

Analyzing Determinant Components on East Java Rice Surplus Contribution Using Dynamical System Approach

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Abstract: The Ministry of Agriculture has proclaimed rice as a main food commodity, beside corn, soybeans, meat and sugar. In order to achieve the target of the Ministry of Agriculture, East Java provincial government has stipulated a policy, focusing on rice surplus of 5 million tons in 2014. This attempt is to reach the surplus number through a wide selection of technological innovations (determinant component) that increases the productivity of rice (New Superior Variety/VUB, Site Specific Nutrient Management/SSNM, Integrated Crop Management/PTT, *Jarwo*/double row planting system, balanced fertilization, SOP harvest / post-harvest), as well as an increase in Planting Index/IP by improving irrigation and food diversification program. By using a dynamical system approach (modeling), it can be measured the contribution of each determinant components in achieving surplus / rice self-sufficiency through simulation. The results of the simulation, it was known that the East Java's rice surplus will continue to decline from 1,806,282 tons (2014) with 170% self-sufficiency index, fell to 1.706.771 tons (2017) and would be 1.367.901 tons (2025). This condition is due to the increasing number of population, agricultural area continues to shrink and productivity is relatively fixed. Index sufficiency / surplus will increase if there is an interference of educational policy to implement a massive exceed of VUB, SSNM, PTT, *Jarwo*, balanced fertilization, SOP harvest / post-harvest, IP increasing and the succession of diversification in East Java. A surplus of 4.7 million tons of rice in 2014 within East Java can be achieved by implementing massive educational policy movement of PTT and VUB (100% of the area), the application of SOP harvest / post-harvest to reach at least 50% of the area of paddy and controlling OPT strictly. The highest self-sufficiency index (281%) and a surplus of 5.22 million tons will be achieved in case of an interference in implementing policy of PTT *jarwo* (100% of the area) and an IP increasing amounted to 1.0 (additional areas that can be irrigated, 33.000 ha). Sustainable rice surplus would be achieved in case of an attempt to make food diversification program completely successful, strengthen family planning programs and strictly guard the Regulation No. 5/2012 on the minimum acreage of paddy fields that must be maintained.

Keywords: Dynamical system, causal loop, surplus, East Java

1. Introduction

The Ministry of Agriculture proclaim that the rice, corn, soybeans, meat, milk and sugar as the five prominent food commodities. The targeted number of rice self-sufficiency is about 76.6 million tons of rice (10 million tons of rice surplus). Based on the data from the Central Statistics Agency (BPS 2011) until July 2011, Indonesian rice import has reached 1.57 million tons amounting to approximately 7.04 trillion rupiahs. The imports are primarily from Vietnam (892 thousand tons), Thailand (665.8 thousand tons), China (1.869 tons), India (1.146 tons), Pakistan (3.2 thousand tons), and some other countries (3.2 thousand tons). This condition requires Indonesian to recover food self-sufficiency issue and to comply with national rice necessity that proportionate to the high population growth of Indonesian within all region (Erwidodo *et al.*, 1996; BKP-LPUI, 2002; Ariani and Ashari, 2003). Central statistics agency (BPS) calculates that the population growth rate in 2005 to 2010 is expected to reach 1.3%, in 2011 to 2015 by 1.18% and 0.82% in 2025 to 2030. While the National Development Planning Agency (BAPPENAS) estimates that by 2015 the population of Indonesia will reach approximately 243 million. Rice consumption per capita of Indonesia reaches 139 kg per year, consequently, 33.78 million tons of rice are needed. In 2030, rice necessity for foos will reach 59 million tons for the approximate total population 425 million people (Mulyana, 1998; Prabowo *et al.*, 2012; Nugraha *et al.*, 2007).

In order to profitably accomplish the target of the Ministry of Agriculture in rice

self-sufficiency, East Java provincial government has promulgated a policy to accomplish 5 millions tons of rice surplus in 2014 (50% of the national target). The agricultural development policy decided and enacted by the central government / province to direct, encourage, control and regulate the development to accomplish the objectives of agricultural development (Maxwell and Timothy, 1992; Simatupang, 2003; Departemen Pertanian, 2005).

It has been known that the attempts to achieve a rice surplus in East Java is obstructed by several things as follows: (1) The rate of population growth is increasing up to 0.76% per year, (2) The shrinking of land which the rate of land conversion is approximately 1% per year (+1.000 ha), (3) rice landform cannot be conducted by the farmers, (4) rice consumption per capita per year is about 100 kg (with a target of 91 kg / capita / year), (5) the condition of irrigation network (JITUT / JIDES) and irrigation networks in 6 (six) region watersheds (DAS) in need to be repaired, (6) shrinkage results due to harvest and post-harvest remains high, (7) the drought / natural disasters and pests that recently is increasing significantly, therefore significantly reduces the harvested area.

The current agricultural development, as well as forthcoming development, is directed to the development of systems and agribusiness which is competitive, populist, sustainable and decentralized. Karama (1999) suggests that programs which ever launched by the department of Agriculture basically have the goal to empower and increase farmer's independency. While Rusastra (2000) stated that relevant to the

implementation of regional autonomy, thus the policy and the implementation of agricultural development will be more decentralized, with the problems and challenges which are more complex, therefore it requires a dynamic and flexible policy according to changes in the strategic environment (Asyawati, 2002; Muhammadi *et al.*, 2001; Tasrif M, 2004)

Although the attempts to achieve rice surplus faces several obstacles, but there are opportunities to overcome these obstacles through the identification and implementation of rice surplus. Determinant component of rice surplus which is also an innovation technology are identified as the VUB (In-pani), SSNM, PTT, Jarwo row, balanced fertilization, SOP harvest / post-harvest. In addition the success of the diversification program and IP enhancement through an improved irrigation systems are also needed to be taken into account (the current IP 1.86). the long-term self-sufficiency has been considered by the East Java provincial government by issuing Local Regulation number 5/2012 to set a minimum area of agricultural land which required to be maintained.

To identify the contribution of each determinant component in achieving self-sufficiency / rice surplus, it has been designed an activity using a dynamic system approach (modeling). Modelling is compiled by identifying and arranging all of the barriers and opportunities in rice advancement (identified as variable / parameter) and to discover a causal relationship of the variables / parameters of the model compiler (Chechland, 1981; Richardson and Pugh, 1986; Suryani, 2006; Bloom, 2008).

The success of agricultural development is commonly followed by policy which are concerning the application of technology, the use of the means of production, commodities, prices of input-output and etc. Agricultural development policy enacted by the government concentrates to direct, encourage, control and regulate development in order to accomplish the objectives of agricultural development (Saad, 1999; Simatupang, 2003).

During the implementation of development, problems or obstacles are typical, yet it should be immediately identified and solved (Suyamto, 2000). In the manner that the attainment of rice self-sufficiency program, it requires a solution for improving rice production and reducing the dependence on rice imports to fulfill the internal demand. The problems related to the accomplishment of rice production need the modeling analysis system to determine the factors that either influence directly or indirectly the rice production. Modeling analysis can be taken as policy recommendations to encourage the attainment of rice self-sufficiency, particularly in East Java (Forrester, 1961; Sugianto *et al.*, 2002; Irawan. 2005; Pudjadi and Harisno. 2007)

This agricultural development policy analysis is adjustable, prompt in implementing and generating output, as for inputting to make a decision in the local region (Suyamto, 2000). The preceding years experience indicates that the results of the policy analysis is able to support the precision of agriculture activity within the local area (Suyamto, 2000). According to Rusastra (2000), the agricultural development policy analysis can

be categorized into two conditions as follows: (1) Anticipatory policy analysis aims to evaluate the ongoing policy and anticipate the new policy, and (2) Responsive policy that essentially responds to the actual issues during the enactment of policy.

The first step of model development is to identify the system that aims to provide an overview of the studied systems. This model development is designed in the form of diagram input component (input) with the environment system which produces an output (output), both expected and unexpected output. The picture is as shown in Figure 1.

2. Materials and Method

The identification and problem-solving suggestions regarding the achievement of rice self-sufficiency in East Java uses dynamic system and correlates several factors that influence in rice production either directly or indirectly toward targets produc-

tion of rice self-sufficiency within East Java in 2014. There are two approaches to obtain the information. The first is identifying the problem directly in the field and obtaining sources of the data or information from the subject or institution that associated with soy-agribusiness. The applied procedures in this study are:

1. Identifying the problem and supporting factors that either related directly or indirectly to the attainment of rice self-sufficiency through a review of the literature.
2. Identifying the problem through the implementation of RRA (Rapid Rural Appraisal) and further analysis through FGD activities (Focused Group Discussion).
3. Preparing problem-solving advice for policy makers by using dynamic systems and implementing simulation models.

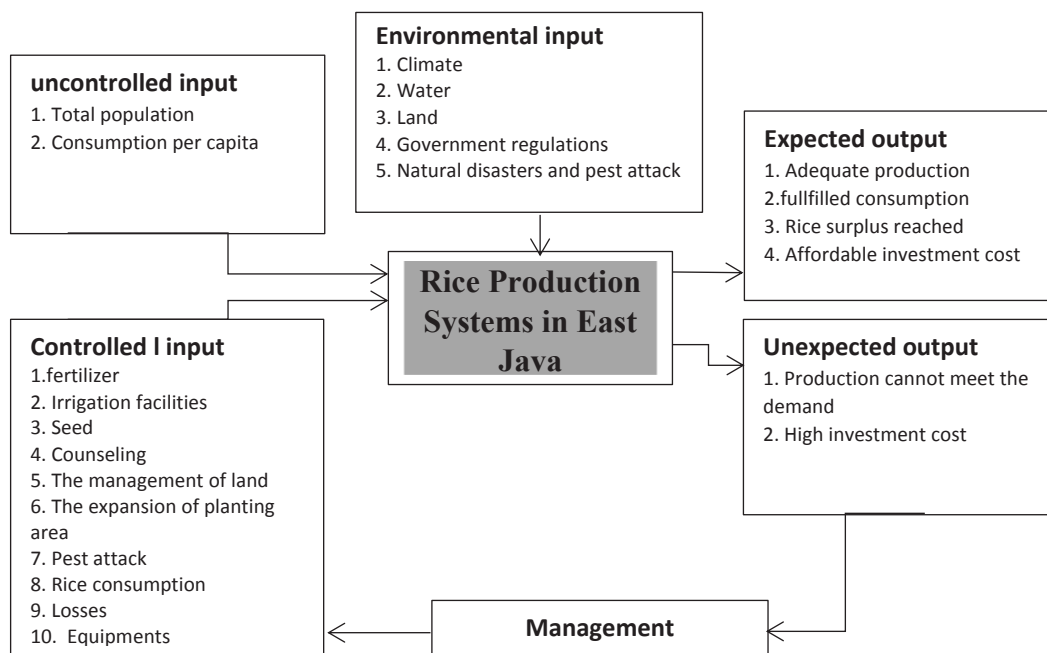


Figure 1. Input-Output Diagram of Paddy Production System

4. Socializing a problem-solving advice and reporting to policy makers in East Java.
5. Conducting sustainable evaluation based on the results of policy analysis in achieving rice self-sufficiency in East Java.

The study was conducted in January to December 2013. The data or information was collected by using secondary data that already occurred (reports from departments, agencies, and other related institutions) as well as the primary data. The primary data was collected through surveys and countryside understanding in a short time (Rapid Rural Appraisal) (Gibbs, 1985 In Surachman *et al.*, 2012). After applying RRA, to learn more about the problem and the potential development of paddy, Focus Group Discussion (FGD) with farmers, extension workers, field workers and businesses at the provincial level was also conducted. During data collection, several information that are being collected are the condition of land use, irrigation, the use of seed, fertilization, pest control, population growth rate and production rate, shrinkage results, mechanization and also local policies related to rice production systems.

Data processing and analysis was done by the following procedure: (1) Preparing Causal loop diagrams which include consumption and production subsystems as well as the inclusion of environmental improvements issues, (2) Preparing stock and flow in Powersim Constructor Lite 2003 (3) Inputting variable data corresponding causal loop diagram into Powersim, 2003, (4) Conducting a test to the validation model. The process

of validation model test starting from 2008 to 2011 which includes the total population, land area, harvested area and grain production, (5) Executing a sensitivity analysis and (6) Performing a simulation. This study used Powersim Constructor Lite 2003 to arranging the simulation. The result of the simulation is used to determine option related to the rice self-sufficiency policy (Shintasari, 1988; Widayani, 1999; Daalen and Thissen, 2001; Waskito, A.B. 2005)

3. Results and Discussion

3.1 Model Arrangement

All of the identification result of surplus obstacles and opportunities has been formulated in the form of causal loop diagram / CLD (Figure 2), through focus group discussions in which many stakeholders were involved. CLD is a diagram that illustrates the interaction between the parameters or variables in dynamic systems consisting of consumption and production subsystems. After CLD has been arranged, the next step is to collect the data or information in accordance with CLD components. Data collection through field observations and followed up by FGD for comprehending the data and information involving farmers, extension workers or officers and policy makers. Before the primary data collected, literature review has been carried out, particularly to obtain quantitative secondary data (Table 1).

Before conducting the simulation, it is necessary to validate the model to test the appropriateness of the developed model which is compatible with field circumstance. The validation of the model has been made for the total population, area and production

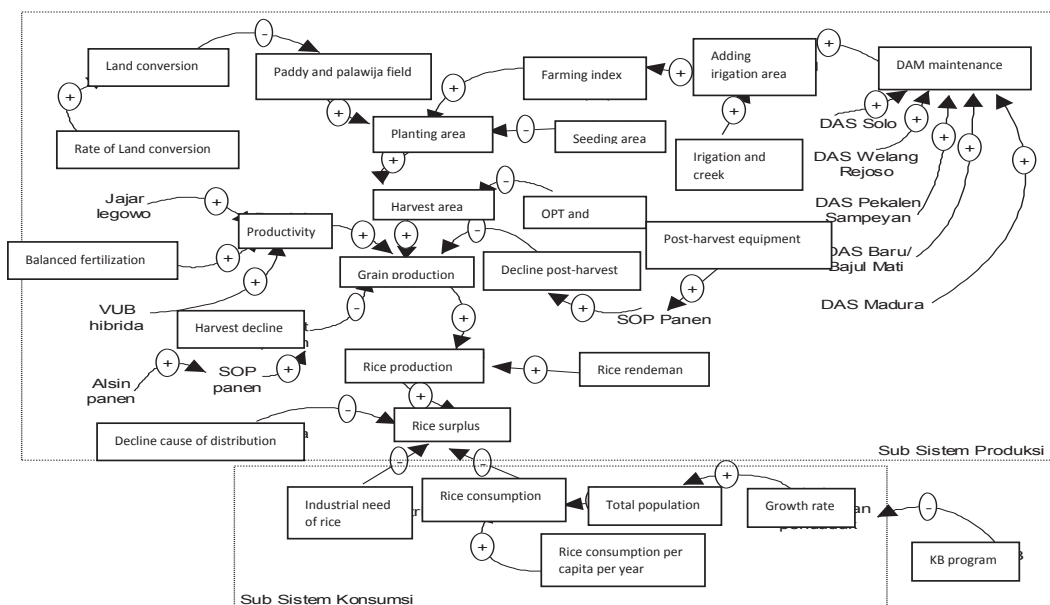


Figure 2. Causal Loop Diagram(CLD) East Java rice surplus

Table 1. The variables/parameters and values used

No	Variable or Parameter	Value(s)	Data Source
1	Total populations of the first (2008) calculation	38,412,548	Disnakertransduk East-Java Province 2012
2	Population growth per year	0.75%	Disnakertransduk East-Java Province 2012
3	Rice consumption per year per capita	0.091 tons	BKP East-Java 2012
4	Rice field area for the initial calculation (2008)	1,108,578 ha	BPS East-Java 2012
5	Land conversion per year	0.01%	Historical Data BPS East-Java 2008-2011
6	If Perda No. 5/2012 enacted, the vast rice-field minimal will be	831,434 ha	DispertaProv 2013*
7	Rice needs for industry	10% from total production	Disperindag Prov 2010 *
8	Farming Index (FI) Rice	1.86	DispertaProv 2011 *
9	Reduction of planting area into a harvest area (pest and drought)	3%	Historical data Disperta-Prov 2008-2011
10	Rice productivity as the basis for calculation	6.174 ton GKP	BPS Prov 2008
11	Land used for seed	17,000 ha	BPSB East Java 2012 *
12	Additional productivity application Jarwo row	0.6 ton/ha	BPTP East Java *
13	Additional productivity, the application of a balanced fertilizer	1.2 ton/ha	BPTP East Java *
14	VUB additional productivity application	0.6 ton/ha	BPTP East Java*
15	Additional productivity application	1.0 ton/ha	
16	Loss due to harvest	3.9%	BB post-harvest 2007
17	Losses due to post harvest	8.08%	BB post-harvest 2007
18	Conversion of GKP to DUP	80.90%	Puslitbangtan 2012
19	Conversion of grain to rice	66.60%	BPS East Java 2011
20	Loss due to the distribution of rice	2.92%	BPS 2008 dan P2HP 2009
21	Improving irrigation (6 DAS) and JITUT/JIDES	33,200 ha, increasing IP 1.0	Dinas PU irrigation, 2012 *

Descriptions:

Assumptions used:

(a) KB/Family Planing program is well-implemented, therefore the population growth rate is constant,

(b) Total Machine equipments for planting, harvest and post-harvest was considered constant

* Data was obtained from the results of the consultation and FGD

of paddy rice harvest began in 2008-2011 (4 years) with reference to the mean square error (MSE) is less than 5% (Appendix Figure 1). According to Suryani (2006), the model is already consistent with the real circumstance of the field, if MSE is <5%.

3.2 Simulation Results

The simulation results show that if intervention is not conducted (action program), then the East-Java rice surplus will be declined steadily from 2014 amounted to 1,806,282 tons (with an index of 170% self-sufficiency), in 2017 to 1,706,771 tons in 2025 amounted to 1,367,901 tons (Figure 3). This is due to the increasing number of population; according to the rate of land conversion, productivity is relatively fixed, while

the area of land continues to decline. The measurement of the contribution of each determinant component of the surplus has been done through simulation with the results as shown in Table 2.

From the options above, the chosen policy interventions to accomplish a surplus of 5 million tons in 2014 is to conduct a massive extension in implementing PTT Jarwo and VUB (100% of the total area), applying SOP harvest or post-harvest (min 50% of the total area) and promoting diversification programs (leading to 80 kg / cap / year) and controlling pests attack strictly which recently the attack is considered high (No. 8, table 3). By performing these attempts, the surplus can be approximately achieved 4.70 million tons (Figure 3 and Figure 4).

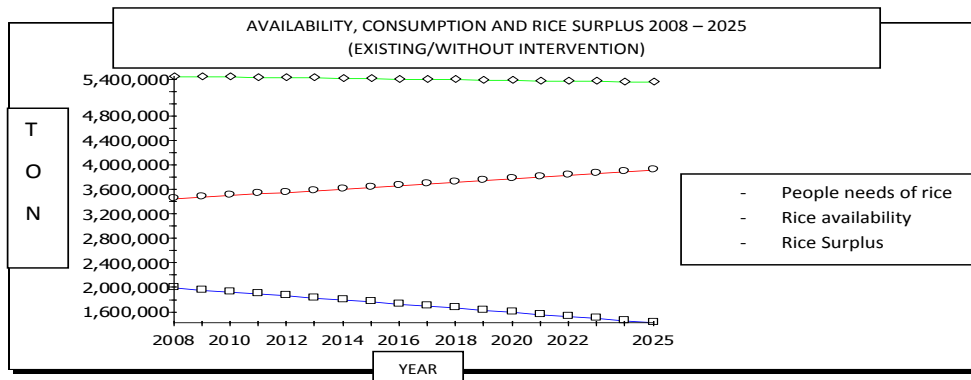


Figure 3. Supply, Consumption and Surplus Rice (2008-2025)

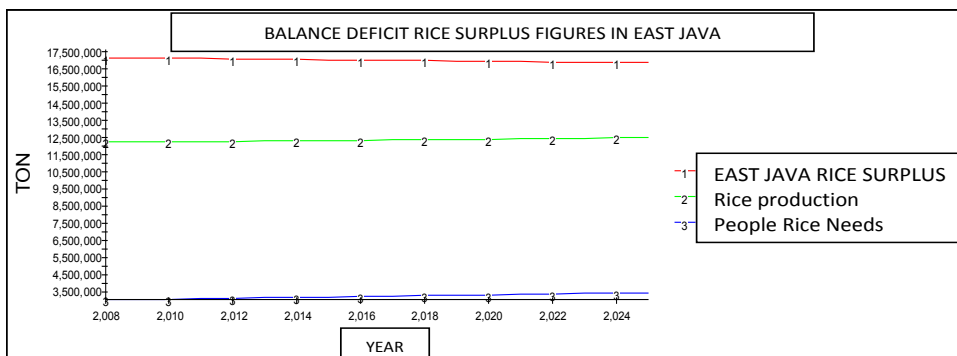


Figure 4. Rice surplus in EJ through intervention of application PTT Jarwo, VUB, SOP harvest /postharvest and diversification

Table 2. Contributions from Each Component Makers on Self-Sufficiency (Surplus Rice) in EJ

No	Determinant Component	Areal Scale Application	Rice Surplus (ton)	Self-Sufficiency Index (%)
1	VUB Inpari	100%	2,27 million	186
2	Jarwo row	100%	2,27 million	186
3	PHSL	100%	2,62 million	199
4	PTT Jarwo	100%	3,34 million	221
5	Balanced fertilizer	100%	2,79 million	204
6	Increasing Farming index (+ 1)	Expanding irrigation area 33,292 ha	3,19 million	216
7	Combination PTT and Farming Index	100%	5,22 million	281
8	PTT jarwo	100 %		
	Diversification	80 kg/cap/th	4,70 million	281
	VUB Inpari	100%		
	SOP Harvest/Post-Harvest	50%		

Sustainable self-sufficiency will be achieved by conducting several things as follows: (1) extending an area that can be irrigated (improvement of irrigation networks in 6 DAS and repair JITUT / JIDES) covering an area of 33,200 ha, (2) enhancing the productivity, (3) promoting food diversification program, (4) establishing the family planning program and strictly controlling the regulation No. 5/2012 on minimum acreage of paddy fields that must be maintained.

4. Conclusion

The conclusion that can be drawn from this study is the target of 5 million tons of rice surplus in East Java in 2014 will be accomplished by intervening PTT application, VUB, handling of harvest/post-harvest which reach all areas of rice and strictly conducting a pest control. In addition, the diversification of rice (rice consumption reduction of 10 kg/cap/year) should be applied. Rice surplus target of 5.22 million tons more will be accomplished when the IP is plus (+1), n giving additional area of irrigated field about 33,200 ha and complete application of PTT (100% of the total area).

The implications of policy relevant to the conclusions can be explained as follows:

a) Short-term: In the short term implication, the compatible program to accomplish a surplus in rice are (1) SLPTT. In applying SLPTT the use of VUB, Jarwo row, pest strictly control, and the application of SOP harvest need to be taken into account seriously, (2) In addition, there should be a special program to reduce losses of post-harvest, (3) The program of diversification of rice must be intensified to accomplish a reduction in rice consumption of 10 kg/cap/year, (4) For the district that still has productivity below 6.7 tons/ha, needs to be enhanced so that the productivity can reach at least 6.7 tons/ha. The application of SOP harvest or post-harvest will have implications for the use of machine equipment; b) Long-term; Sustainable rice self-sufficiency can be accomplished by extending the irrigated areal (improvement of irrigation networks in 6 DAS and repair JITUT / JIDES) covering an area of 33,200 ha, enhancing the productivity, promoting food diversification program, establishing the family planning program and controlling regulation No. 5/2012 on the

minimum acreage of paddy fields that must be maintained.

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