INDONESIA RICE SUPPLY AND DEMAND DYNAMIC MODEL

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ABSTRACT

Demand for rice in Indonesia is high and it is difficult to decrease. Meanwhile there is a big problem in supply side. We also face problem in rice import, land conversion, price fluctuation and leveling of productivity. Unbalanced condition between demand and supply can threat sustainability of food security. Therefore, to maintain balanced in rice supply and demand is important. Related to the aforementioned, the aim of this study is focused on dynamic model development of rice supply and demand. The result of this study reveal that conversion make land farming can't increase rapidly and land extensification program is bounded by available land. Domestic rice production can't cover rice demand so that BULOG has to conduct market operation with higher rate and cannot avoid rice import.

To achieve rice self sufficiency in supply side, production technology is very important to increase productivity. In demand side, we need to decrease rice consumption through consumption diversification campaign.

INTRODUCTION

Indonesia is one of agricultural countries in the world that has significant role to endow with rich agricultural potentials. Furthermore, agricultural sector plays a big role in forming Gross National Income and also plays a role in supplying food and industrial raw materials. Refers to the Indonesian Government Policy, this sector can make an equal development through the endeavor of poverty reduction and the improvement of people's income. The role of food supplier is to achieve food self-sufficiency especially rice. Thus, any activities to increase rice production will be important for sustainable food security. Therefore, there is a need to revitalize agriculture and rice policy in a wider sense throughout Indonesia. One alternative to achieve the national production target is innovating technology and improving productivity in rice production system. Furthermore, demand for rice is increasing with population growth. With 237 million people, in 2010 demand for rice is 32 million tons and rice per capita consumption is 139 kg/year.

Rice production is influenced by farming land. Farming land has been converted to another uses like industry and real estate needs. This fact can influence sustainability of rice supply. We also face problem in rice import, land conversion, price fluctuation and leveling of productivity. Unbalanced condition between demand and supply can threat sustainability of food security in Indonesia and it can be a serious problem in whole sectors like economy, social politic, and safety. Therefore, to maintain balanced in rice supply and demand is important. Related to the

aforementioned, the aim of this study is focused on dynamic model development of rice supply and demand in order to achieve sustainability of rice self sufficiency.

RESEARCH METHODOLOGY

Conceptual Framework

In this research, sustainability of rice self sufficiency is the outcome. Rice self sufficiency will be achieved if rice supply, especially from domestic production is higher than national rice demand. However, many variables that influence rice supply and demand so it is not easy to maintain self sufficiency. If we look at Figure 1 below, we can see that national demand is influenced by income, population, household consumption and industry consumption. Meanwhile, rice supply or rice availability is influenced by BULOG rice stock, rice import, rice export, and national paddy production. Relationship among other variables can be described in Figure 1.

FIGURE 1: CONCEPTUAL FRAMEWORK
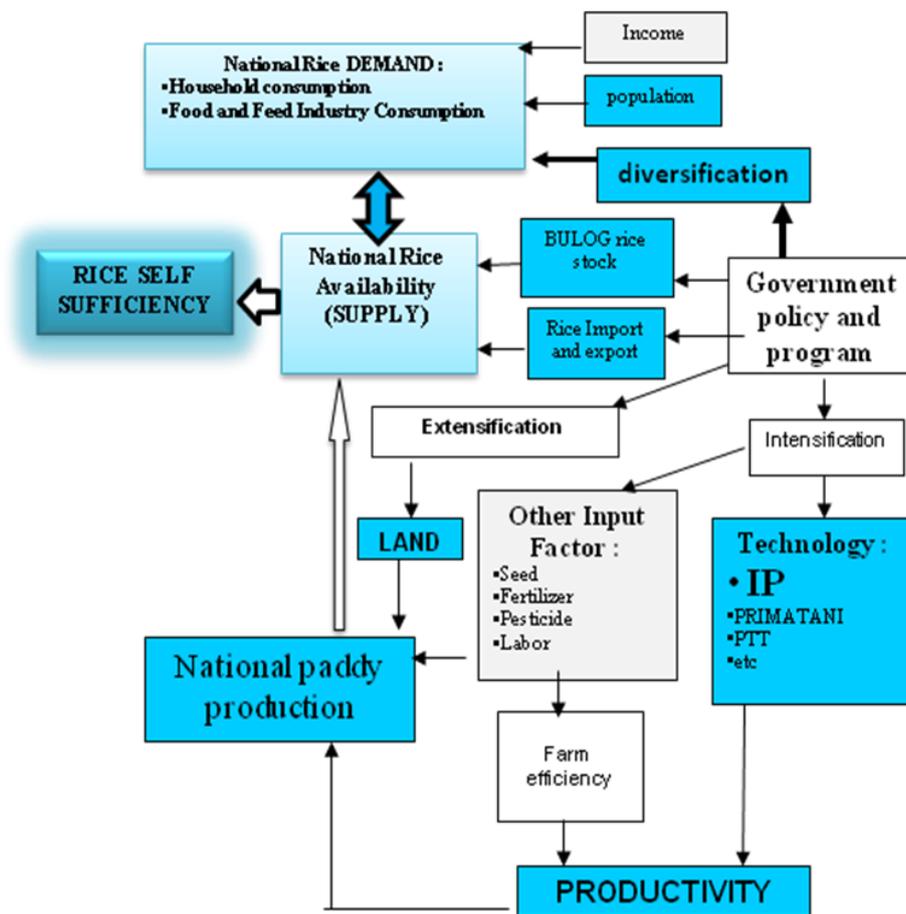
This research develops a dynamic simulation model of advanced rice demand and supply considering interactive feedback relationships with several government policy and program such as intensification, extensification, diversification, and trade (export and import). This research utilizes the System Dynamics method, a method of studying the world around us by viewing the system as a whole. System Dynamics

examines the interaction between all objects or individual parts of a system and their relationship to one another.

System Dynamics has two typical methodological characteristics. First, it focuses on a system's dynamic behavior, that is, the behavior changes within the system according to the progression of time. Second, System Dynamic analysis the fundamental reasons for dynamic change through a feedback structure. These characteristics precisely relate to the objectives of this research, which is the identification of the effect of dynamic changes of extensification or new farming land, rural and urban consumption, diversification program, price, BULOG rice stock, market operation, and trade (export and import) on rice supply and demand by investigating interactive feedback relationship with rice supply and demand. Thus, this is the reason for using System Dynamics as the methodology for pursuing the objectives of this research.

Traditionally, there are two Systems Dynamics modeling approaches. One is known as the top-down modeling approaches, and the other is known as the bottom-up modeling approach. In the top-down approach that emphasizes 'feedback loop thinking', a causal loop diagram is made, followed by a detailed System Dynamics diagram. In the bottom-up approach that emphasizes 'operational thinking', a System Dynamics diagram is established first by linking individual stock and flow variables, and then a causal loop diagram is completed by gradually expanding the System Dynamics diagram. This research employs the top-down modeling approach. Specifically, System Dynamics analysis of this research is implemented through a three stage simulation modeling process of establishing a causal loop diagram, designing a System Dynamics diagram, and formulating an equation.

System Dynamics

For developing the model, mechanism of the research is described as follows; identifying key variables and its behavior in the system, developing inter-relationship among key variables in the form of mathematical formulations, programming the model by using dynamic system based application software, and then simulating, validating the model to improve performance of the model. The model was tested in national coverage with base period 2005. Data was collected from some agency or institution and some literature and textbook that related to this research. For data processing, this research uses *I-Think* 9.03 version as system dynamic software.

In order to fully address research questions and objectives, more sophisticated models must be constructed and more comprehensive simulations must be carried out. Thus, this research will develop a dynamic simulation model of rice demand and supply considering interactive feedback relationships with several government policy and program such as intensification, extensification or new farming land, rural and urban consumption, diversification program, price, BULOG rice stock and trade (export and import) on rice supply and demand. This research uses the System Dynamics method. In the 1960s, Massachusetts Institute of Technology Professor Jay W. Forrester (1961) created Systems Dynamics, a method of studying the world around us by viewing the system as a whole. Systems Dynamics examines the interaction of all objects or individual parts of a system and their relationship to one another. Basic system structures are assessed to better understand the cause and effect that may be produced. Many of these systems can be built as computerized models and are able to perform reliable calculations at a much greater speed than the human-mind based model.

Even though the application scope and focus of System Dynamics have changed continuously, the typical methodological characteristics of System Dynamics have still remained strong during the last 40 years. The first characteristic is that System Dynamics focuses on the dynamic behavior of systems, that is, the behavioral changes of systems according to the progression of time. This implies that System Dynamics emphasizes practical perspectives such as the change, evolution, development, and decline of systems. The second feature of System Dynamics is that it analyzes the fundamental reasons of dynamic change through feedback structure. Feedback structure means that a closed loop is established by linking causal relationships among variables (Richardson 1991). Emphasizing feedback loop indicates that the dynamic change of a system is analyzed through endogenous variables rather than exogenous variables. Explaining the change of a system by exogenous variables makes it difficult to alter the behavior of a system strategically. However, the utilization of endogenous variables makes it possible to change the behavior of a system within a model. Another strong point of the feedback structure is to analyze the change of a system in terms of the overall structure of the system rather than the change of parameter related to a specific variable. These characteristics precisely correspond to the objective of this research, which is the identification of dynamic changes rice demand and supply by investigating interactive feedback relationships with several government policy and program such as intensification, extensification, rice self sufficiency, food security, and trade. This provides the reason for using System Dynamics as the methodology to pursue the objectives of this research.

System Dynamics Modeling Process

The simulation modeling process by the System Dynamics method can be largely classified into three stages; establishing a causal loop diagram, designing a System Dynamics diagram, and formulating an equation.

Stage 1: Establishing a causal loop diagram

A causal loop diagram is the map identifying the feedback structure of a system and organizes the cause and effect that may be produced in a system by indicating the feedback structure on a two-dimensional diagram. A causal loop diagram is established by a set of causal propositions or hypotheses on the shape of relationships among selected construct variables.

Stage 2: Designing a System Dynamics diagram

A System Dynamics diagram is the map quantitatively actualizing the feedback relationships derived from a causal loop diagram through the consideration of two concepts on system behavior such as system state and system activity. System state is indicated as the values of all variables constructing a system at time 't'. Such values are the changing values obtained as a result of activities occurred between time 't-1' and 't'. Also, information on such system state leads to the change of future activity by feedback.

Stage 3: Formulating equations

In this stage, equations corresponding to system state and system activity indicated in the System Dynamics diagram are formulated by computer simulation language. Such formulation of equations is completed through supplementation by several test runs of the simulation model.

INDONESIAN RICE CONDITION

The Importance of Rice

Indonesia archipelago stretches 5,110 kilometers from west to east and 1,888 kilometer from north to south along the equator and consists more than 17,000 islands. Total population is more than 210 million people and around 60% lives in Java island which has only 7% of the total land area. Therefore in country like Indonesia, logistics function has decisive role in determining the successful achievement of national food policy, particularly in ensuring adequate food supply at affordable price. Efforts to attain food price stabilization through distribution of staple food throughout the country is of importance to the national economic development.

Rice is still considered the most important grains in Indonesia since this crop is the staple food for majority of the people. In addition millions of people engaged in rice production, rice processing and other post-harvest activities related to rice. Considering the importance of rice, Government of Indonesia has launched many programs to boast rice production in order to meet the demand, and trying not too much dependent on imported rice.

Success story of Indonesia rice production seems to become a history of government capability to formulate a comprehensive food policy with particular reference to rice, coupled with social engineering program that was able to gear-up people to boast rice production. In addition, important supporting elements ranging from provision of agricultural inputs for rice production such as increasing fertilizer supply, provision of good quality seed, credit with low interest rate etc. played a key role in providing basic support to increase productivity, improving rice quality and minimizing losses. All contributed greatly to Indonesia's self-sufficiency in rice. However, later in the development, many changes have been occurring in Indonesia food policy which directly translated into new implementation strategy. Remarkable impact on the availability of food as well as on domestic market has been noted. The demand for rice keeps moving on the upward trend, in line with increasing population and income of the people. On the other hand production seemed to move more sluggishly and is unable to keep-up with the fast increasing demand. As a result in the 1990's Indonesia has become major rice importing countries with import around 2 MMT (Million Metric Tons) annually. Ironically, in 1998 Indonesia had changed its status from rice self-sufficient country to become the largest importing country, after they recorded import nearly 6 MMT.

Rice in The Context of Food Security

Rice has been considered not only as a trade commodity but also political commodity. During Soekarno era, the first president of Indonesia used rice as a vehicle to gain international support for Indonesia global political policy. As realization thousands tons of rice was shipped to other countries as a gesture of solidarity and to get positive response to strengthen Indonesia international policy.

The New Order regime led by Suharto has looked rice from different angle but still placed rice as one of the most important political instrument. Therefore in the early seventies programs to increase rice production were launched as an integral part of comprehensive food policy with ultimate objective to strengthen food security and alleviate poverty. Rice had to be made available at all time, in every place at affordable price. Rice policy at this period covered various aspect from inputs of

production by providing seed, fertilizer, pesticide and financial support through special credit line set up in government banks with low interest.

Bulog used to be a para-statal organization with its main function to stabilize price of basic food commodities in line with government food policy. In executing this tasks Bulog implements buffer stock strategy, which buys rice at floor price level during harvest season to absorb supply to prevent declining price. This farm gate price is set-up well above the production cost, aiming at ensuring farmers profit thus providing a better income for rice farmers. In the leaning months market intervention was conducted to smooth-out price fluctuation, as an effort to maintain affordability of lower-income groups to ensure their household food security.

Domestic procurement carried-out by Bulog basically to guarantee market for rice farmers to sell their product and to purchase rice for Bulog operation in supplying rice for public service obligation and for national stock reserve. Bulog was supported with special credit line set-up in Central Bank (Bank Indonesia), therefore Bulog could purchase rice without any difficulty. Farmers were very happy since they received significant subsidy through cheap fertilizer, pesticide and financial support during planting season and guaranteed market for their product.

By implementing rice policy and supported with large investment for improving irrigation and massive subsidy provided by government, rice production increased significantly at the rate of more than 4.5% in 1969-1990. These all-out efforts to boast rice production was culminated in 1984 when Indonesia was pronounced to be self-sufficient country in rice and President Suharto received an award from FAO for the country achievement. In 1984 Indonesia rice production was million metric tons (MMT), and BULOG had an ending stock more than 3.0 MMT, the largest ending stock in the history of this organization . It was the time when food security in this country including households food security was considered very strong, and the primary source of the food supply particularly rice came from domestic production. Many privileges were given to Bulog, among others monopoly right to import basic food commodities such as rice, sugar, wheat, soybean, corn etc.

More than three decades the price stabilization strategy was considered effective and contributing significantly to socio-economic stability which provides strong foundation for economic development. Empirical data showed that favorable conditions had stimulated remarkable increase in the contribution of agricultural sector to GDP, which grew more than 5.7% per year during 1978-1986. All sub-sector of food crops, cash crops, livestock and fisheries all enjoyed such conducive environment and progressing rapidly. Government had placed agricultural sector as back-bone of economic development and vehicle to encounter poverty and malnutrition, particularly in rural areas. During this period Bulog had the monopoly right to import rice and other basic food commodities such as sugar, wheat, corn and soybean. Later in the development one by one these commodities was released to private importers and Bulog had no longer monopoly right for importing those commodities including rice. The argument raised by scholars primarily lingered on the accountability, transparency and efficiency of Bulog operation. They suggested that direction on Indonesia food policy should move towards more open and fair in international trade of rice and other commodities.

Economic crisis hampered Indonesia and other countries had severe impact on every facet of Indonesia economy. Industrial sector and agricultural sector were hit and many of them had closed down their plants. Further down, numbers of poor people rose significantly and there numbers of malnutrition prevalence increased rapidly. Such conditions forced government to change its strategy particularly on food

policy, and it translated, among others by rationalizing the price stabilization strategy. Rather than providing general price subsidy through what so-called market operation at which government intervene the market by distributing low price of rice, a targeted subsidy program through special market intervention and later changed to rice for the poor (*Raskin*) was introduced. This program was specifically design for strengthening food security of the low-income group and the poor family. A set of criteria was used to determine target beneficiaries and the one eligible to receive this subsidized rice can get the ration 20 kg per family per month, with the price of Rp.1,000.-. The program has been launched since 1998 and annually government provides around 2.2 MMT rice distributed to the poor with total subsidy approximately Rp.4.6 trillions . As indicated earlier basically implementation of Indonesia food policy covers the following:

1. Implementing domestic price support by guaranteeing market for rice in terms of floor price to support farmer to improve their income and to stimulate rice production. This price is reviewed adjusted annually to accommodate inflation rate which affect cost of production and also the changing of rice price in international market. On consumers side a ceiling price is set-out to maintain price stability at affordable level, particularly for the low-income groups. During leaning months rice price tend to increase due to short of supply, and to prevent excessive increase in price government through Bulog would intervene the market my releasing its stock at price level lower than the prevailing market price.

2. Control rice import. Considering free flow of rice after deregulation of rice trade, with zero percent tariff had increased downward pressure to domestic rice market, government has decided to manage rice import by imposing import tariff at around 30% (Rp.430,-/kilogram or around US$45/ton) in 2000. The tariff should be reviewed and evaluated routinely to verify its impact on domestic rice market as well on farmers' income.

3. Provision of subsidized rice for the poor. Targeted rice subsidy through Rice for the Poor (*Raskin*) program aims at providing support to the fulfillment of minimum rice requirement for poor family. Ration of rice at the amount of 20 kg/month/family is intended to avoid malnutrition among poor family, as a part of the social safety net program which was initiated after the crisis in 1997.

4. Diversification of consumption. Recognizing dependent too much on rice as source of energy for majority of the people may have a negative impact on rice production and national food security as a whole. To meet constant increasing demand on rice due to increasing income and population growth, Indonesia has to import million tons of rice annually. Therefore diversification on consumption has to be started in a more serious manner and supported with program to increase production of other source of carbohydrate crops. Indonesia, in fact is rich in other sources of carbohydrate such as sago, cassava and other tuber crops. To implement this policy various programs to boast production of other food crops have been launched since 2000.

Rice in The Context of Trade Liberalization

As indicated earlier, the Government of Indonesia has deregulated trade of food crops, and liberalized trade of those commodities including rice. Monopoly right which used to be enjoyed by Bulog has been abolished, with expectation that such moves can reduce domestic barrier to entry and exposes domestic producers to international competition. Furthermore, government expects that the policy would promote trade, increase market access and economic efficiency and at the end improve consumers' welfare. It should be pointed-out, however, liberalizing rice trade in relatively short period of time seemed to have more negative than positive one.

Statistical data showed that at zero percent import tariff (which In fact far beyond the WTO or AFTA arrangement which allow tariff up to 120% for rice until 2003) the quantity of rice import had doubled from at the average of 1.5 MMT per year in 1995 – 1997 to more than 3.0 MMT in 1998-2001. Rice import remained high even until recent years averaging around 2.0 MMT. Those statistical data indicated that import dependency grew from 4.3% to 9% in 1995 – 1998, which was certainly not a good sign , recognizing too much dependent on import may endanger domestic rice producers. In addition, Government argues that such a situation was considered dangerous to national food security, knowing that rice in the international market is relatively limited and frequently called thin market.

On the other hand Indonesia rice production declined significantly as compared to sharp increased during 1980's. In 2002 for instance, rice output was 51.4 MMT, approximately 4.5% below the production in 1996. Rice production was low as compared to previous decade, particularly after El-Nino and La Nina phenomena hit Indonesia at the same time when economic crisis hampered this country. In addition some argued that uncontrolled rice import with relatively low tariff coupled with low price of rice in the world market had brought about domestic rice price relatively depressed. Such a low price became disincentives to rice farmers, and it might have long term effect on rice production in Indonesia which can endanger national food security. Liberalization was frequently accused to be responsible for low productivity and the decline in rice production. Data on rice production and rice harvested areas as depicted in Table 1 below.

Recognizing the negative impact of liberalization of rice market government was under great pressure to make a concrete step to protect domestic rice farmers from the flood of rice import. Government started imposing import tariff in 2000 at the level of approximately 30% of the world rice price. The primary objective of this tariff policy was to protect farmers from further decline in price due to deregulation of domestic rice market, and low price of rice in the world market.

TABLE 1: RICE HARVESTED AREA AND RICE PRODUCTION IN 1990-2010

Year	Harvested Area (Ha)	Productivity (Qu/Ha)	Production (Ton)
1990	10 502 000	43,00	45 179 000
1991	10 282 000	43,50	45 689 000
1992	11 103 000	43,40	48 240 000
1993	10 993 920	43,78	48 129 321
1994	10 717 734	43,48	46 598 380

1995	11 420 680	43,52	49 697 444
1996	11 550 045	44,20	51 048 899
1997	11 126 396	44,34	49 339 086
1998	11 730 325	41,97	49 236 692
1999	11 963 204	42,52	50 866 387
2000	11 793 475	44,01	51 898 852
2001	11 499 997	43,88	50 460 782
2002	11 521 166	44,69	51 489 694
2003	11 488 034	45,38	52 137 604
2004	11 922 974	45,36	54 088 468
2005	11 839 060	45,74	54 151 097
2006	11 786 430	46,20	54 454 937
2007	12 147 637	47,05	57 157 435
2008	12 327 425	48,94	60 325 925
2009	12 883 576	49,99	64 398 890
2010	13 118 120	50,30	65 980 670

Source : Indonesia Statistical Central Agency (2010)

However, the effectiveness of import tariff was questionable since it seemed to have minimal effect on the free flow of rice into domestic market. It appears inability to enforce the implementation of tariff policy and weak coordination and in-efficient institutional arrangement had caused rice smuggling or under invoicing which had contributed to the excessive flow of imported rice to domestic market, even during the harvest season. Price disparity between international rice price and domestic retail price in Indonesia had speed-up the flow of rice into Indonesia. The direct impact was that rice price in domestic market fell below the official supported price and Bulog was accused for not being able to anticipate such conditions.

Opening domestic rice market freely also caused price fluctuation in international market directly transmitted to domestic price, which may cause price instability. When the world market reached its high level inability to shield off domestic market is certainly has negative impact on household food security of low-income family due to their low purchasing power. Empirical data showed that the world rice price was much more volatile than domestic prices over the past two decades. Such situations would pose poor-family to high degree of risk of price instability and furthermore might increase prevalence of malnutrition in this country.

Another argument on the impact of liberalization was the fact that Indonesian farmers were mostly subsistence farmers who only have very small land with average ownership less than 0.5 ha per family. Uneven competition between farmers in developed countries and Indonesian farmers and farmers in most of developing countries was even more by looking at the access to information, infra-structure, technology and human resource. Thus they are really not in the same level of playing field and certainly incomparable and farmers in developed countries even received much more subsidy from their government than their colleague in developing nations. Therefore liberalization appears to give more benefit to farmers in developed country rather than in developing countries. Free trade liberalization is often accused of

bringing-about remarkable increase in food crops importation, reduced incentive and producers income and triggered urbanization of landless labors and poor farmers to the neighboring cities (Nainggolan, 2000).

Liberalization of agricultural commodities trade particularly rice has to take into consideration various important determinant factors; among others the 'status' of rice in the nation from socio-economics and political perspective. A combination of trade policy and price stabilization policy which usually translated into implementation of buffer-stock strategy, ensuring adequate supply of rice, provision of subsidized rice for the poor to ensure household food security are among the most commonly policy instruments implemented in most rice eating countries like Indonesia. It is considered too risky leaving rice price fluctuates erratically due to shortage of supply as effects of pests, or natural calamities or other reasons that cause surge in price in international market. Since it may destabilize price in domestic market and disrupt political and stability in the country due to its high degree of social cost and political consequences.

Recognizing the political and socio-economics implication of rice economy, government has to be more careful in formulating such a policy, whether it be producer- or consumers bias. From producer's side keeping the floor rice as high as possible is the most reasonable way in order to maintain farmers income and level of welfare. It would not be matter if the guaranteed price has been well above the world price, providing there is a great effort to discourage rice import and adherence to rules and procedures of import. On the other side, consumers' demands affordable price with reasonable quality of rice, and government still has to provide rice ration through targeted subsidy program or public distribution system of subsidized rice for the poor.

Indonesia still has the comparative and competitive advantage to grow rice, and rice is still the most labor-intensive agricultural activities that can be considered the best vehicle for rural development. Number of peoples engaged in rice production and post-production activities including processing, storage, transport and distribution is enormous. Absorption of unskilled labor in rural areas and its potency to reduce urbanization are great, providing there is supporting policy that can provide environment conducive enough for maintaining rice production. Therefore it is obvious that government of Indonesia has been placing increase of rice production to keep up with the growing demand as one of the highest priority in agricultural development.

Self-sufficiency in rice and other food crops is no longer placed as national goal in agricultural development, although once in a while it is used as political jargon. It should be pointed-out, however, recognizing the great importance of rice in Indonesia economy and political stability in the country principle of self-reliance has become more frequently used as motivation to increase production. It means domestic production is still be used as a major source for meeting rice consumption for the people, which reaches more than 130 kg/capita/year (in 2010 is 139 kg/capita/year). Should there be a shortfall in domestic production due to various reasons, rice import can be carried-out both by government and private importers.

Rice in the Context of Government Policy

Implementation of rice policy is adjusted in line with government food policy. Institutional change has been aired since the late nineties, particularly proposal to restructure Bulog. After intensive and long winded discussion President has come to decision to agree on the proposed Bulog reorganization. As a realization since January

2003 this strong and powerful institution has officially changed its status from a para-statal agency to become State Owned Enterprise (SOE). Since then Bulog has dual functions namely to conduct public service obligations to carry-out business as commercial organization. Under its new purview Bulog still retains its public service function to distribute rice for the poor under Raskin program, and to maintain national stock reserve to encounter food shortage during natural disaster, social unrest or others. In addition Bulog is allowed to enter into trading activities of various strategic commodities as a pure profit making institution, as far as government gives the mandate to do so.

As a business entity Bulog has to compete fairly with other company either as rice importer or other food crops business activities, in order to generate income which has to be contributed to state budget. In 2003 apparently most of Bulog activities is still dominated by the implementation of public service responsibility. It should be noted, however, with the changed status, Bulog is no longer responsible for price stabilization of basic food commodities or in improving farmers' welfare. This new tasks has to be disseminated to the people, academia, observers etc. since most of them still have wrong perception on Bulogs' responsibility particularly in food price stabilization. Although it is true that ability of Bulog to maintain farm-gate price at the guaranteed buying price (used to be floor price) will contribute significantly to the farmers' income and encouraging farmers to improve rice productivity which in turn increasing rice production.

Government in 2004 has changed the level of guaranteed price from Rp. 1,500.- /kg for paddy (un-husked rice meeting government standard quality) to Rp. 1,700,-/kg effective January 2004. With this new reference in buying price the price for milled rice has also increased to Rp. 2,750.-/kg. As a comparison the price of medium quality of Thai rice in the world market is US$180 or equivalent to approximately Rp.1.600.-/kg and with Rp.430,-/kg import tariff the Thai rice can be sold in the retail price in Jakarta at Rp. 2,150.- or Rp2,200.-. Therefore, low price in the world market may add complication in the procurement policy implemented by Bulog. This organization is frequently accused to have preference towards imported rice for its operation in distributing rice to the poor and armed forces, as compared to domestic rice since rice import can generate a better profit.

In fact rice import is only complementary to domestic procurement; meaning import is conducted whenever domestic procurement is not enough for fulfilling Bulog public service obligation. Annually Bulog procures rice from domestic production ranged between 1.75 to 2.0 MMT in milled rice term or approximately 6-7% of the total rice production. Another significant progress recently announced by the government is the control of import of rice. Recognizing the free flow of rice import to domestic market has number of negative effects, government decides that since January 2004, rice can only be imported one month before and two months after peak harvest which runs from February to May each year. The decision were made by Minister of Trade and Industry and Minister of Agriculture who specifically described the period of peak harvest of rice, in response to public demand to abolished import of rice during harvest season.

In addition there has been an intensive discussion to propose an increase in import tariff to Rp.510.-/kg (approximately US $55/ton). The underline policy objective of this proposal is to protect domestic rice farmers from competing with cheap imported rice, which cause disincentive to farmer to increase rice production. The proposal so far has not been decided by Minister of Finance, thus the import tariff is still pegged at Rp.430.-/kg or approximately US $45/tons.

RESULT AND DISCUSSION

Causal Loop Diagram

The explanation on the causal loop diagram in this research starts from the impact of land conversion and extensification program on wet land area and dry land area. Land farming is divided into wet land and dry land. This variables is influence by new farming land and land conversion. New farming land program or extensification program will increase land farming area. On the other hand, land conversion will decrease land farming area.

FIGURE 2: LAND FARMING SECTOR
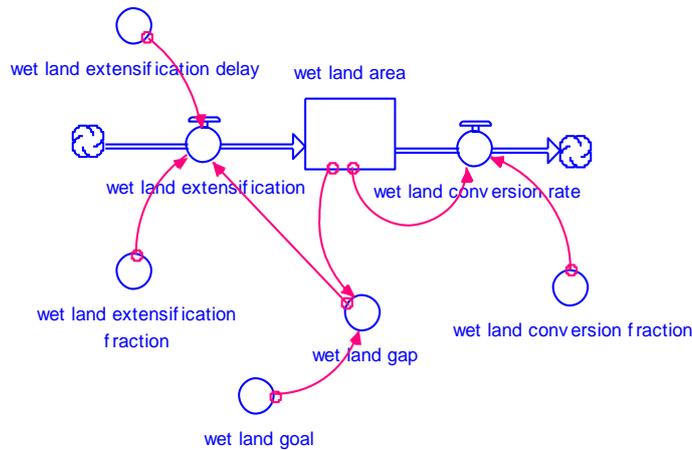
Paddy production is attained by the sum of wet land paddy production and dry land paddy production. Production is influence by IP technology, productivity, and land area. So that increasing in these determinants will increase paddy production. Total paddy production is net paddy production after seed, feed, and scattered paddy substraction. National rice supply is sum of domestic rice production, market operation from BULOG rice stock, and rice import. Rice export will cut down national rice supply. BULOG is government agency that conduct rice policy. BULOG is regulator agency that has to maintain rice stock. BULOG has to buy farmer rice with floor price in peak harvest season and conduct market operation with ceiling price in lack season.

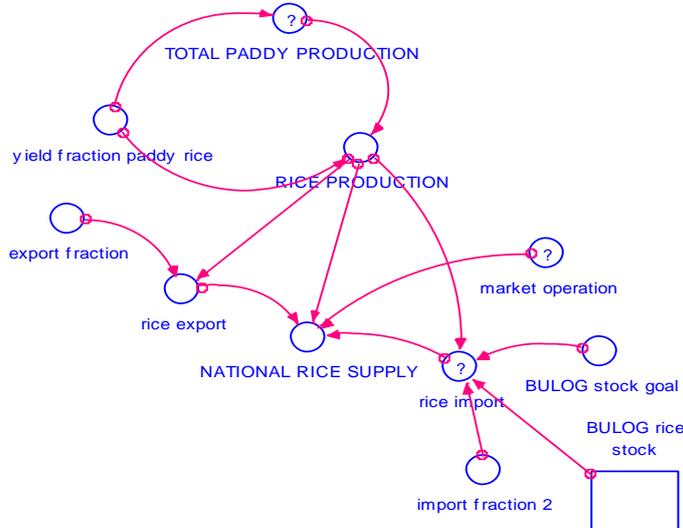**FIGURE 3: NATIONAL RICE SUPPLY SECTOR**

Figure 3. National Rice Supply Sector

In demand side, household is divided into urban and rural household. Household rice demand is sum of urban rice demand and rural rice demand. Rice demand is influenced by population and rice per capita consumption. In this research, household rice demand will be decreased by consumption diversification program or campaign in order to achieve rice self sufficiency in demand side. Price has an important role in rice demand. High price will reduce demand and vice versa. National rice demand coming from household and industry rice demand. Finally, rice self sufficiency is balance of supply and demand so that rice demand and supply balance is ratio between demand and supply.

FIGURE 4: NATIONAL RICE DEMAND
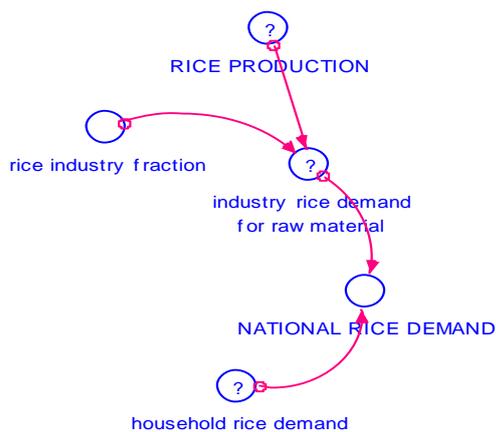
Equations

As the consequence of causal loop diagrams, the result of this research are these equations as below :

*BULOG_rice__stock(t) = BULOG_rice__stock(t - dt) + (rice_procurement - market_operation) * dt*
INIT BULOG_rice__stock = 1500000
INFLOWS:
rice_procurement = IF(Price<minimum_price)THEN rice_procurement_rate ELSE+BULOG_stock_gap
OUTFLOWS:
*market_operation = BULOG_rice__stock*market_operation_fraction*
*dry_land_area(t) = dry_land_area(t - dt) + (dry_land_extensification - dry_land_conversion_rate) * dt*
INIT dry_land_area = 1165000
INFLOWS:
*dry_land_extensification = dry_land_gap*dry_land_extensification_fraction/dry_land_extensification_delay*
OUTFLOWS:
*dry_land_conversion_rate = dry_land_area*dry_land_conversion_fraction*
*Price(t) = Price(t - dt) + (Change_in_Price) * dt*
INIT Price = 2800000
INFLOWS:
Change_in_Price = (Indicated_Price - Price)/Price_Adjustment_Time
*rural_population(t) = rural_population(t - dt) + (rural_population_growth_rate) * dt*
INIT rural_population = 93859252
INFLOWS:
*rural_population_growth_rate = rural_population*rural_growth_rate_fraction*
*rural_rice_per_capita_consumption_2(t) = rural_rice_per_capita_consumption_2(t - dt) + (- rural_rice_consumption__change_rate) * dt*
INIT rural_rice_per_capita_consumption_2 = 0.142
OUTFLOWS:
*rural_rice_consumption__change_rate = rural_rice_per_capita_consumption_2*rural_per_capita_consumption__gap*
*urban_population(t) = urban_population(t - dt) + (urban_population_growth_rate) * dt*
INIT urban_population = 123210200
INFLOWS:
*urban_population_growth_rate = urban_population*urban_growth_rate_fraction*
*urban_rice__per_capita_consumption_3(t) = urban_rice__per_capita_consumption_3(t - dt) + (- urban_rice_consumption__change_rate_2) * dt*
INIT urban_rice__per_capita_consumption_3 = 0.1238
OUTFLOWS:
*urban_rice_consumption__change_rate_2 = urban_rice__per_capita_consumption_3*urban_per_capita_consumption__gap_2*
*wet_land_area(t) = wet_land_area(t - dt) + (wet_land_extensification - wet_land_conversion_rate) * dt*
*INIT wet_land_area = 8400030*
INFLOWS:

wet_land_extensification =
*wet_land_gap*wet_land_extensification_fraction/wet_land_extensification_delay*
OUTFLOWS:
*wet_land_conversion_rate = wet_land_area*wet_land_conversion_fraction*
BULOG_stock_gap = BULOG_stock_goal-BULOG_rice__stock
BULOG_stock_goal = 3000000
dry_land_conversion_fraction = 0.0032
dry_land_cultivation_intensity_IP = 0.89
dry_land_extensification_delay = 2
dry_land_extensification_fraction = 0.01
dry_land_gap = dry_land_goal-dry_land_area
dry_land_goal = 15000000
dry_land_paddy_production =
*dry_land_area*dry_land_paddy_productivity*dry_land_cultivation_intensity_IP*
dry_land_paddy_productivity = 2.430
Effect_of_Demand_Supply_Balance_on_Price =
RICE_DEMAND_SUPPLY_BALANCE^Sensitivity_of_Price_to_Demand_Supply_Balance
export_fraction = 0.016
*feed = PADDY_PRODUCTION*feed_fraction*
feed_fraction = 0.044
household_rice_demand = (rural_rice_demand+urban_rice_demand)
import_fraction = 0.00629
*Indicated_Price = Price*Effect_of_Demand_Supply_Balance_on_Price*
industry_rice_demand_for_raw_material =
*RICE_PRODUCTION*rice_industry_fraction/100*
market_operation_fraction = 0.1
minimum_price = 2500000
NATIONAL_RICE_DEMAND =
household_rice_demand+industry_rice_demand_for_raw_material
NATIONAL_RICE_SUPPLY = RICE_PRODUCTION+market_operation-
rice_export+rice_import
PADDY_PRODUCTION =
wet_land_paddy_production+dry_land_paddy_production
Price_Adjustment_Time = 0.5
RICE_DEMAND_SUPPLY_BALANCE =
NATIONAL_RICE_DEMAND/NATIONAL_RICE_SUPPLY
*rice_export = RICE_PRODUCTION*export_fraction*
rice_import = IF(BULOG_rice__stock<BULOG_stock_goal)THEN
*import_fraction*RICE_PRODUCTION ELSE 0*
rice_industry_fraction = 0.0056
rice_procurement_delay = 0.45
rice_procurement_fraction = 0.2
rice_procurement_rate =
*TOTAL_PADDY_PRODUCTION*rice_procurement_fraction/rice_procurement_delay*
RICE_PRODUCTION =
*TOTAL_PADDY_PRODUCTION*yield_fraction_paddy_rice*
rural_growth_rate_fraction = 0.0135

rural_per_capita_consumption__gap = rural_rice_per_capita_consumption_2-rural_rice_consumption_diversification_program

rural_rice_consumption_diversification_program = 0.142-STEP(0.003,5)-STEP(0.003,10)-STEP(0.003,15)

rural_rice_demand = rural_population*rural_rice_per_capita_consumption_2

scattered_paddy = PADDY_PRODUCTION*scattered_paddy_fraction

scattered_paddy_fraction = 0.11

seed = PADDY_PRODUCTION*seed_fraction

seed_fraction = 0.009

Sensitivity_of_Price_to_Demand_Supply_Balance = 0.45

TOTAL_PADDY_PRODUCTION = PADDY_PRODUCTION-feed-seed-scattered_paddy*yield_fraction_paddy_rice

urban_growth_rate_fraction = 0.0135

urban_per_capita_consumption__gap_2 = urban_rice__per_capita_consumption_3-urban_rice_consumption_diversification_program_2

urban_rice_consumption_diversification_program_2 = 0.1238-STEP(0.004,5)-STEP(0.004,10)-STEP(0.004,15)

urban_rice_demand = urban_rice__per_capita_consumption_3*urban_population

wet_land_conversion_fraction = 0.0026

wet_land_cultivation_intensity_IP = 1.4419

wet_land_extensification_delay = 3

wet_land_extensification_fraction = 31427/192739

wet_land_gap = wet_land_goal-wet_land_area

wet_land_goal = 15000000

wet_land_paddy_production = wet_land_area*wet_land_paddy_productivity*wet_land_cultivation_intensity_IP

wet_land_paddy_productivity = 4.415

yield_fraction_paddy_rice = 0.62

DISCUSSION

The results of this study reveal that land farming will slightly increase until 2019. This condition is influenced by high land conversion, meanwhile extensification program of new farming land is difficult to implement. Although farming land is dominated by wet land, but dry land has potential prospect as rice farming land.

FIGURE 5: WET LAND AND DRY LAND AREA
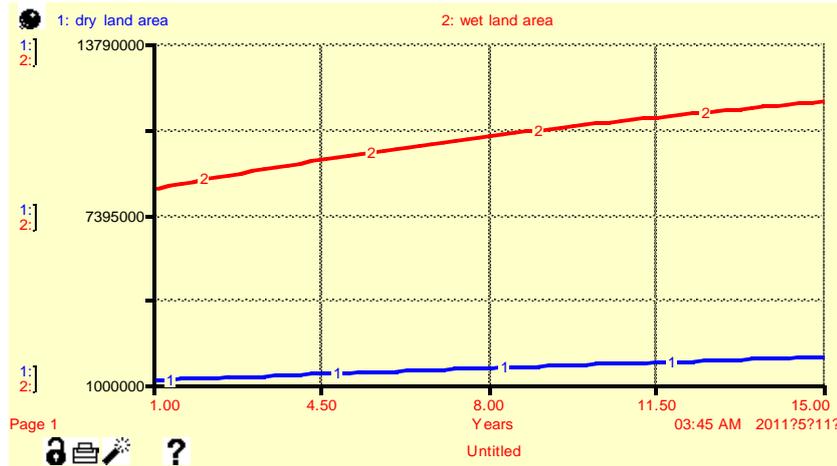
In supply side, wet land production is higher than dry land production. Beside wet land area, this value is also caused by high wet land productivity and IP technology. If IP technology can be increased, it will increase domestic paddy production. National rice supply is comes from domestic rice production, rice import, and market operation from BULOG rice stock. If there is rice export, it will cut down national rice supply. For further description, it can be shown from Table 2.

TABLE 2: PADDY PRODUCTION , RICE PRODUCTION AND NATIONAL RICE SUPPLY ESTIMATION UNTIL 2019

YEAR	DRY LAND PRODUCTION	WET LAND PRODUCTION	PADDY PRODUCTION	TOTAL PADDY PRODUCTION	RICE PRODUCTION	NATIONAL RICE SUPPLY
2,005	2,519,545.50	53,474,494.38	55,994,039.88	49,207,562.25	30,508,688.59	30,362,449.23
2,006	2,660,653.08	55,573,691.94	58,234,345.02	51,176,342.41	31,729,332.29	31,660,060.46
2,007	2,800,607.13	57,555,866.03	60,356,473.16	53,041,268.61	32,885,586.54	33,196,999.66
2,008	2,939,417.08	59,427,540.33	62,366,957.41	54,808,082.17	33,981,010.94	36,493,961.70
2,009	3,077,092.28	61,194,874.83	64,271,967.12	56,482,204.70	35,018,966.92	39,594,744.05
2,010	3,213,642.02	62,863,686.15	66,077,328.17	58,068,756.00	36,002,628.72	42,512,035.56
2,011	3,349,075.49	64,439,466.64	67,788,542.13	59,572,570.82	36,934,993.91	45,257,644.37
2,012	3,483,401.81	65,927,402.47	69,410,804.28	60,998,214.80	37,818,893.17	47,842,563.69
2,013	3,616,630.03	67,332,390.68	70,949,020.72	62,349,999.41	38,656,999.63	50,277,032.43
2,014	3,748,769.15	68,659,055.35	72,407,824.50	63,631,996.17	39,451,837.62	52,570,590.86
2,015	3,879,828.04	69,911,762.75	73,791,590.79	64,848,049.99	40,205,790.99	54,732,131.92
2,016	4,009,815.56	71,094,635.77	75,104,451.33	66,001,791.82	40,921,110.93	56,769,948.48
2,017	4,138,740.45	72,211,567.44	76,350,307.89	67,096,650.57	41,599,923.35	58,691,776.85
2,018	4,266,611.40	73,266,233.78	77,532,845.18	68,135,864.35	42,244,235.90	60,504,836.94
2,019	4,393,437.03	74,262,105.89	78,655,542.92	69,122,491.12	42,855,944.49	62,215,869.28

Rural rice per capita consumption is higher than urban. However, because of lower population, rural rice demand is lower than urban. If demand increase very fast and supply is leveling of, in the future it will disturb demand supply balance and rice self sufficiency can't be achieved. Hence, we need to decrease rice per capita consumption. One way to do that is consumption diversification campaign. If we look at figure below, rice demand become slightly increase as the effect of consumption diversification campaign. With this program, Indonesia can maintain rice self sufficiency.

FIGURE 6: URBAN AND RURAL RICE DEMAND
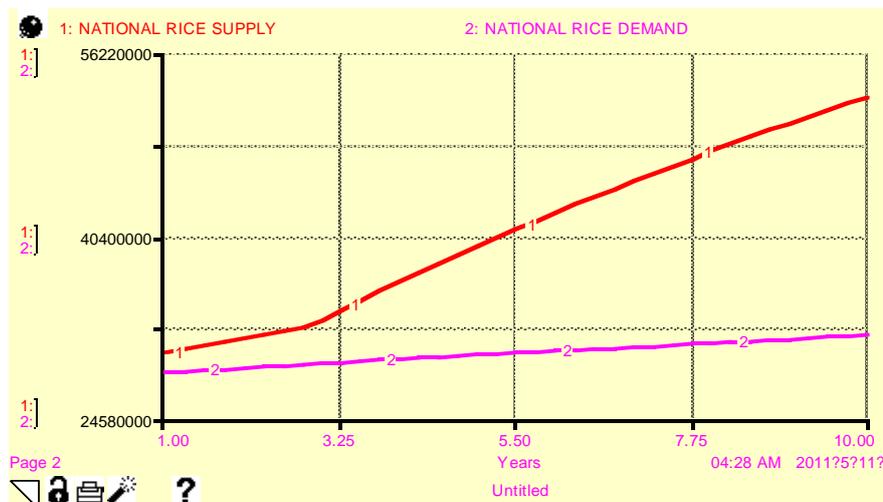
CONCLUSION AND POLICY IMPLICATION

Conversion make land farming can't increase rapidly and land extensification program is bounded by available land. Domestic rice production can't cover rice demand so that BULOG has to conduct market operation with higher rate and cannot avoid rice import. To achieve rice self sufficiency in supply side, new farming land program can increase domestic rice production, and new technology like IP is very important to increase productivity. In demand side, we need to decrease rice consumption through consumption diversification campaign.

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