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Dynamic modeling of rice stock in Bali Province, Indonesia

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Abstract

The aim of this study is to discover rice stock design in Bali Province from production and consumption point of view, as well as overview of current and future progress.The approach used in this study was simulation model with PowerSim software. Results of the study showed that dynamic modeling of rice stock in Bali Province consisted of six submodels: (1) population submodel; (2) income submodel; (3) production submodel; (4) gross regional domestic product submodel; (5) land submodel; and (6) consumption and rice balance sheet submodel. Relationship between submodels was depicted in a form of causative diagram. Causative relationship (causal diagram) showed that there was positive feedback. Results of model simulation showed that dynamic modeling of rice stock successfully explained annual dynamic behavior in every submodel. With accurate initial data input, this model can be used as control of system or anticipation to changes of policies related to rice stock in Bali Province. Model simulation with combined scenario, such as intensification, minimalizing rice consumption, or mantaining timeless rice field soil, is needed to overcome the threat of food crisis in Bali Province in the future.

Keywords: dynamic system, rice stock, Powersim

1. Introduction

1.1 Background

Food deficiency and food security cannot be separated from the rice commodity, considering that rice is the main food consumed by nearly the entire Indonesian population. It is seen from the high point of rice consumption, 100%, which means that almost all of the households are consuming rice (Ariani and Ashari, 2003).

Problem in achieving rice sufficiency is that rice demand grows faster than rice supply. Rice demand increases along with population, economic growth, purchasing power and changes of market taste. The dynamic demand causes the increasing need of rice nationally, in terms of quality, quantity and variety. Meanwhile, the capacity of national rice production is growing slowly, i.e. stagnant. If this problem cannot be solved, the need of importing rice will increase, which may lead to a high dependability of imported rice and depleting our foreign exchange.

Bali as a world tourism destination has its own carbohydrate source of rice with relatively fluctuating production level, although the level tends to be increasing at the rate of approximately 0.43% per year with average production of 854,562 tons (BPS Bali, 2011). Increase in production has been achieved through some efforts: maximizing the intensification quality, efficient technology application, maximizing cultivation index, as well as maximizing harvest and post-harvest treatment, resulting in increasing rice productivity from 53.35 quintals per hectare in 2001 to 56.25 quintals per hectare in 2011, with annual average increase of 0.54 quintals per hectare. Area of irrigated rice field soil was 87,850 ha before 2005 and in 2011 was only 82,664 ha, shrinking by 5,186 ha. Land use conversion, from agricultural use to tourism or residential use, will be followed by the degradation of water and land quality as the result of non-agricultural sector development that concerns less about the environmental aspect.

The fact that total population in Bali in 2011 was 3.89 millions and keeps increasing with a rate of 2.15% per year results in Bali having to face a big challenge in fulfilling primary food needs, i.e. rice. Furthermore, Indonesian Acceleration of Expansion of Economics Development Masterplan (MP3EI, 2010) stated that Bali as a corridor of Bali-Nusa Tenggara is a gate of national tourism and national food support. A pressure from population will demand need of rice and economics activity that can provide job opportunities, as well as land for industry, housing, roads, and general facilities. Hence, the pressue from population will increase competition in utilization of resources, especially land and water.

1.2 Problem Statement

Based on the stated fact, problems that need to be addressed are (1) How is dynamic model of rice stock in Bali Province observed from production and consumption sectors? (2) How are rice production and consumption in Bali Province progressing?

1.3 Research Objectives

In general, the objectives of the research are (1) To find a dynamic system modeling of rice stock in Bali Province that can be used as one of the aids in decision making in controlling the system and anticipating changes of policies related to rice stock in Bali Province; (2) To know the progress of rice production and consumption in Bali Province at different conditions that affect rice production and consumption sectors.

II. LITERATURE REVIEW, FRAMEWORK, AND RESEARCH CONCEPT

2.1 Literature Review

Several studies in national rice supply and consumption have been done, however most of the studies used econometrics approach and were not integrated with environment. Some of the research that are related to rice stock and consumption are as follows:

Mulyana (1998) did a study about ”Presentation of Indonesian Rice Supply and Demand, and Self-sufficiency Prospect Toward Free Trade”. This study aimed to evaluate and predict self-sufficiency of rice in the future, as well as review alternating effects of unilateral and multilateral policies, and non-policies toward supply and demand of rice, and the wealth of domestic economic actors. The study used econometric model analysis of rice supply and demand in domestic and international markets. Domestic production was disagregated to five regions, Java and Bali, Sumatera, Kalimantan, Sulawesi, and the rest of the regions, while the supply was agregated nationally.

His results showed that rice field areas in Java and Bali have reached closing cultivation frontier regionally, which means that they have reached the maximal limit of qualified fertile soil for rice fields, as a result of increasing competition in land utilization. Thus, response of rice area toward grain price in Java and Bali was more inflexible compared to other areas. Other factors that impacted rice areas in all regions were rainfall, irrigation area, counseling performance, target of production program, and rice field soil conversion in Java and Bali.

In general, model simulation by Mulyana (1998) showed that national implementation of uniform policy alternatives was not always responded with the same manner by components of rice supply in every region and the impacts would be different to the welfare of farmers. Important implication of the result is that implementation of proper policy that is also able to support the welfare of farmers is needed. Economically, self-sufficiency of rice during 1984-1996 could be maintained by applying the policy to raise the base price by 15.38%, add irrigation area by 3.61%, add intensification area by 5.25% or devaluate currency by 100%, however it created opposite effect to welfare of farmers and consumers. Hence, combination of policies that can promote both increase in rice production and welfare of farmers and consumers are needed.

Simulation without policy alternatives showed that contribution of Sumatera, Sulawesi, and other regions in Indonesia in rice production would increase in the future, while roles of Java and Bali would gradually decrease as a consequence of implementation of free trade. Indonesia was predicted to be capable of having absolute self-sufficiency of rice and even exporting rice starting in 2013. Indonesia rice production seemed to be quite prospective.

To achieve self-sufficiency of rice and improvement of well-being, Mulyana (1998) recommended to increase the area of irrigated rice fields and intensification in Sumatera, Sulawesi, Nusa Tenggara, Maluku and Irian Jaya, improve cost efficiency and rice farm technology efficiency according to region specification, apply base price policy that is supported by increase of supply, improve marketing distribution network of rice inside and cross regions, as well as improve technology of rice/grain storage. Operating system of rice market was still needed in short term, thus government role currently performed by Bulog should be maintained in short term.

Rachman (2001) did a study entitled ”Review of Pattern of Food Consumption and Demand in Eastern Region of Indonesia (ERI)”. Data used in the study was data from National Social Economics Survey in 1996 that was compiled by Bappenas. Study results showed that rice consumption dominated overall food consumption pattern as carbohydrate source, in region and income group. Although average household consumption of rice in ERI was still considered low compared to national consumption.

Analysis by Rachman (2001) showed that projection of rice production in 2005 based on time series data in 1997-2001 was 28.47 million tons, in 2010 was 28.53 million tons, and in 2015 was 28.59 million tons. Rice consumption projection in 2005 and 2010 based on nutritional adequacy standard was 116.80 kg/capita/year and 113.15 kg/capita/year, respectively. Rice consumption in 2015 based on the same standard was 109.5 kg/capita/year. Thus, national projection of rice demand in 2005, 2010, and 2015 based on national adequacy standard was approximately 26.06 million tons, 26.97 million tons, and 27.77 million tons, respectively. In 2015, if consumption of Indonesian population is in accordance to nutritional adequacy standard, domestic production is able to suffice the demand. However, increase of rice consumption per capita as a result of economic growth that will occur in 2015 should be on the lookout. We should always be alert and keep working on increasing domestic growth of rice production.

A shift in staple food pattern toward rice was also shown by in provinces in Eastern Region of Indonesia. In 1979 South Kalimatan was the only province having rice as staple food; however, in 1996 other provinces such as West Nusa Tenggara, West Kalimatan, Central Kalimantan, South Kalimantan, East Kalimantan, North Sulawesi, Central Sulawesi, and South Sulawesi have been having rice as staple food. Rice has become a prestigious commodity as shown by increase of rice consumption along with increase of income.

Badan Bimas Ketahanan Pangan, Departemen Pertanian together with Pusat Studi Pembangunan Lembaga Penelitian IPB (2002) did a study on "Analysis on Fulfillment of National Food Need Scenario until 2015 from Agribusiness Aspect". Analysis showed that there might be a chance for Indonesia to have production level that is higher than consumption level starting from 2010. The surplus was mainly created by the fact that increase in production was faster than increase in consumption. Surplus of rice would be reached faster with implementation of supportive policies. Among several simulated polices, policies on increase of irrigation fund and budget on development of agricultural sector resulted in greater positive effect in increasing production compared to other policy scenarios, such as policies on subsidy of fertilizer, import fare, or base price.

Lembaga Penelitian UI together with Badan Bimas Ketahanan Pangan, Departemen Pertanian (2002) did a study on "Analysis on Projection of National Rice Production and Consumption". The analysis was done using linear regression analysis (trend analysis). Analysis based on nutritional adequacy rate from Widya Karya Pangan dan Gizi in 1979, 1988, 1993 and 1998 was used to predict nutritional adequacy in 2002-2015. The adequacy was converted to a form of food needs that is based on General Guidance on Balanced Nutrition.

Currently the unbalanced food consumption pattern still occurred due to the role of grains (especially rice) in one side and smaller role of other food, especially meat, vegetables and fruit, as well as insufficiency of oil and fat. Based on this, grain consumption per capita, especially rice, was projected to decrease in 2000-2015, while other commodities, especially vegetables and fruit, meat, oil and fat, as well as nuts, was projected to increase.

Based on AHP analysis, among several functions that were predicted to support food security, availability function was found to be the most important. Other functions, such as distribution, consumption, and alertness of food, gained smaller value than availability function. This hypothesis was supported by opinion of respondents in all sample provinces. Hence, approaches on production and availability are still considered to be able to assure food security.

Regional autonomy that has been implemented was predicted to give a big impact in achieveing food security. Regional government (regency/city level) would play an important role in planning stage up to evaluation stage. Government on this level was also responsible in all components that are needed in application of management process of achieving food security. Role of central government was expected in one important component, which is funding. Central government was expected to be the primary source of funding in food security policy.

Irawan (2005) did a study on "Analysis on National Availability of Rice: Simulation Review on Dynamic System Approach". The analysis used secondary data, which its main data source was statistics from Indonesia and Agricultural Profile in Numbers. Simplification was done in this study; it did not cover distribution and commerce subsystem, as well as ignore the effect of environment factor and effect of rice grain price to supply level. Results showed that self-sufficiency of rice would not be achieved if rice field soil conversion continued like what occurred in 1992-2002 (-0.77% per year) and application of rice cultivation technology did not move from its state in 1990-2000. Self-sufficiency of rice would be achieved if soil conversion rate in Java and outside Java could be each suppressed up to 0% and 0.72% per year, respectively, starting from 2010. At the same time, efforts on increasing rice productivity as big as 2.0-2.5% per year, as what was achieved during self-sufficiency of rice in 1983-1985, were also needed. Policy on expanding rice field soil area outside Java as big as a million hectares in five years would not be sufficient to reach self-sufficiency of rice in the next fifteen years if land conversion and rice productivity remained unchanged.

Fundamental difference between the above studies and this dissertation are seen from site, object, study approach, and theoretical background that are used. However, the studies are similarly reviewing problems in food, especially rice commodity.

2.2 Framework

Gardner (1987) stated that management of problems in rice matters needed public policies that are a part of agricultural development policy. Public policy is a government decision that affects people or public interest. Determination of government purchasing price, rice import fee, fertilizer subsidy, and licensing of rice field soil conversion are several forms of the mentioned public policies.

Policy analysis that aims to synthesize information to find recommendation of policy plan alternatives is needed beforehand. Policy in rice is a national policy that is intersectoral and dynamic, hence it needs approach and simulation in dynamic system to get initial information on varying possibilities before implementation of the policy.

National rice system consists of several subsystems: production, consumption, distribution, commerce, and price (Irawan, 2005). Each subsystem consists of elements that are more specific and closely affected by time change hence national rice system is dynamic. Besides, rice system is intersectoral because it covers several related institutions, such as demand of rice is related to population problem and community income level, production is related to land area and agricultural cultivation.

System approach requires knowledge of reciprocal relationships or causative relationships between subsystems in a system and between elements in a subsystem, as well as knowledge of both positive and negative causative relationships. Causal depiction of the supply of rice based on system approach in general is described in Figure 1.

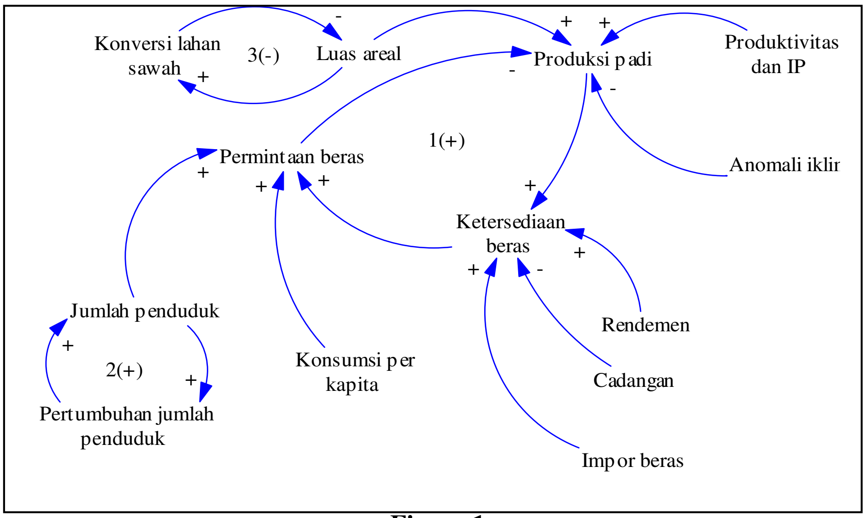

Figure 1
Causative Relationship in Dynamic Modeling of Rice Stock in Bali

The above diagram ignores the effects of grain/rice price to production/supply level. This is because the elasticity of price of rice to total supply is not real (Irawan, 2001). To date, an increase in rice or grain price does not actually affect farmers efforts in increasing rice production. It happens because land area of farmers is relatively small and rice farming is seasonal.

Rice production is affected positively by rice field area, farming technology, and post-harvesting. Technology indicators are in forms of productivity and rice planting index. The larger the rice field area is and the higher the productivity and planting index are, the more the rice production is. Opposite effect to total rice production, i.e. negative, happens during abnormal seasons. The more often the frequency of abnormal seasons are, such as La Nina, El Nino or pest attacks, the less the level of rice production is.

Rice availability is also positively affected by the level of rice production, rice yield, and rice import. On the contrast, rice reserves will decrease the level of rice availability because reserves eliminate current production for consumption needs in the following year. Rice availability has a positive causative relationship to rice demand, in which the more rice available, the more the demand is. This condition mirrors positive elasticity of income to demand. In this review, the indicator is mirrored by annual increasing level of rice consumption per capita and increasing demand of rice due to increase in population.

Causative relationship between rice production, rice availability, and rice demand in Figure 1 stated in circle/loop one (1) is positive. Causative relationship between population number and rate of population growth stated in loop two (2) is positive. Positive relationship can be in forms of either linear or exponential relationship. On the contrary, causative relationship between rice field soil and rice field soil conversion in loop three (3) is negative.

2.3 Research Concept

Detailed definitions of main variables in this study are as follows:

1. Dynamic model in this study is of things that are related to supply (production) and demand (consumption) of rice.
2. Rice stock in general is a condition in which need of food (i.e. rice) is sufficient for whole population that is shown in availability of good rice in production and consumption sectors.
3. Production is defined as total production of rice commodity produced in Bali Province that comes from components of average soil productivity and harvest area, as well as production that comes from rice field or farming soil.
4. Population, in general, using demographic concept, is everybody who has been residing in geographical region of Bali Province for six months or more and/or those who reside less than six months but plan to stay. Tourists visiting Bali, despite consuming rice in Bali, are not counted in the study.

5. Income is income value per capita coming from agricultural sector that is derivatice of gross value added.
6. Soil is land area that comes from protected forests, rice field agricultural soils, non-rice field agricultural soils, as well as non-agricultural soils.
7. Rice balance sheet is the difference between total of rice needs and available rice. Available rice is gross rice production minus shrinkage (from transportation, handling, and storage process).
8. Gross regional domestic product is normal numbers of growth as a tool to know the effect of income per capita due to small effect of gross value added from rice.

III. RESEARCH METHODS

3.1 Research Design

This study used the quantitative method supported with qualitative method, from perspective of dynamic model. The research steps were site selection, determination of reviewed objects, selection of respondents (quantitative and qualitative), selection of data type and source, and selection of key variables through prospective analysis.

3.2 Research Site and Schedule

This research was conducted in Bali Province covering nine regencies/cities: (1) Badung; (2) Denpasar; (3) Gianyar; (4) Klungkung; (5) Bangli, (6) Karangasem; (7) Buleleng; (8) Jembrana; and (9) Tabanan.

The selection of Bali Province as the research site was based on several considerations: (1) Bali Province is one of the provinces in Indonesia that is expected to be a region for national rice production beside a main destination of world tourism; (2) Preservation of rice production in Bali Province will give positive value to evaluation of Subak organization as one of world heritage; and (3) Rice stock in Bali Province becomes a security assurance for tourism development.

The research was conducted for 12 months, from May 2012 until April 2013.

3.3 Type, Source, and Method of Data Collection

Data type in this study was quantitave data and supported with qualitative data. Source of quantitative data (numbers) was from respondents as a form of primary and secondary data such as from Bulog/Dolog, Dinas Pertanian, Badan Ketahanan Pangan Daerah, Dinas Perindustrian dan Perdagangan, instructors, researchers from BPTP and universities, as well as BPN. Data was collected by several methods, such as observation, interviews, and documentations.

3.4 Sample Selection

Selection of purposive sampling was based on the fact that respondents had expertise, reputation, and experiences on the research area. For identification of factors/dimensional attributes in rice stock and selection of key factors, 15 respondents were selected consisting of lecturers from universities, and researchers in area of cultivation, agroclimate and post-harvesting of rice.

3.5 Data Analysis

Analysis methods used in this study were: (1) Prospective analysis, used to identify dominant factors (key factor) that affect rice stock in Bali. The analysis was done by firstly analyzing dominant changer and need analysis, or important changer, of respondents from several regencies/cities representing rice ecosystem. The result of this analysis was then used in the later analysis that is dynamic system analysis; (2) Dynamic system analysis with Powersim software. This approach was used to design models of rice stock in Bali and identify future rice stock (shortage or excess), which consisted of: (a) need analysis; (b) problem formulation; (c) system identification; (d) model formulation; (e) model validation and verification; and (f) implementation; (3) Sensitivity analysis, done to see sensitivity of parameters, variables, and relationship between variables in the model; (4) Simulation analysis, done to test and evaluate the model, make predictions, and study the effects of changes in **exogenic changers** to endogenic changers in the model.

IV. RESULTS AND DISCUSSIONS

4.1 General Review on Agriculture in Bali Province

Bali as a main destination of world tourism has an area of 5,636.66 km^2 (0.29% of area of Indonesia). Out of the area, only 81,744 ha (14.50%) are rice fields, the rest are 273,655 ha of non-rice field soil (48.55%) and 208,267 ha of non-agricultural soil (36.95%). Non-rice field soil is soil that is used in activities related to agriculture, such as farm, plantation, forest, fishpond, pasture or yard planted with agricultural plants. Non-agricultural soil is soil that is used for housing, other buildings, state forests, marshes, etc.

Utilization of main rice field soil is performed by four regencies in Bali: Tabanan, Gianyar, Badung, and

Denpasar. Each of the four regencies consists of more than 20% of their total area. Between 1977-2001, a shift of rice field utilization to other forms of land utilization in Bali Province was as big as 6,105 ha (on average: 436 ha or 0.5% per year). The largest decrease was Denpasar (1.55% per year), followed by Jembrana (1.14% per year) and Badung (0.82% per year). Shifting trends in utilization of rice field soil to other forms of utilization are relatively massive.

4.2 Dynamic Model of Rice Stock in Bali Province

In order to understand the complexity of dynamic modeling of rice stock design systems in Bali Province, the general model was developed to the causative diagram. Development of the causative diagram was based on components present in the general model and research obejectives to be answered. Hence, both of the previous components acted as a system boundary in creating the causative diagram shown in Figure 2 below.

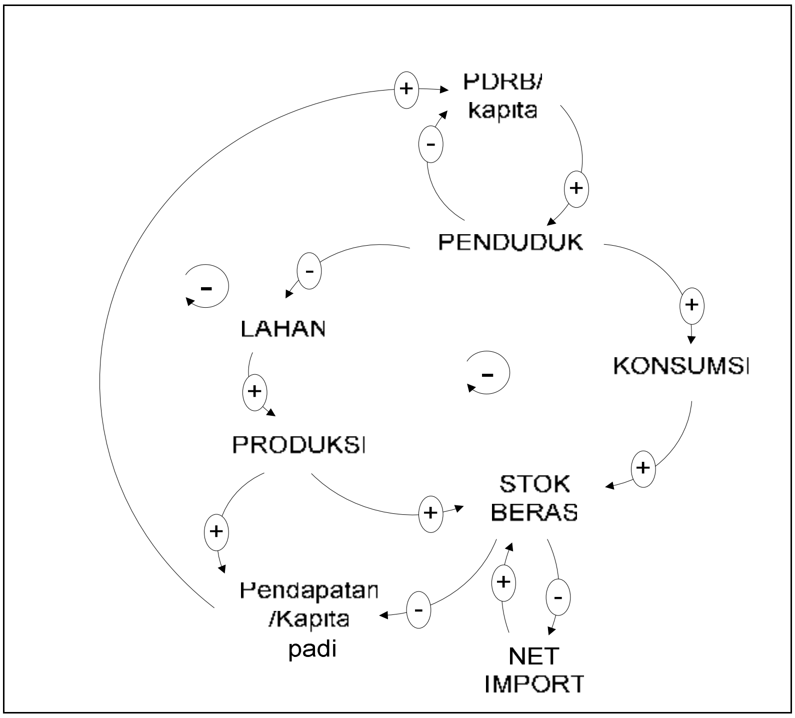

Figure 2
General Causative Diagram of Rice Stock in Bali Province

The dynamic modeling system that was developed was limited to items that were related to supply (production) and demand (consumption) of rice. To ease in modeling, the system of rice supply was constructed into two levels. The first level was the aggregate diagram that described the relationship between subsystems in rice supply system, as depicted in Figure 2. The second level was a more detailed dynamic system modeling in each subsystem that consisted of (a) population submodel; (b) income submodel; (c) production submodel; (d) gross regional domestic product submodel; (e) soil submodel; and (f) consumption and rice balance sheet submodel.

A simulation of the dynamic modeling of rice stock was a model designed using an approach on dynamic system and was named Beras.Sim. This model was based on problem identification that is depicted on the causal diagram (causal loop), formulated in the flow diagram (stock and flow), and simulated using Powersim Studio 8 SR 5 software.

V. CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

The result showed that the design of dynamic system can be applied to rice stock system in Bali Province. Conclusions of the study are:

1. Dynamic modeling of rice stock in Bali Province consisted of six submodels: (1) population submodel; (2) income submodel; (3) production submodel; (4) gross regional domestic product submodel; (5) soil submodel; and (6) consumption and rice balance sheet submodel. Relationships between submodels were depicted in a form of the causative diagram. The causative relationship (causal diagram) showed

that there was positive feedback, which means that if this system is working by itself without external factors, rice stock will diminish because of increasing demand (consumption). The reliability of this model can be verified by comparing simulation results with actual data. The common method used actual data from the previous year and compared it with simulation results, and the discrepancy should not have been more than five percent.

2. Results of the model simulation showed that the dynamic system modeling of rice stock successfully explained annual dynamic behavior in every submodel. With accurate initial data input, this model can be used to control the system or as anticipation to changes of policies related to rice stock in Bali Province. The model simulation of combined scenarios, such as intensification, minimalizing rice consumption, or mantaining timeless rice field soil, is needed to overcome the threat of food crisis in Bali Province in the future.

5.2 Suggestions

Continuing deficit in rice production that might occur after 2015 will result in increasing dependency between islands and even increasing dependency of imported rice. To suppress the deficit level, efforts directed toward improvement of supply capability (production) and reduction of the demand level (consumption) are needed. Specifically, following efforts can be done.

1. Development and rehabilitation of irrigation systems, as well as improvement in water resource management to provide adequate water for agriculture through the Subak organization.
2. Supressing irrigated soil conversion to other non-agricultural utilization. This is related to regulation or limitation with incentive system that is done cross-institutionally, such as: (i) establishment of policies and strict implementation by Pemda and BPN (Badan Pertanahan Nasional); (ii) facilitation of development of agriculture-based community businesses by Departemen Teknis; and (iii) supervision by community as businessmen.
3. Opening new agricultural soil in possible areas while paying close attention to city planning and principles of environmental sustainability, facilitated by Pemda.
4. To perfect the dynamic model of rice stock in Bali Province, price and rice distribution variables should be added in the next study.

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References

Ariani, M. dan Ashari. 2003. Dinamika Konsumsi Beras Rumah Tangga dan Kaitannya dengan Diversifikasi Konsumsi Pangan oleh Ekonomi Padi dan Beras Indonesia. Jakarta: Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Arifin, B. 2001. Kebijakan Beras di Persimpangan Jalan oleh Pangan Media Komunikasi dan Informasi. Jakarta: LPEM Fakultas Ekonomi UI, 36(10).

Asyawati, Y. 2002. "Pendekatan Sistem Dinamik dalam Penataan Ruang Wilayah Pesisir (Studi Kasus Wilayah Pesisir Kabupaten Bantul, Provinsi DIY)" (tesis). Bogor: Institut Pertanian Bogor.

Badan Bimas Ketahanan Pangan. 2001. Pemantapan Ketahanan Pangan Nasional. Jakarta: Departemen Pertanian.

Badan Ketahanan Pangan-Lembaga Penelitian UI. 2002. Analisis Skenario Pemenuhan Kebutuhan Pangan Nasional Hingga Tahun 2015. Ditinjau dari Aspek Sosial Kelembagaan dan Pedesaan. Jakarta: Departemen Pertanian.

Badan Ketahanan Pangan-Pusat Studi Pembangunan Lembaga Penelitian IPB. 2002. Analisis Skenario Kebutuhan Pangan Nasional Hingga 2015. Ditinjau dari Aspek Sosial Ekonomi Pertanian. Jakarta: Departemen Pertanian.

Badan Pusat Statistik Bali. 2011. Diunduh dari Situs BPS Bali http://www.bps.bali.go.id., tanggal 12 Maret 2012.

Baharsyah, S., F.Kasryno, D.H. Darmawan. 1998. Kedudukan Padi dalam Perekonomian Indonesia. Jakarta: Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Chechland, P. B. 1981. System Thinking, Systems Practices. Wiley Chichester. p.120-131.

Coyle, R.G. 1996. System Dynamics Modelling: A Practical Approach. Chapman & Hall/CRC. p.65-67

Daalen, V., and W.A.H. Thissen. 2001. Dynamics Systems Modelling Continous Models. Delft: Faculteit Techniek, Bestuur en Management (TBM). p.35.

Departemen Pertanian. 2005. Prospek dan Arah Pengembangan Agribisnis Padi. Jakarta.

Dharmawan, A. H dan R. Kinseng. 2006. Aspek Sosial Budaya dalam Rekonstruksi Kelembagaan Sosial Penanganan dan Pencegahan Rawan Pangan dan Gizi Buruk. Dalam P. Hariyadi, D. Martianto, B. Arifin, B. Wijaya, F.G. Winarno., editors. Rekonstruksi Kelembagaan Sosial Penanganan dan Pencegahan Rawan Pangan dan Gizi Buruk. Prosiding Lokakarya Nasional II Penganekaragaman Pangan. Forum Kerja Penganekaragaman Pangan-Bogasari Flour Mills. Jakarta 10-12 Oktober.

Eriyatno. 1987. Analisis Sistem Industri Pangan. Pusat Antar Universitas Pangan dan Gizi. Bogor: Institut Pertanian Bogor. p.84.

Eriyatno. 1999. Ilmu Sistem : Meningkatkan Mutu dan Efektivitas Manajemen. Jilid I, Edisi Ketiga: IPB Press. p.67.

Erwidodo, T. Sudaryanto, A. Purwono, M. Ariani dan K. S Endraningsih. 1996. Telaahan Trend Konsumsi Beras di Indonesia. Kerjasama Pusat Penelitian Sosial Ekonomi Pertanian dengan Proyek DPG Pusat. Bogor: Departemen Pertanian. p.31.

Forrester, J.W. 1961. System Dynamics: The foundation Under System Thinking. Sloan School of Management MIT. Cambridge, MA 02139. Diunduh dari ftp://sysdin.mit.edu/ftp/sdep/papers/D-4828.html pada tanggal 12 Maret 2012.

Gardner, B. 1987. The Economics of Agricultural Policies. Macmillan Publishing Company. New York. USA. p. 45-56

Irawan. 2001. Perilaku Suplai Padi Ladang dan Sawah di Indonesia dan Kebijakan Peningkatan Produksi Padi. Diunduh dari http://www.hayati-ipb.com pada tanggal 1 Maret 2012.

Irawan. 2005. Analisis Ketersediaan Beras Nasional : Suatu Kajian Simulasi Pendekatan Sistem Dinamis. Prosiding Multifungsi Pertanian dan Ketahanan Pangan. Pusat Penelitian Tanah dan Agroklimat Bogor. Bogor. Diunduh dari http://www.hayati-ipb.com pada tanggal 1 Maret 2012.

Kasryno, F, dan E. Pasandaran. 2004. Reposisi Padi dan Beras dalam Prekonomian Nasional. Dalam F. Kasryno, E. Pasandaran dan A. M. Fagi., editors. Ekonomi Padi dan Beras Indonesia. Jakarta: Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Manetsch, R.P. and G.L. Park. 1977. System Analysis and Simulations With Application to Economic and Social System. Michigan State University, USA. p.201-219.

Marimin. 2004. Teknik dan Aplikasi Pengambilan Keputusan Kriteria Majemuk. Jakarta: Gramedia Widiasarana Indonesia.

Maxwell, S. and R. F. Timothy. 1992. Houshold Food Security : Concepts, Indicators, Reasurements, A Technical Review. Rome : International Fund for Agriculture Development.

Muhammadi, E. Aminullah dan B. Soesilo. 2001. Analisis Sistem Dinamis : Lingkungan Hidup Sosial, Ekonomi, Manajemen. Jakarta: UMJ Press.

Mulyana, A. 1998. "Keragaan Penawaran dan Permintaan Beras Indonesia dan Prospek Swasembada Menuju Era Perdagangan Bebas Suatu Analisis Simulasi" (disertasi). Bogor: Institut Pertanian Bogor.

Nainggolan, K. 2006. Arah dan Kebijakan Perberasan Nasional dalam Inpres Nomor 13 Tahun 2005. Jakarta: Badan Bimas Ketahanan Pangan. Departemen Pertanian.

Nurmalina, R. 2007. "Model Neraca Ketersediaan Beras yang Berkelanjutan untuk Mendukung Ketahanan Pangan Nasional" (disertasi). Bogor: Institut Pertanian Bogor.

Pudjadi, T. dan Harisno. 2007. Model Pengelolaan Stok dan Konsumsi Beras Berbasis DSS pada Era Otonomi Daerah (OTDA). Diunduh dari: http://journal uii.ac.id/index.php/Snati/article/view/1675 pada tanggal 20 Januari 2015.

Rachman, H. P. 2001. "Kajian Pola Konsumsi dan Permintaan Pangan di Kawasan Timur Indonesia" (disertasi). Bogor: Institut Pertanian Bogor.

Richardson, G.P. and A.L. Pugh. 1986. Introduction to System Dynamics Modelling with Dynamo. The MIT Press, Cambridge, Massachussete, and London, England.

Saad, M. B. 1999. Food Security for The Food Insecure; New Challengers and Renewed Commitment. Centre for Development Studies, University College Dublin, Ireland.

Sawit, M. H. 2000. Arah Kebijakan Distribusi Perdagangan Beras dalam Mendukung Ketahanan Pangan: Aspek Perdagangan Beras Dalam Negeri. Makalah pada Semiloka Penyususnan Kebijakan Perberasan. Bogor 14-15 Maret 2000. Kerjasama LP-IPB dengan Ditjen Tanaman Pangan dan Hortikultura. Bogor.

Shintasari, I. 1988. "Dinamika Persediaan Daging Sapi: Suatu Model Dinamik untuk DKI Jakarta" (skripsi). Bogor: Institut Pertanian Bogor.

Siahaan, H. M. 2006. Revolusi Kebijakan dan Aksi Menuju Penganekaragaman Pangan. Dalam Dharmawan, A. H dan R. Kinseng. Aspek Sosial Budaya dalam Rekonstruksi Kelembagaan Sosial Penanganan dan Pencegahan Rawan Pangan dan Gizi Buruk.

Sugianto, Tjahyadi, Pantjar Simatupang, Moeljarno Djojomartono. 2002. Faktor_faktor Yang Mempengaruhi dan Sistem Pengendalian Stok Beras di Mayarakat. Jakarta: Badan Pusat Statistik.

Tasrif, M. 2004. Model Simulasi untuk Analisis Kebijakan: Pendekatan Metodologi Sistem Dinamik. Kelompok Penelitian dan Pengembangan Energi. Bandung: Institut Teknologi Bandung.

Timmer, C.P. 1996. Does Bulog Stabilize Rice prices in Indonesia? Should it Try? Bull. Indon. Econ. Studies 32.

Todaro, Michel P. 2000. Economic Development. Seven Edition, New York University.

Waskito, A.B. 2005. "Pemodelan Ekonometrik dan Dinamika Sistem Daya Saing Ekspor Komoditas Agroindustri Karet Alam Indonesia" (skripsi). Bogor: Institut Pertanian Bogor.

Widayani, K. 1999. "Analisis Perencanaan Kebijakan pengembangan Produksi Buah-buahan di Indonesia dengan Pendekatan Sistem Dinamik (Studi Kasus Pengembangan Produksi Mangga di Jawa Barat)" (tesis). Bandung: Institut Teknologi Bandung.