



UNIVERSITI PUTRA MALAYSIA

***EVALUATING POLICY OPTIONS FOR THE MANDARIN ORANGE
INDUSTRY IN INDONESIA USING SYSTEM DYNAMICS FRAMEWORK***

LYLI MUFIDAH

FEP 2016 31



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By

LYLI MUFIDAH

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

October 2016

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the Degree of Master of Science

EVALUATING POLICY OPTIONS FOR THE MANDARIN ORANGE INDUSTRY IN INDONESIA USING SYSTEM DYNAMICS FRAMEWORK

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October 2016

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The mandarin orange industry is one of the important fruit sectors in Indonesia. This industry shows a benefit over cost ratio of 1.8 in medium scale cultivation, suggesting a higher economic return. The average annual rate of growth is 25% between 1999 to 2007. However, after 2007 to 2012 there was a significant decline from 2.5 million tonnes to 1.4 million tonnes. This makes the local production's ability to meet mandarin orange consumption reduced from 98% in 1999 to 92% in 2012; while, the gap was fulfilled by imports. The increase of mandarin orange imports from 27 thousand tonnes to 179 million tonnes from 1999 to 2012 became a government concern. The government tried to give a stimulus to the local production by issuing protection policies. These interventions will make a change in the mandarin orange industry landscape.

The general objective of this study is to evaluate the market protection policies on mandarin orange industry in Indonesia using system dynamics framework. The specific objectives are: (i) to examine the relationship between structure and behavior of the mandarin orange industry in Indonesia, (ii) to assess the impact of the protection policies on the local production and consumption, and (iii) to simulate the impact of changes in policy scenarios on the mandarin orange industry.

A mandarin orange system dynamics model was developed to study and understand the behavior of the mandarin orange industry. The system dynamics methodology was used because of its ability to accommodate causal relationships, non linearity and delays that exist in the Indonesian mandarin orange industry. The model was divided into two main sectors; they were the local and imported mandarin oranges. Each had production and consumption sub models as inflow and outflow rates. The study also identified four policy frameworks: the domestic protection policy, stimulus policy, R&D policy and disease management that includes funding and the improvement of

extension agent ratio that decanted into six scenarios. Scenario 1 (S1): referred to “business as usual” (BAU) scenario, where only the domestic protection policy was applied; Scenario 2 (S2): the stimulus strategy was added to the policy; Scenario 3 (S3): combination of S2 with R&D policy; Scenario 4 (S4) was a combination of S3 with disease management, including fund and improvement extension agent-area ratio; Scenario 5 (S5): introduced free market situation where no protection policies were applied; and Scenario 6 (S6): free market was supported with R&D and disease management, including fund and improvement extension agent-area ratio.

The results showed that S4 was the best policy alternative, where it was estimated that the production of oranges may reached 2.9 million tonnes in 2034, relative price value of 0.8, expected profit of Rp18.638,00/kg and reduction in imports to 43 thousand tonnes. S6 showed that the removal of the protection policy, supported by R&D and disease management still increase production to 2.5 million tonnes, relative price 0.77, expected profit Rp12.623,00/kg and make import lower than BAU with the value of 215 thousand tonnes. This suggests that the protection policy can be gradually reduced as under an open market the mandarin industry would gain competitiveness through a strong support of R&D and technology adaption through extension agents and effect of disease management.

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

**PENILAIAN PILIHAN POLISI UNTUK INDUSTRI LIMAU MANDARIN DI
INDONESIA DENGAN MENGGUNAKAN KERANGKA
SISTEM DINAMIK**

Oleh

LYLI MUFIDAH

Oktober 2016

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Industri limau mandarin ini adalah salah satu sektor buah-buahan utama di Indonesia. Industri ini menunjukkan nisbah keuntungan/kos (B/C) 1:8 menyorotkan pulangan ekonomi yang tinggi. Industri limau mandarin mengalami kadar pertumbuhan tahunan 25% antara 1999 dan 2007. Walau bagaimanapun dari tahun 2007 ke 2012, penurunan besar berlaku iaitu pengeluaran telah menurun daripada 2.5 juta tan kepada 1.4 juta tan. Keadaan ini menyebabkan pengeluaran tempatan tidak mampu memenuhi penggunaan limau mandarin yang telah menurun daripada 98% pada tahun 1999 kepada 92% pada tahun 2012. Kekurangan pengeluaran tersebut diatasi melalui limau import. Import bagi limau mandarin mencatat peningkatan daripada 27 ribu tan kepada 179 juta tan dari tahun 1999 ke 2012 yang membimbangkan pihak kerajaan. Maka pihak kerajaan telah mengambil inisiatif untuk meningkatkan pengeluaran tempatan melalui polisi perlindungan pasaran. Campur tangan kerajaan akan dijangka membawa perubahan ke atas industri limau mandarin.

Objektif umum kajian ini adalah untuk menilai dasar perlindungan pasaran industri limau mandarin di Indonesia, menggunakan kerangka sistem dinamik. Objektif khusus adalah: (i) untuk meneliti perkaitan antara struktur dan gelagat industri limau mandarin di Indonesia, (ii) untuk menilai kesan ekonomi polisi perlindungan ke atas pengeluaran dan penggunaan, dan (iii) untuk melaksanakan simulasi senario polisi ke atas industri limau mandarin.

Sebuah model sistem dinamik bagi limau mandarin telah dibangunkan bagi mengkaji dan memahami struktur industri limau mandarin. Kaedah sistem dinamik diguna pakai kerana ia mampu menganalisis hubungkait penyebab tak linear dan lengah masa yang terdapat dalam industri limau mandarin di Indonesia. Model tersebut terbahagi kepada dua sub-model utama: limau mandarin tempatan dan import. Kedua-duanya terdiri

daripada sub-model pengeluaran dan penggunaan dalam bentuk kadar aliran masuk dan kadar aliran keluar. Kajian ini juga mengenalpasti empat kerangka kerja polisi: polisi perlindungan domestik, polisi dorongan, polisi R&D dan pengurusan penyakit yang mana terdiri daripada pembiayaan dan pembaik pulih nisbah penyuluh pertanian, yang dirumuskan kepada enam senario. Senario I (S1): merupakan senario dasar (*business as usual scenario*), dimana hanya polisi perlindungan domestik yang diterapkan; Senario II (S2): polisi perlindungan domestik yang sudah ada ditambah dengan polisi dorongan; Senario III (S3): merupakan gabungan S2 dengan polisi R&D; Senario IV (S4) gabungan S3 dengan pengurusan penyakit; Senario V (S5): memperkenalkan pasaran bebas tanpa ada polisi yang diterapkan; dan Senario VI (S6): pasaran bebas diperkenalkan dengan sokongan R&D dan pengurusan penyakit.

Dapatan kajian menunjukkan bahwa S4 memberi kesan yang paling baik, di mana Industri limau mandarin Indonesia dijangka mampu mencapai pengeluaran 2.9 juta tan, nilai harga relatif 0.8, jangkaan keuntungan Rp18.638,00/kg dan mengurangkan import kepada 43 ribu tan. Sementara itu S6 menunjukkan kesan pengeluaran 2.5 juta tan, nilai harga relatif 0.77 jangkaan keuntungan Rp12.623,00/kg dan import sebanyak 215 ribu tan. Dapatan ini menunjukkan bahwa polisi perlindungan boleh ditarik secara perlahan-lahan kerana industri ini mampu membina daya saing melalui sokongan kuat daripada R&D dan penerapan teknologi melalui penyuluh pertanian dan pengurusan penyakit yang efektif.

ACKNOWLEDGEMENTS

First and foremost, I would like to thank to Allah SWT for giving me the love and strength to complete this Master thesis. To HIM I pledge my love and devotion, now and hereafter. I owe my deepest gratitude to my supervisor, Prof. Dr. Fatimah Mohamed Arshad for her patience, motivation, enthusiasm, and sharing her paradigm and knowledge with me. Your warmth personality and advices touched me, and I will always keep them in my heart. My sincere thanks and deep appreciation to Dr. Nguyen Luong Bach who have taught me to be consistent, detail and sharp. I would also like to thank Dr. Shaufique Fahmi Sidique for his input to my thesis. I feel so blessed to have a very competent supervisory committee who provides support and guidance until my thesis is completed.

I cannot find words to express my gratitude to *almarhum* mom and dad (Nurjannah and Muslimin) also my mother and father in law (Nur Ilmiah and Arief Sugianto) for their unconditional love and support. My deepest thank goes to my beloved husband, Havabe, and my son, Aufaa Faiz, for their sacrifice, love, support and patience. I am also indebted to family members, *bunda* Icha, *om* Suke, Ayik, Adi, Ita, *mas* Isa and all of my aunties and uncles. I love you all with all of my heart. This degree is as much of an accomplishment for them as it is for me.

My sincere appreciation also goes to Balai Penelitian Tanaman Jeruk dan Buah Subtropika (Balitjestro), Pusat Penelitian dan Pengembangan Hortikultura (Puslitbang Hortikultura) also Badan Penelitian dan Pengembangan Kementerian Pertanian for the opportunities and support to study at UPM. This thesis is dedicated to them along with the Indonesian mandarin orange farmers that inspire me with their hard work and modesty.

Finally, I would like to thank my friends, Novyandra Ilham Bahtera, Abdullah Ibragimov, Zuhdiati Ermy Putri, Nur Atiqah Aziz, Nor Akhlisah Zulkipli, Indah Sriwahyuni, Rahmat Ilahi, for their help, support and being there for me when I needed them.

Thank You.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment 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

ACFTA	ASEAN China Free Trade Agreement
AEA	Agriculture Extension Agent
APRINDO	<i>Asosiasi Pengusaha Ritel Indonesia</i> or Indonesian Retailers Association
ASEAN	Association of Southeast Asian Nations
B	Balancing loop
B/C	Benefit Cost
BF	<i>Blok Fondasi</i> or Block Foundation
BI	<i>Bank Sentral</i> Republik Indonesia
BPMT	<i>Blok Penggandaan Mata Tempel</i> or Bud wood multiplication blocks
BPS	<i>Badan Pusat Statistik</i> or Indonesia, Central Bureau of Statistics
CLD	Causal Loop Diagram
CO ₂	Carbon dioxide
CPO	Crude Palm Oil
CVPD	Citrus Vein Phloem Degeneration
Ditjen Hortikultura	<i>Direktorat Jenderal Hortikultura</i> or General Directorate of Horticulture
DNA	Deoxyribonucleic acid
DKI	Daerah Khusus Ibukota
EBITDA	Earnings before Interest, Tax, Depreciation and Amortization
FCOJ	Florida frozen concentrated orange juice
FOB	Free on Board
FTA	Free Trade Agreement
FTZ	Free Trade Zone
GAP	Good Agriculture Practice
GDP	Gross Domestic Product
ha	Hectare
HS	Harmonized System
IAARD	Indonesian Agency for Agricultural Research and Development
IP	<i>Importir Produsen</i> or Importer manufactures
IRR	Internal Rate of Return
IT	<i>Importir terdaftar</i> or Registered importer
JICA	Japan International Cooperation Agency
KIPH	<i>Ketentuan Impor Produk Hortikultura</i> or Import provision of horticultural product
M-DAG	<i>Menteri Perdagangan</i> or Minister of Agriculture
MFN	Most Favored Nation
MSE	Mean Square Error
NPK	Nitrogen, Fosfat, Kalium (Nitrogen, Phosphate, Potassium)
NPV	Net Present Value
PBP	Pay Back Period
PCR	Polymerase Chain Reaction
PER	<i>Peraturan</i> or Regulation
Permentan	<i>Peraturan Menteri Pertanian</i> or Regulation of Minister of

	Agriculture
PLE	Personal Learning Edition
PPO	Processed Palm Oil
Pusdatin	<i>Pusat data dan sistem informasi pertanian</i> or Data centers and agricultural information system
R	Reinforcing loop
R&D	Research and Development
RIPH	<i>Rekomendasi Impor Produk Hortikultura</i> or Import recommendation of horticultural product
RMSPE	Root Mean Square Percent Error
ROE	Return on Equity
RoG	Rate of Growth
ROI	Return on Investment
S	Scenario
STG	Shoot Tip Grafting
t	Tonnes
Exchange rate	
2015: 1 USD = Rp13.305,00	
2016: 1 USD = Rp13.398,00	
Source: BI (2016)	

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Mandarin oranges have become one of the horticultural commodities which have been prioritised to be developed by the Indonesia Ministry of Agriculture. The development is motivated by the high import of mandarin oranges that is reducing the country's foreign exchange reserves. The local mandarin orange is expected to be the substitution for the imported mandarin orange (Kementerian Pertanian Republik Indonesia, 2015). As shown in Figure 1.1, the import of mandarin oranges has increased both in quantity and value, from 27 thousand tonnes with the value of USD 13 million in 1999 to 179 thousand tonnes with a value of USD 176 million respectively in 2012, suggesting an increase of 562.9% in quantity.

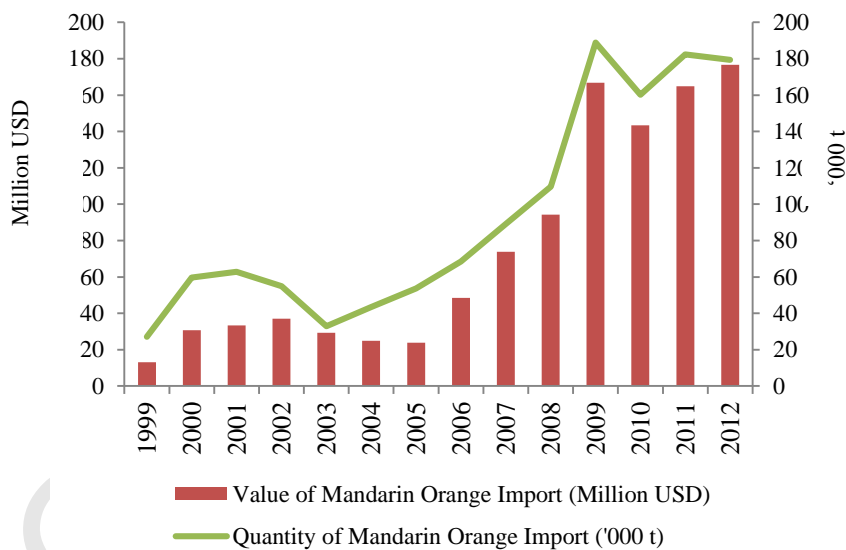


Figure 1.1: Value of Mandarin Orange Import (Million USD) and Quantity of Mandarin Orange Import ('000 t), 1999-2012
(Source: BPS, 2015)

The mandarin oranges import sector appears to go through two major phases, they were: 1999-2003, and 2004-2012. The average annual rate of growth (RoG) of mandarin oranges import in 1999-2003 was 18%. In this phase, the margin between the mandarin orange import and local prices were small, which is believed limits the import growth.

In 2004-2012, mandarin orange import growth slowly rose to an average annual RoG of 23%. During this period, the ASEAN China Free Trade Agreement (ACFTA) was firstly implemented in 2004, where import tariff for mandarin orange import from China was lowered to 5%, and 0% afterward. This has lowered the impact price of mandarin orange from China. China was the biggest supplier of Indonesia mandarin orange import as seen in Figure 1.2 where after ACFTA mandarin orange import share from China increased from 47.26% to 83.27%.

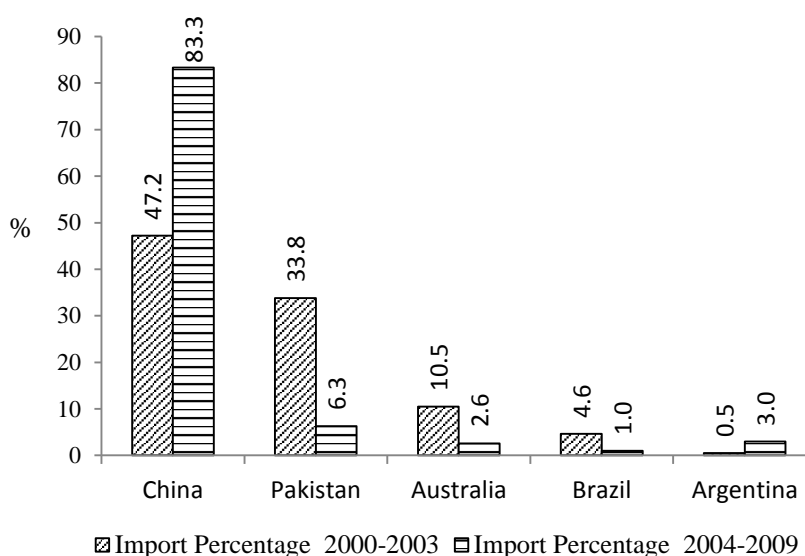


Figure 1.2: Share of Indonesia Mandarin Orange Import from Five Biggest Sources, 2000-2009
(Source: BPS, 2015)

The development policy of the Indonesia's mandarin oranges between 1985 to 1990 aimed to improve the welfare of farmers (Devy, 2014; "Gubernur Kalbar", 1998). Kalimantan which is one of the centres of mandarin orange production that contributed to the state levy amounting to Rp.1.6 billion from mandarin oranges ("Perjalanan jeruk", 1996). The policy appeared to improve the economic returns of the producers. The financial analysis of the mandarin orange cultivation on a medium scale (50 hectare) shows that the mandarin orange still meets the economic criteria with the benefit/cost (B/C) ratio of 1.8, net present value (NPV) 28 billion, internal rate of return (IRR) 85.6, return on investment (ROI) per year 17, return on equity (ROE) per year 56 and payback period (PBP) 11.7 (IPB, 2013). Mandarin orange is consumed daily by the Indonesian consumers (Raisa, 2011).

The above policy has impacted the sector in terms of land usage. The ratio of horticultural land area to GDP is highest at 2.43 followed by the staple (0.23) and estate (0.09) in 2012. Furthermore, horticulture sub-sector for fruit with a concession area of only 0.8 million hectare (ha), was able to contribute relatively a large share to GDP (1.86%). On the other hand, the staple and estate sub sector, with 17.9 and 21

million ha of land tenure contributed 4.21% and 1.94% to GDP respectively (Figure 1.3).

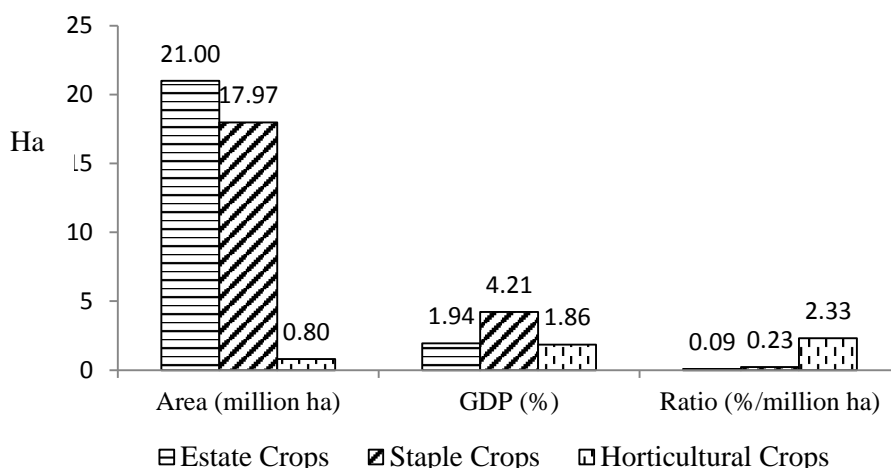


Figure 1.3: Production Area ('000 t), GDP Contribution (%) and Land Ratio to GDP for Horticultural, Staple and Estate Crops, 2012

(Source: BPS, 2015, Ditjen Hortikultura, 2015, and Pusdatin, 2013)

Indonesia produced about 98% of total consumption in 1999 but it has declined to 92% in 2012. The overall trend of mandarin orange production between 1999-2012 was increasing from 483 thousand tonnes to 1.4 million tonnes. However, since 2007 to 2012, there was a significant decline in production from 2.5 million tonnes to 1.4 million tonnes.

The apparent consumption has increased from 491 thousand tonnes in 1999 to 1.6 million tonnes in 2012, an increase of 229.6%. The increase is largely due to population growth and health awareness among consumers. The mandarin orange deficiency has widened up from 27 thousand tonnes in 1999 to 179 thousand tonnes in 2012. This gap is filled up through imports. As shown in Figure 1.4, mandarin orange import has increased by 562.9%, between 1999 to 2012.

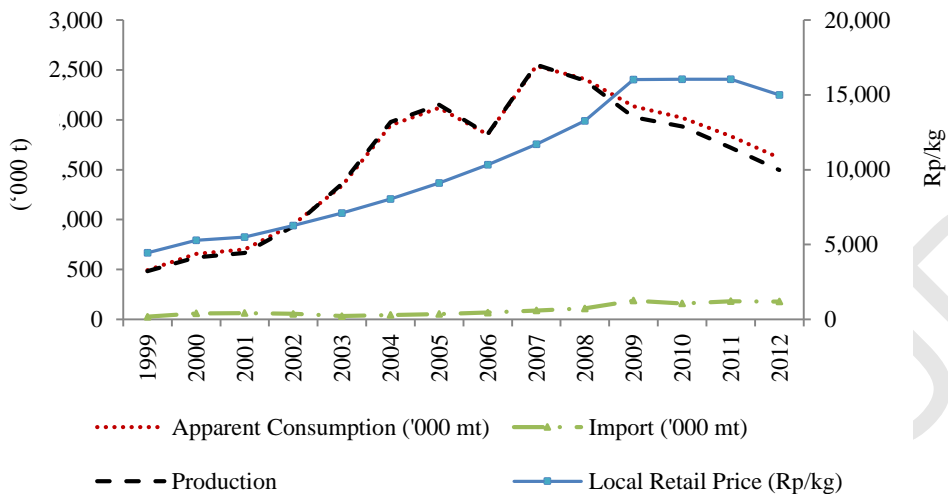


Figure 1.4: Mandarin Orange Production, Import, Loss and Apparent Consumption ('000 t) and Local Orange Mandarin Price (Rp/kg), 1999-2012
(Source: BPS, 2015)

1.2 Overview of the Mandarin Industry in Indonesia

The mandarin orange cultivation in Indonesia was in existence as far back as 1920s in Aceh (Mahyadi, 2015) and in 1940 in West Kalimantan (Irmawati, 2015). The cultivation of these plants evolved to meet the demand of the domestic market, because the mandarin orange is one of the preferable types of fruit of the consumers. Figure 1.5 shows that the production increased from 483 thousand tonnes in 1999 to 2,551 thousand tonnes in 2007, with an average annual growth rate of 14%. However, after 2007 it encountered a declining trend, where production decreased to 1,498 thousand tonnes in 2012, with an average annual growth rate of -2%. The attack of citrus vein phloem degeneration (CVPD) diseases became one of the causes of production decline, which makes the mandarin orange crop productivity and harvested area declined, while eradication and maintenance costs increases. The CVPD diseases was caused by gram negative bacteria that belongs to the group of alpha subdivision of Proteobacteria (Jagoueix et al, 1994) and can be transmitted from infected plants to healthy plants by *Diaphorina Citri* Kuwayana insects and the use of infected citrus seedlings which propagated through the eye patch.

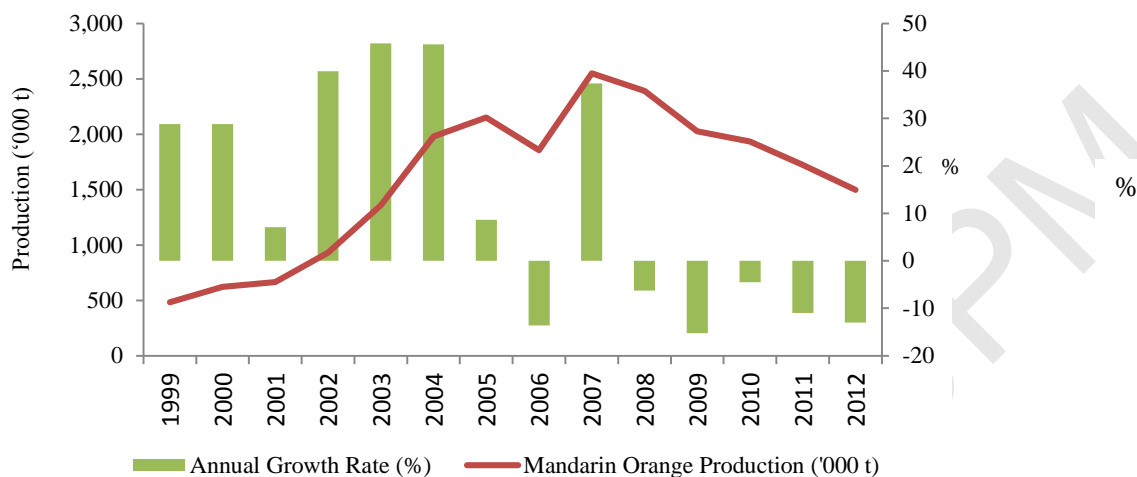


Figure 1.5: Mandarin Production ('000 t) and Annual Growth Rate (%), 1999-2012

(Source: BPS, 2015)

Figure 1.6 shows the percentage share of imports to production moved dynamically, where during 1999 to 2004 they had declined from 5.6% to 2.2%. However, they experienced a growing trend afterwards, which reached 11.9% in 2012. The mandarin import development in the Indonesian market may be attributed to the competitive price, the stability of the supply and the availability of an adequate storage facility (Arsanti et al., 2012).

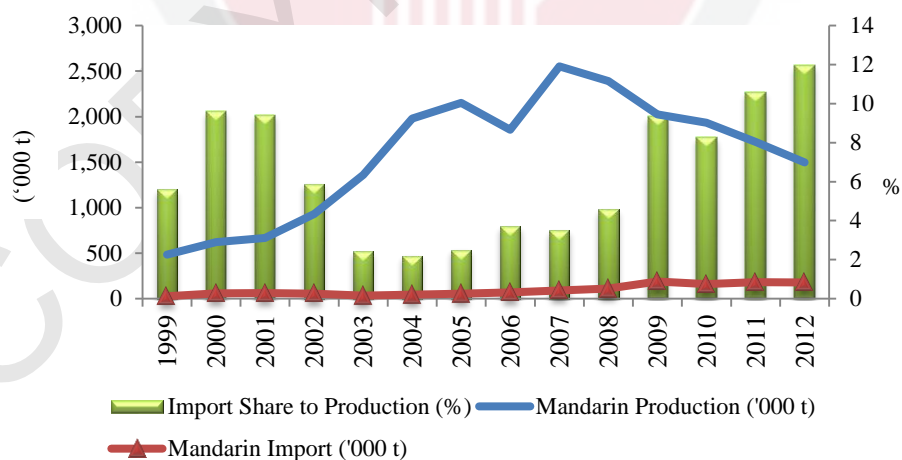


Figure 1.6: Mandarin Orange Production and Import ('000 t), Import Share to Production (%), 1999-2012

(Source: BPS, 2015)

The government has attempted to suppress the pace of the imports with a set of tariff and non-tariff barriers. The tariff barrier was created by increasing the rate for the mandarin orange imports, where previously most favored nation (MFN) rate in 1998-2004 was 5% to 25% in 2005-2008. However, in 2010 it was reduced to 20% (Departemen Keuangan RI, 2011). Exceptions were applied to mandarin oranges from China after the ACFTA was signed, of which in 2004 the rate was 5%, but zero afterwards (Marks, 2012).

The non-tariff barrier consisted of several policies, they are: (1) The regulation No.42/Permentan/OT.140/6/2012, where fresh fruits and fresh vegetables can only enter through the four formal entrances, which was previously through 14 ports. (2) The regulation No.60/M-DAG/PER/9/2012, which was meant to tighten the import procedures; whereby, importers that shipped imported fruits and vegetables on 28 September 2012 and thereafter must be registered as a registered importer (IT) and importer manufactures (IP). (3) The limitation of imported mandarin that are sold in modern stores at 20% by the publishing of Permendag No.70/M-DAG/PER/12/2013, which will come into effect on 12 June 2016. This policy is indirectly a production quota to encourage producers to produce more mandarin oranges and provide a ready market in the large scale retail chains which were impenetrable before.

1.3 Problem Articulation

The mandarin orange industry is an important sector in terms of its contribution to GDP, employment and fruit consumption among the population. Reviewing background of the industry poses a number of issues that being faced by this industry. First, the production has not been able to keep up with the increase in demand due to population growth and changing lifestyle. The consumption gap become bigger which are met through import and diversification of fruit intake. Second, the production of mandarin orange has not moved in tandem to the increase in mandarin orange price. That is, despite the increase in the price of mandarin orange from Rp11.696,00/kg in 2007 to Rp15.000,00/kg in 2012, the production showed a declining trend. During the same period, the production has declined by 41.3%. There are two major factors that led to the decline. First, the pull of higher return in the oil palm plantation and the push of higher production cost, because of the attack of mandarin orange diseases, especially CVPD, in some production centres (Nurhadi, 2015; Meitayani et al., 2014). The spread of CVPD disease depends on the presence of inoculums and its vector in the crop area (Bove et al., 2000 and Poerwanto & Solichah, 2010), which resulted in area shrinkage because the affected crop area need to be quarantined, which farmers pushed to leave the area and seek other opportunities. It is well known fact that oil palm plantation is relatively easier in terms of maintenance compare to mandarin orange farming which is labor intensive and require larger amount of maintenance hours. The mandarin orange farming faces higher risk particularly volatile price and highly susceptible to disease compared to the oil palm crop.

In view of the economic importance of the mandarin orange industry the government has taken a number of measures to revive the sector. These include; imposition of non-

tariff barriers to suppress imports and hence encourage local production through a number of strategies, they are: (i) protection policy, which consisted of reducing the formal entrance and tightening imports, and (ii) stimulus policy, which gave an obligation to a modern store to sell 80% of mandarin orange. The non-tariff policy was chosen over tariff policy as the major importer of mandarin orange is China, which accounted for 90% of the total import in 2012 (BPS, 2012).

The above deliberations indicate a number of structural complexities such as feedback relationship between variables in the mandarin orange ecosystem. A change in one variable, such as an increase of production cost leads to a change of events, such as reduction of income which led them to seek better alternatives such as oil palm plantation. The reduction of production in turn led to consumption gap which caused an upsurge mandarin orange import which is relatively cheaper, where after 2007 the average price is 40.8% cheaper compared to the local price. Cheaper import price makes mandarin orange less economical. The influence of cheaper import forced the government to take protective intervene, through tariff and non-tariff measures. These interventions will certainly change the landscape of mandarin orange industry in the future.

Under such a complex environment, an industry analysis is deemed suitable. Among the methodologies available to analyze the performance of industry is system dynamics framework (Forrester, 1961). System dynamics is highly suitable to address feedback relationship between elements in a system, non linearity and delays (Sterman, 2000, 2004). It is a robust methodology to address a complex array of causal relationship, among variables as in the case of Indonesia mandarin orange industry.

Clearly the mandarin orange industry in Indonesia is at a cross road. After a stellar performance between 1999 to 2007, it began to decline despite the increase in the local consumption due to increase in population and income of the consumers. In short, the supply was not able meet the local demand where the deficit was compensated through import. The decline in area and production of mandarin orange was attributed the push and pull factors. These include: (i) the pull of relatively high remunerative crop such as oil palm and other agricultural ventures; the advent of massive attack of CVPD disease; and (iii) poor extension system which limits productivity growth.

Import of mandarin orange has increased significantly in the last decade to meet the local demand. The government has taken initiatives to revive the mandarin orange industry by introducing (i) domestic protection policy and (ii) stimulus policy. The government intends to introduce domestic protection policy by restricting entry points of mandarin orange import as well as tightening the import procedure. The stimulus policy involves the imposition of quota to modern stores to sell 80% local mandarin oranges from the total sale of the produce. This study attempts to analyze the economic impact of these protective policies on the mandarin orange industry. In view of the complexity of the problem circular causality between variables in the system and delays, in response system dynamics is applied as it is the most suitable approach to address those issues.

1.4 Research Questions

This study attempts to answer the following questions:

- i. What are the structural factors that explain the decline in the production and area of Indonesia's mandarin orange?
- ii. What are the possible impacts of the protection policy, in the form of domestic protection policy (reducing the formal entrance, and tightening the import procedure) and stimulus policy (obligation for moderns store to sell 80% of local products) on local production and mandarin orange consumption in the long term?; and
- iii. What are the alternative strategies to sustain Indonesia's mandarin orange industry in the future?

1.5 Objectives of the Study

The general objective of this study is to evaluate the impact of the market protection policy on the mandarin orange industry in Indonesia using system dynamics framework. The specific objectives are:

- i. To examine the relationship between structure and behavior of the production of the mandarin orange industry in Indonesia;
- ii. To assess the impact of the protection policy on the local production and consumption; and,
- iii. To simulate the impact of changes in policy scenarios on the mandarin orange industry.

1.6 Scope of the Study

The system dynamic framework was used to find alternative policies to sustain the mandarin orange industry in Indonesia. The study focused on two sub modules which were production and consumption that are distinguished for two sectors, namely: the local mandarin orange and import. The imported mandarin orange sub modules focused on the import behavior so as to complement the local mandarin orange production system.

The simulation covered the periods of 2013-2034, with reference mode started from 1999-2012 built upon BPS data. The periods of 1999-2012 was selected to indicate the major shift that had occurred in mandarin orange production. The considered policies were: (1) the domestic protection policy, (2) stimulus policy, (3) R&D policy and (4) disease management. The study has examined six simulation scenarios where each is unique in terms of policy combination. The impact of the various policy combinations are evaluated on variables such as (i) relative value of import price over local price, (ii) production, (iii) expected profits and (iv) import value.

1.7 Dynamic Hypotheses

- i. The CVPD disease and the pull of oil palm leads to the reduction in area and mandarin production;
- ii. The protection policy (domestic protection and stimulus policy) will increase Indonesia mandarin production and consumption in the long term; and
- iii. An increase in research and development (R&D) and extension agent in disease management will enhance productivity and hence production and profit of the producers.

1.8 Justifications of the Study

This thesis aims to provide system dynamics framework of Indonesia mandarin orange industry, regarding (1) the interaction between its components: production (area, productivity), consumption, import, and the major variable that build the component, (2) the effect of existing policy that was applied and (3) implication of government platform by observing some important policy.

The findings of the study are expected to provide some understanding on the structural factors that shape the behavior of the industry which is useful input to the policy makers in designing strategies for further market development. The findings are useful to industry analyst as well as research in understanding the structural shift that has taken place in the industry. The simulation exercise provides an evidence-based analysis of the best policy alternative towards growth and improving the competitiveness of the industry. The application of system dynamics framework the effectiveness of the market protection policy contributes to the enhancement of knowledge in the field of agricultural policy studies.

1.9 Organization of the Thesis

This thesis is organized as follows. Chapter I discusses the major problems regarding the industry, objectives and justifications of the study. The following chapter describes the mandarin industry in Indonesia. Chapter III gives the literature review, from previous empirical researches related to this thesis. Chapter IV explains the methodology that has been used. It is accompanied with the Indonesia mandarin industry model, consisting of a causal loop and stock flow diagram. The simulation results and model testing are located in Chapter V. The thesis is concluded in Chapter VI along with future research and limitations.

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