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The mandarin orange industry in Indonesia: a policy evaluation

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ABSTRACT

The mandarin orange industry experienced an increasing trend during the period of 1999 to 2007, with an average annual rate of growth of 25%. However, after 2007 to 2012 there was a significant decline from 2.5 million mt to 1.4 million mt. 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 mt to 179 million mt 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 impact of the selected policy interventions on the mandarin industry in Indonesia. 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 findings of this research indicate that the protection policy that was implemented was estimated to help to preserve local mandarin orange production and consumption from a sharper decline, which were 899% and 112%, respectively, in the next 22 years.

KEY WORDS
consumption, Indonesia, mandarin orange, production, system dynamics

INTRODUCTION

Mandarin oranges have become one of the horticultural commodities which have been prioritized to be developed by the Indonesian Ministry of Agriculture. The development is motivated by the high import of mandarin oranges that is reducing the country's foreign exchange reserves. Therefore, the Indonesian mandarin orange is expected to become the substitution for the mandarin orange import. As shown in Figure 1, the import of mandarin oranges has increased both in quantity and value, from 27 thousand mt with the value of USD 13 million in 1999 to 179 thousand mt with a value of USD 176 million respectively in 2012, suggesting an increase of 562.9% in quantity.

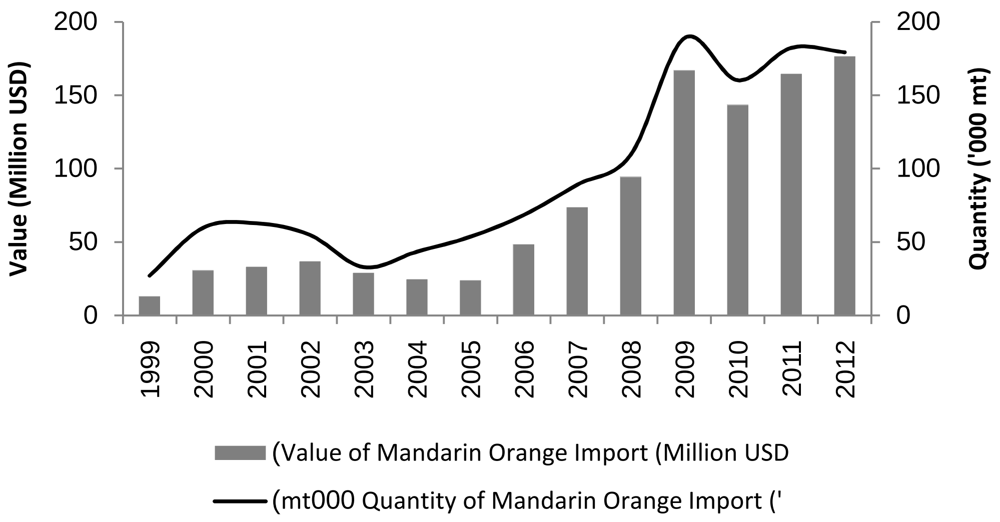

Fig. 1: Value of Mandarin Orange Import (Million USD) and Quantity of Mandarin Orange Import (‘000 mt), 1999-2012
Source: BPS (2015)

The mandarin orange cultivation in Indonesia was in existence as far back as 1920s in Aceh [9] and in 1940 in West Kalimantan. 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 2 shows that the production increased from 483 thousand mt in 1999 to 2.551 thousand mt 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 mt 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 [8] 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.

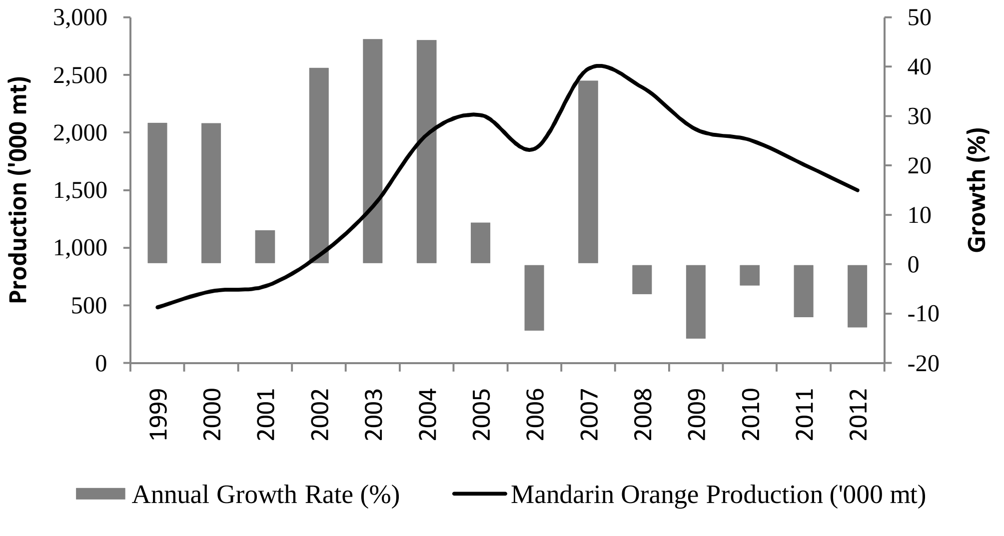

Fig. 2: Mandarin Production (‘000 mt) and Annual Growth Rate (%), 1999-2012
Source: BPS (2015)

Figure 3 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 [2].

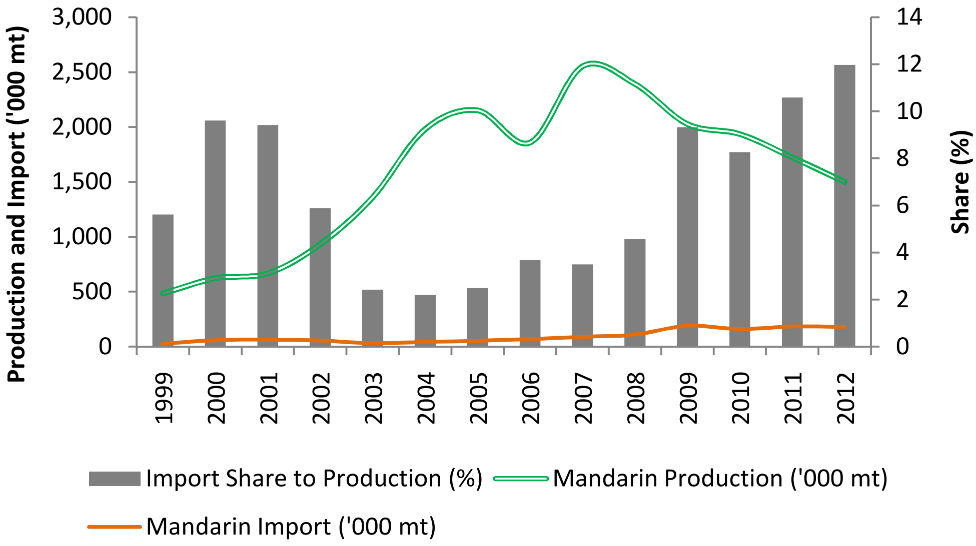

Fig. 3: Mandarin Orange Production and Import (‘000 mt), Import Share to Production (%), 1999-2012
Source: BPS (2015)

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% [6]. Exceptions were applied to mandarin oranges from China after the ACFTA was signed, of which in 2004 the rate was 5%, but zero afterwards [10].

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 September 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.

The mandarin orange industry is an important sector in terms of its contribution to GDP, employment and fruit consumption among the population. Indonesia produced about 98% of total consumption in 1999 but it has declined to 92% in 2012. The overall trend of mandarin orange production in 1999-2012 is increasing from 483 thousand mt to 1.4 million mt. However, since 2007 to 2012, there was a significant decline in production from 2.5 million mt to 1.4 million mt.

The apparent consumption has increased from 491 thousand mt in 1999 to 1.6 million mt 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 mt in 1999 to 179 thousand mt in 2012. This gap is filled up through imports. As shown in Figure 4, mandarin orange import has increased by 562.9%, in 1999-2012.

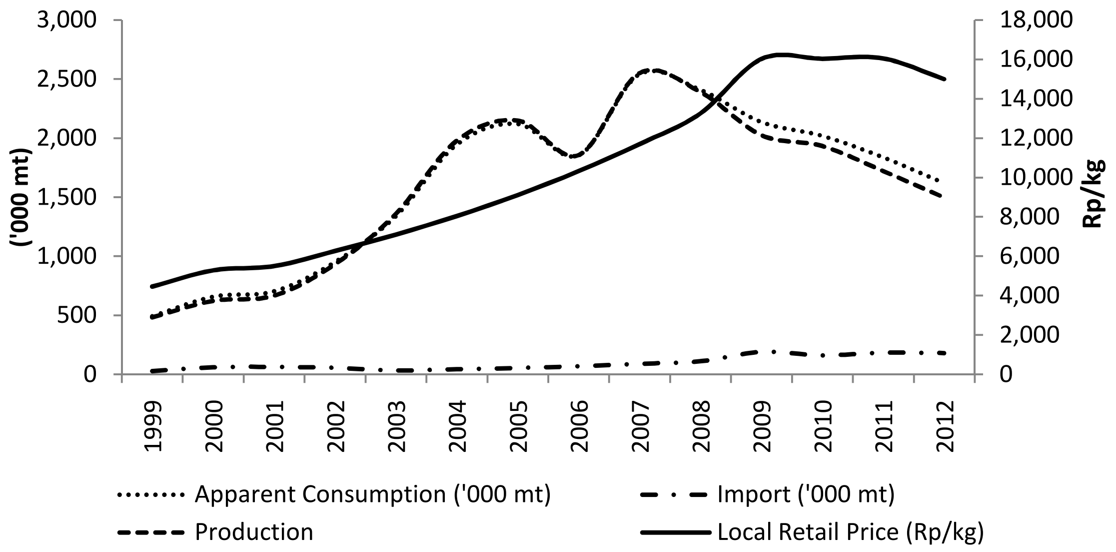

Fig. 4: Mandarin Orange Production, Import, Loss and Apparent Consumption (‘000 mt) and Local Orange Mandarin Price (Rp/kg), 1999-2012
Source: BPS (2015)

The above description poses a number of issues. 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 Rupiah (Rp.) 11.696/kg in 2007 to Rp.15.000/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 centers [16,13]. The spread of CVPD disease depends on the presence of inoculums and its vector in the crop area [5,17], 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 due to its highly susceptibility to diseases 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 due to the exception for China as the major importer of mandarin orange, which accounted for 90% of the total import in 2012, from the tariff policy imposed (BPS 2015). 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. 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.

This research seeks to address 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? The general objective of this study is to evaluate the impact of selected policy interventions on the mandarin industry in Indonesia. The specific objectives are: (i) to examine the relationship between structure and behavior of the production of the mandarin orange industry in Indonesia and (ii) to assess the impact of the protection policy on the local production and consumption. The paper is organized as follows: Section 2 on materials and methods, Section 3 on results and discussion Section 4 on policy implications and conclusions.

MATERIALS AND METHODS

Owing to the complex nature of the production and management problems, it is beneficial apply management policy choices only after careful modeling and simulation of different policy strategies [1]. System dynamics paradigm provides a foundation for building computer models to do examine the structure, the interrelation and mode of trend of complex economic, and environmental and technological systems. The principle idea of system dynamics is that any dynamic behavior of a system arises from its feedback structure. Put differently, the system structure and interacting relationships are responsible for generating a systematic pattern of behavior. System dynamists are primarily interested in discovering the patterns of system behavior over time. It is a robust methodology to address a causal relationship, among variables as in the case of Indonesia mandarin orange industry. A comprehensive description of the system dynamics tool is given in [22].The main stages and activities in the system dynamics modeling process are: problem articulation, formulating a dynamic hypothesis or theory about the causes of the problem, formulating a simulation model, testing the model or model validation and designing and evaluating policies for improvement [22,11].

Modeling of Orange Industry in Indonesia:

The system dynamics model of the Indonesian mandarin orange industry has been developed to capture the structure and behavior that underlie production. It has also been used to evaluate the impact of the government import policy on production. The causal loop diagram (CLD) consisted of: Indonesian mandarin orange area, productivity, consumption and import**.** The causal loop diagram of mandarin production system in Indonesia is shown in Figure 5.Causal loop diagrams show the main feedback loops of the systems. The causal loop graphs have been utilized to indicate fundamental causal mechanisms hypothesized to produce the reference mode of behavior over time**.** The closed feedback loop in system dynamics models represents the decision making structure or organizational relationships. For instance, structural decisions are derived from information about the state of the system, and then actions are taken to alter the state of the system. New information about the state brings further decisions and changes. The circular process and interactions repeat perpetually unless the system collapses. A feedback loop comprises two or more causally related variables that close back on themselves. The relationship between one variable and following can be either positive or negative. A positive relationship denotes that if one increases, the following also grows. In a negative relationship the two variables adjust inversely. If there are an even amount of negative relationships in total, then the loop is called positive; if there are odd amount of negative relationships, the loop is called negative. Positive feedback loops produce growth and negative feedback loops are goal seeking. There are 15 main feedback loops in orange production system in Indonesia. Of which 5 are reinforcing and 10 are goal seeking.

The stock and flow diagram of the system dynamics model of mandarin production system in Indonesia is shown in Figure 6. The stock and flow diagram put more emphasis on the physical structure of the model, which could be used to track the accumulation of information, money and materials as they move within the system [22]. The stock and flow transformed the causal loop diagram into a quantitative structure and interpreted it with values, parameters and equations [15]. The stock was the entity that had accumulated in the system; while the flow was the rate that went into or out of the stock.

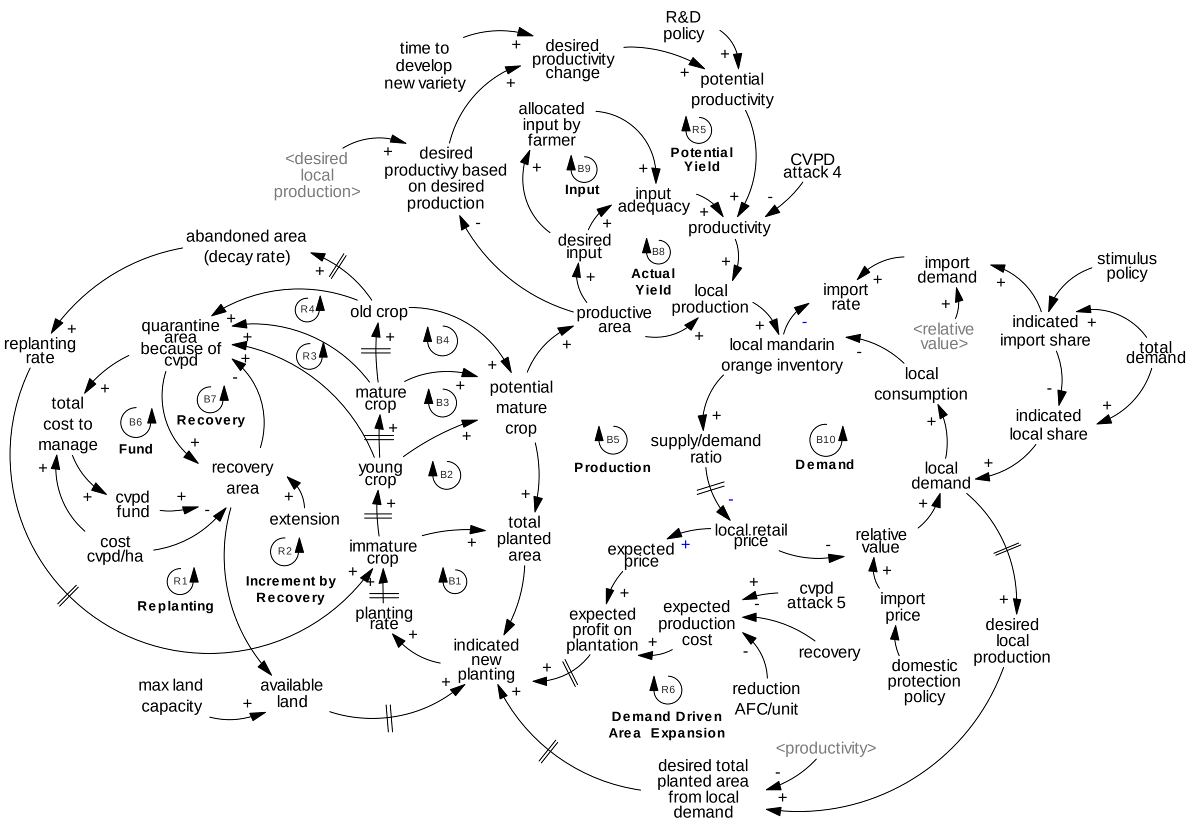

Fig. 5: CLD for Mandarin Orange Industry in Indonesia

Consumption of mandarin oranges affects the price through the inventory coverage (supply-demand ratio) and it is expressed as:

Local consumption = Min(local demand, Max local mandarin orange consumption)

The retail price of the local mandarin orange that experienced an increasing trend from Rp 4.456/kg in 1999 to Rp 15.000/kg in 2012 indicated an increasing demand during the year. As the price increased the expected profit, it was also estimated to increase and trigger the mandarin orange producer to expand the plantation area. However, the profit was also determined by the production cost; while the area expansion was limited by the maximum land capacity. In 2005, the increase of the mandarin orange production cost was also affected by the CVPD attack. A previous study [14] shows that the CVPD attack can increase the production cost in citrus plantation. In terms of the availability of land for mandarin orange plantation, it was estimated by the Indonesian Agency for Agricultural Research and Development (IARRD) that it could be developed in ten provinces, with a total area of 5.6 million ha besides the existing area of 63 thousand ha in 2005.

The mandarin orange life cycle is between 20-25 years, with the aging profile that can be divided into immature, young, mature and old crops. The immature crop needs 3 years to become a young crop that starts to bear fruit while the next phase takes 4 and 8 years, respectively. It is computed as:

Immature crop = INTEG(planting rate + replanting rate - early maturation rate, 0)
Early maturation rate = immature crop/early maturation period

After 15 years, the mandarin old crop productivity is reduced, and between 20-25 years the mandarin orange crop needs to be replaced. In some areas of the centers of mandarin orange, the CVPD's severe attacks also contributed to a reduction in plantation area, because the infected land had to be quarantined [16,13]. CVPD management that was included in the model consisted of two components, namely funding and extension agent. CVPD management's cost was estimated at 1.4 times the production cost [14].

The extension program that includes an accurate assessment of technology adoption is believed to be one means of CVPD prevention [20]. Birkhaeuser [4] research has found that five out of eight studies showed the positive impact of the extension in technology adaption. Furthermore, the innovating enterprise need consistently innovate and invest in research strategies to be competitive, as the propagation of innovation indicates a return to the original situation, with average costs greater than marginal revenue and negative profit margins [23]. Referring to law No.19/2013 on the protection and empowerment of farmers in the farming village, every farming region has at least one person to supervise the agricultural land area of 100 ha. The agriculture extension agent (AEA) has currently estimated a shortage of 39,180 people from 47,418 personnel that are available [19]. Mandarin orange land conversion to oil palm as has happened in West Sulawesi, was indicated to be one of the causes of the reduction of the mandarin orange planted area [12]. Based on Sawit Watch research, every year 500 thousand new oil palm plantations in Indonesia come from the conversion of food land; however, horticultural land is only 4% of the total food land.

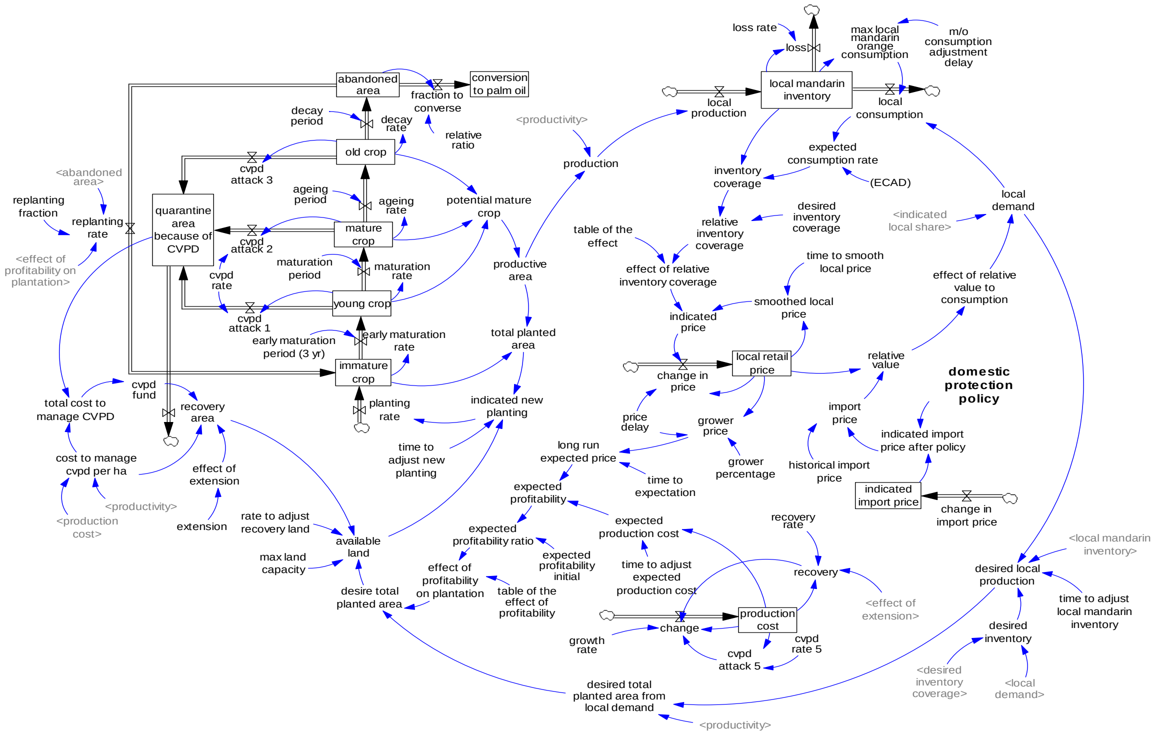

Fig. 6: Stock and Flow for the Local Mandarin Orange Production Area and Consumption

The relative value of the mandarin orange import price compared to the local price experienced a decreasing trend from 0.94 in 1999 to 0.60 in 2012. This situation was due to the reduction in the import price and the increase of the local price. The domestic protection policy that was implemented by the Indonesian government in 2012 was estimated by the Indonesian retailers association (APRINDO) to add 20% on the average to the import price, due to the rising cost [10].

The mandarin orange productivity in this model was influenced by: potential productivity, CVPD attack and input adequacy and it expressed as:

Productivity = potential productivity × effect of input on productivity × cvpd attack 4
Effect of input on productivity = f (Input Adequacy); f '(1) = 1, f '≥0
Input Adequacy = Desired input / Allocated input by farmer

The growth of the potential productivity was determined by the existing mandarin orange research and development (R&D). The R&D policy was included to find out the effect of an upgraded in the R&D on productivity. The input variables included: organic fertilizer, inorganic fertilizer and pest control management.

The import rate was determined by the import demand and desired local production that was unfulfilled by the local production and it is described as:

Import rate = IF THEN ELSE(Time<=2012, import look up Max(0,desired local production-local production + import demand))

The stimulus policy, that limits the mandarin import share to 20% was also injected to see its effect on the import rate through the import demand (Permendag No.70/M-DAG/PER/12/2013).

RESULTS AND DISCUSSION

The Indonesian mandarin orange industry model was simulated by Vensim PLE and DSS software, from 1999 to 2034. The model is expected to be useful to assess a long term trend and policy analysis. The validation procedure that was used was based on Sterman [21], where the historical fit of the Indonesian mandarin orange industry model was tested by using the root mean square percent error (RMSPE) and Theil inequality statistics, which is a decomposition of the mean square error (MSE) into systematic (U^m), unequal variations (U^s) and unsystematic (U^c) components. Table 1 summarizes the error analysis for the six key variables in the system.

Table 1: Error Analysis of the Indonesian Mandarin Orange Industry Model, 1999-2012

Variable	RMSPE (%)	Theil Inequality Statistics		
		Um	Us	Uc
Production	17	0	0.2	0.8
Productive Area	19	0	0.2	0.8
Productivity	9	0	0.1	0.9
Price	7	0	0.1	0.9
Local Consumption	21	0.5	0	0.5
Import Consumption	15	0.4	0.1	0.5

The RMSPE for six variables (production, productive area, productivity, price, local consumption and import consumption) were small (7-21%), indicating that the model was able to track all these variables. Figures 7–8 show the comparisons of simulated behaviors of area, productivity and production with the historical data. In terms of the Theil inequality statistics, the results can be divided into two: (1) four variables (production, productive area, productivity and price) show that 80-90% of the error was due to unsystematic components, (2) two variables (local consumption and import consumption) show that 50% of the error was due to unsystematic components. Based on Sterman [21], the condition shows that the fit of data and model behavior can be accepted with confidence, because it indicates that the bias (unable to capture the full increase in actual data) can be due to the model boundary.

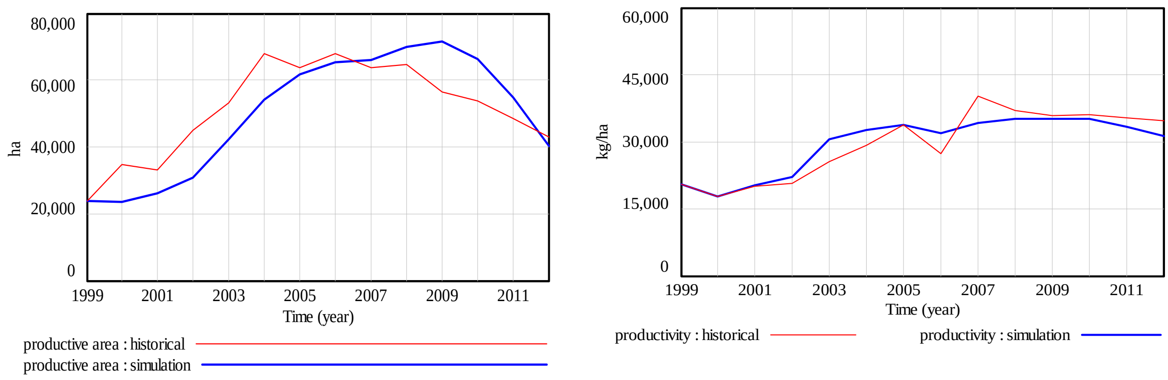

Fig. 7: Simulation of Productive Area and Productivity, 1999-2012

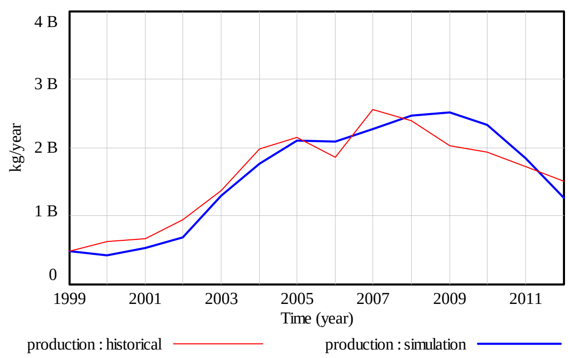

Fig. 8: Simulation of Production, 1999-2012

Simulated Scenario:

The Indonesian mandarin orange industry model was simulated for purpose to assess the impact of the protection policy on production and total consumption. The simulation covers the period during 2013-2034. The protection policy in the model consists of: 1) domestic protection policy (reducing mandarin orange import entrance and tightening import procedure for importers). Here, the import price is expected to rise by 20% on average due to the additional cost on transportation and import permits, 2) stimulus policy, which indirectly restricts mandarin orange imports by 20% of the total supply consumption demand.

Production

The simulation results of the production are presented in Figure 9. Fluctuations occurred because of the delay in the production system, which took approximately three years to bear fruit in addition the productive age of the plant only reached 20 years old. The average annual growth rate in the free market and implemented protection policy were -6.5 and 0.7, respectively. This result provides an indication that the protection policy can help preserve local mandarin orange production from a sharper decline in the next 22 years. The total mandarin orange production in the implemented protection policy scenario in 2034 is estimated to reach 1 million mt, 899% higher than the total mandarin orange production under the free market scenario. However, further policies to increase mandarin orange productions are still needed referring to the decrease that still happened in the year-end estimate, even at a slower rate.

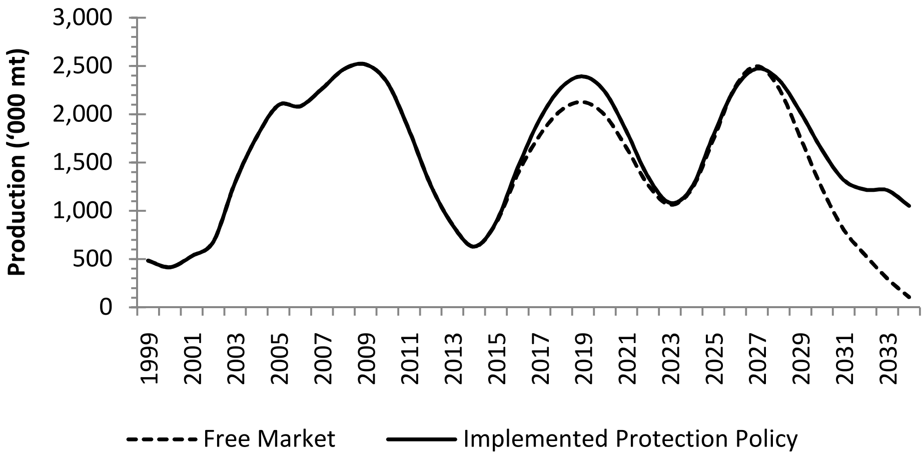

Fig. 9: Simulation Results of Production ('000 mt), 1999-2034

Total Consumption

The simulation results related to the total consumption are depicted in Figure 10. Both scenarios show a similar pattern. The protection policy initially made the total consumption in 2023 fall more than in the free market scenario, but its ability to maintain the mandarin orange local production, where give a huge impact in fulfilling the total consumption demand, makes the total mandarin orange consumption for this scenario decreased at a slower rate after 2031 than in the free market scenario. The average annual growth rates for the free market and implemented protection policy during 2012-2034 were: -3.7 and -1, respectively. Further policies to boost production to meet total consumption demand for mandarin oranges are still needed, referring to the total consumption decrease in the year-end estimation, even at a slower rate.

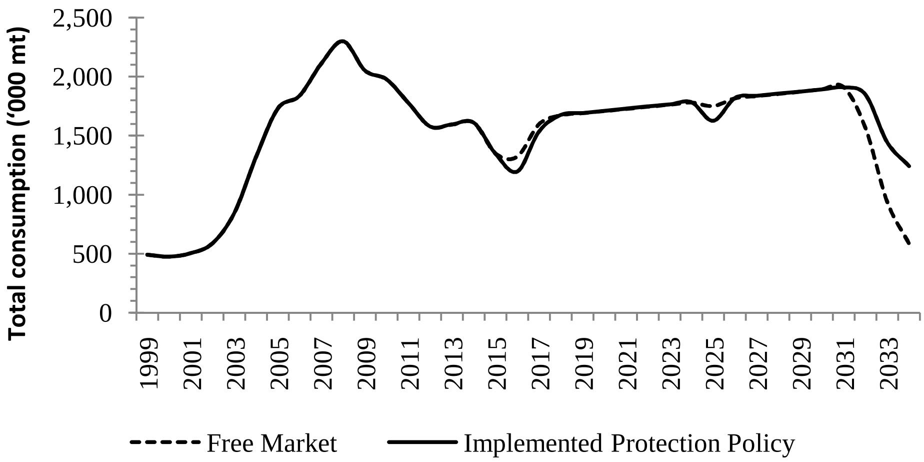

Fig. 10: Simulation Results of the Total Consumption ('000 mt), 1999-2034

Conclusions:

A system dynamics model was used to examine the Indonesian mandarin orange industry in terms of production and area structural factors, protection policy impacts, and alternative strategies. The results indicate that the structures which built Indonesian mandarin orange industry model were valid and can explain the production and productive area decline behavior. The protection policy that was implemented had been estimated to help to preserve local mandarin orange production and consumption from a sharper decline, which were 899% and 112%, respectively, in the next 22 years. However, further policies to improve mandarin orange local production are still needed. In the business as usual scenario, where only the protection policy was applied, the relative value was expected to increase by 2.5% over the next twenty two years from 0.5 in 2012 to 0.65 in 2034. However, production and expected profit were estimated to decrease 90% and 496% from 1.3 million mt and Rp.4001/kg to 0.13 million mt and negative Rp.15,836/kg, while the import rate would continue to increase from 179 thousand mt in 2012 to 3.2 million mt in 2034.

The overall simulation results show that the Indonesian mandarin orange industry still requires support from the government, particularly in supporting the improvement and stability of mandarin orange production. This is related with the high risk of the mandarin orange production, where when the plague of CVPD happened the cost of production become increased and farmer chose to leave the land or switch to another crop cultivation which are more profitable. In the medium term protection policy can help stimulate the production, but in the long term if the root causes of production decline not being addressed (disease and technology adaption) then the production will face the downturn risk.

For the future research a simulation of the impact of changes in policy scenarios on the Indonesia's mandarin orange industry can be conducted to find an alternative strategy to sustain the industry in the future. Weather and Good Agricultural Practice (GAP) are predicted to have a significant contribution in mandarin orange production and can be incorporated into the model to improve the production subsystem and give a better understanding of the mandarin orange industry behavior. On the consumption subsystem side, the boundary can be expanded by including quality, availability and consumer taste, which affect mandarin orange demand.

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Ethics:

This article is original and the corresponding author confirms that no ethical issues involved.

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