate of 3.0% per annum (Table 1.1). The paddy production in ASEAN has increased from 111.3 billion metric tonnes in 1990 to 200.9 billion metric tonnes in 2010. In 2010, Indonesia is the largest paddy producer in ASEAN region with a share of 33.1% of the total paddy production in ASEAN, followed by Vietnam (19.9%), Myanmar (16.5%), Thailand (15.7%) and the Philippines (7.9%). In terms of average annual growth rate, Malaysia has recorded the lowest average annual growth rate of 1.6% per annum. Cambodia has the highest average annual growth rate of 7.2%, followed by Myanmar (4.6%), Laos (4.3%), Brunei (3.9%), Vietnam (3.8%), Thailand (3.2%), Philippines (2.9%) and Indonesia (2%).

**Table 1.1: Paddy Production ('000 mt) and Growth Rate (%) in ASEAN Countries, 1990 – 2010**

Country	1990	1995	2000	2005	2010	Average Growth Rate 1990-10 (%)
Brunei	0.93	0.51	0.30	0.85	1.07	3.93
Cambodia	2,500.00	3,447.80	4,026.09	5,986.20	8,245.32	7.21
Indonesia	45,178.80	49,744.10	51,898.00	54,151.10	66,469.40	2.00
Laos	1,491.50	1,417.83	2,201.70	2,568.00	3,070.64	4.34
Malaysia	1,884.98	2,127.27	2,140.80	2,314.00	2,548.00	1.61
Myanmar	13,971.80	17,956.90	21,323.90	27,683.00	33,204.50	4.61
Philippines	9,885.00	10,540.60	12,389.40	14,603.00	15,771.70	2.89
Thailand	17,193.20	22,015.50	25,843.90	30,291.90	31,597.20	3.22
Viet Nam	19,225.10	24,963.70	32,529.50	35,832.90	39,988.90	3.78
<i>Total</i>	<i>111,331.31</i>	<i>132,214.21</i>	<i>152,353.59</i>	<i>173,430.95</i>	<i>200,896.73</i>	<i>3.02</i>
Rest of world	407,236.95	415,216.29	447,001.87	461,014.25	495,427.66	1.03
World	518,568.26	547,430.50	599,355.46	634,445.20	696,324.39	1.51

(Source: FAOSTAT, 2012)

As a member of the WTO and the Association of Southeast Asian Nations (ASEAN), Malaysia has to abide by the call for liberalization which include the withdrawal of price control and input subsidies in the rice sector.



Despite this, after the food crisis in 2008, Malaysia has moved inward with deeper interventions in the form of higher subsidies to producers as well as introducing a new subsidy to millers. This stance is clearly opposite to what WTO demands. In view of this, there is a clear need on the understanding of the implication of liberalization in particular withdrawal of input subsidies in the industry and hence the SSL target.

The paddy and rice industry is a complex system due to the interaction of many policy strategies and market variables. These in turn shape the behaviour of the industry. Also, there appears to be a number of circular causal relationships between the variables and events in the industry. This is proven on a number of occasions including a deeper intervention stance after the 2008 crisis. Under such a complex environment, an econometric model is not able to model complexity, circularity and market dynamics of the industry. Therefore, a “system dynamics” methodology is a relevant tool to examine the impact of structure and behaviour of the industry (Sterman, 2004). The system dynamics (SD) method is able to examine the feedback or circular causal relationship between variables as well as the nonlinearities in the system. Hence, this study attempts to apply SD approach to answer the following questions:

- i. What are the impacts of withdrawal of the input and cash subsidies on the SSL target?
- ii. What is the effect of post-harvest losses in the industry?
- iii. What is the alternative strategy to minimize paddy land conversion to non-paddy activities;
- iv. The prospect of organic fertilizer as an alternative to fossil-based fertilizer; and
- v. What is the impact of a change in the calculation of the SSL target from the conventional method of estimating “desired” productivity implicitly to an explicit target of productivity in the future to achieve the SSL objective?



#### **1.4 Objectives of the Study**

The general objective of the study is to examine the food security of paddy and rice industry in Malaysia under a changing macro-economic environment. The specific objectives are:

- i. To understand the structure and behavior of paddy and rice industry;
- ii. To develop a system dynamics model for paddy and rice sector;
- iii. To simulate a number of scenarios and their impacts on the sustainability on food security i.e., SSL targets. These scenarios include; withdrawal of subsidies, post-harvest losses, paddy land conversion, organic farming and adoption of an explicit desired productivity target approach in calculating the SSL level.
- iv. To recommend alternative policies towards a sustainable food security in Malaysia.

#### **1.5 Justifications of the Study**

The above discussion indicates the complexity of problems faced by the paddy and rice industry which is continuously challenged domestically and internationally. In a bid to ensure food security, the government has set a self-sufficiency target level as a proxy for rice availability to its people. This policy is further supported by the need to provide higher price to the producers and protect the producers from market vagaries. A comprehensive package of market supports, interventions and subsidies have been implemented. Despite massive intervention, the industry has shown a reduction in market growth as well as productivity in the last two decades. The industry exhibits a non-linear behaviour and circular causal interactions between policies and impact and vice versa. Under such a system, a system dynamics approach is the most suitable method to understand the relationship between structure and its impact on behaviour, non-linear relationship between elements or variables, delays in the system as well as simulating the impact of changes in policies on the system.

It is hoped that the findings from this study can be used by the industry players as well as policy makers to better plan the future of the industry, improve policy analysis and decision, and to take necessary steps to achieve sustainability in the sector.

There is a dearth of system dynamics analysis of the agricultural sector at large in Malaysia particularly the paddy and rice sector. This is a first attempt to study the complexity of the paddy and rice industry using system dynamics approach in Malaysia. It is hoped that this study will provide the starting point for a much more comprehensive and advanced application of system dynamics to complex problems in the paddy and rice sector as well as other industries.



## **1.6 Organization of the Study**

The thesis comprises six chapters. The first chapter provides an overview and nature of the problem to be studied, the objectives and justification of the study. Chapter II presents an overview of the paddy and rice sector in Malaysia. The chapter following this reviews the previous theoretical and empirical works related to this study. Chapter IV explains the methodology that will be used and the development of the paddy and rice system dynamics model. Chapter V provides the simulation results and discussion. The final chapter concludes the study and gives recommendations for future research.





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