Structural Model of Organic Rice Farming System

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[Submitted October 2014, Accepted November 2014]

Abstract. *Conventional rice farming has decreased land quality so that rice productivity becomes diminished and unhealthy. Therefore, it is necessary to develop environmental friendly and sustainable organic rice farming to support food security. Organic rice farming is an interrelated system and involves various stakeholders and it is important to have understanding on the structure of the system. The objective of this study was to determine the structural model of organic rice farming system. The method used was survey and in-depth interviews from various experts such as bureaucracy, farmers, researchers, and academics. Interpretative Structural Modeling (ISM) was used to determine variables that built organic rice farming systems. The results showed that the structure of organic rice farming system consisted of 6 elements in each subsystem and 223 sub-elements namely 30 sub-elements in autonomous quadrant, 70 sub-elements in dependent quadrant, 47 sub-elements in linkage quadrant and 76 sub-element in independent quadrant, as well as 32 key elements.*

Keywords: *organic rice farming system, structural model, Interpretative Structural Modeling*

JEL codes : *Q10, Q18*

Introduction

Background

Efforts to increase rice productivity through agricultural intensification program to meet food demand have decreased soil fertility due to the use of

chemical fertilizers and pesticides. Rice production in the period 1980-1989 increased by 5.32 percent per year through the use of improved seeds that were very responsive to chemical fertilizers. In 1984, Indonesia was able to achieve rice self-sufficiency, but after that the growth of rice productivity decreased and became negative in the period 1996-2000 (Maulana et al., 2006). Low rice productivity and more expensive fertilizer prices have made farmers suffer losses (Irawan, 2007). In addition, the use of chemical fertilizers and pesticides produced unhealthy rice.

Organic farming is an agricultural system that can create optimal and sustainable agro-ecosystems socially, ecologically, economically as well as ethically (BSN, 2010). Organic farming is based on the use of minimum external inputs and does not use chemical fertilizers and pesticides. Previous research showed that although production declined in the early years of the transition to organic farming, later on it increased and may be even higher than the conventional one (Suwantoro 2008, Mayrowani et al., 2010, Prayoga 2010). According to Wijayanti (2005), Anugerah et al., (2005), and Mutakin (2007), income from organic rice farming was higher than conventional one; and in turn it improved the welfare of farmers.

Cianjur Regency as one of the rice production centers in West Java, Indonesia has experienced a decrease in rice productivity from 5.85 tons/ha in 2010 to 5,68 tons/ha in 2011 (Disperta, 2012). According to information from Agriculture Office staff, rice productivity has declined due to saturated soil condition that is caused by the use of chemical fertilizers. Pesticide applications have also increased pests and diseases that decrease rice production and cause crop failures.

Since 2007, *Balai Besar Wilayah Sungai Citarum (BBWSC)* has conducted organic System Rice Intensification (SRI) training for farmers in 10 regencies of West Java that aimed to increase rice productivity without chemical applications. Up to 2012, as many as 430 farmers had participated in the training, and they were expected to be able to apply and share the systems to other farmers. However until now the farmer trainees applying organic rice farming system have been only 156 or 36.28% or only 0.05% of total farmers around 296 549 with a land area around 79.3 ha or 0.13% of total paddy area around 63 299 ha (GPO, 2012).

Organic rice farming is a system. Basically, organic rice farming development is development of cultivation techniques or farming subsystem. Development of organic rice farming needs to be supported by the availability of inputs and marketing as well as supporting institutions that are integrated in an agribusiness system. The subsystems are so closely related that to develop organic rice farming or farming subsystems, input, marketing and supporting subsystems should be developed (Saragih, 2007). Each subsystem has its own problem that needs to be overcome.

Since organic rice farming is an interrelated system among four sub-systems and involves various stakeholders, a system approach is needed to develop it. Therefore, it is important to understand the structural model of organic rice farming through the system's strategic variables in order to achieve organic rice farming development more effectively.

Objective

The objective of this study was to determine the structural model of organic rice farming system through the system's strategic variables.

Research Methodology

Location and Time

This research was conducted in Cianjur Regency, Province of West Java, Indonesia. The data were collected from December 2013 to April 2014.

Data Collection Method

The data were obtained by survey from selected experts, in-depth interviews using questionnaires, and field observations. The selected experts consisted of staff from Department of Agriculture and Horticulture, Cianjur, Agricultural Extension Staff (PPL), researchers from Rice Research Institute (BPTP), BBWSC staff, chairman of Organic Farmers Group (GPO) and academicians. Secondary data were obtained from reports of Department of Agriculture and Horticulture, Cianjur, Organic Farmers Group, Agricultural Extension Center (BPP) and other relevant agencies as well as scientific publications.

Data Analysis Method

Interpretative Structural Modeling (ISM) was used to determine the structural model of organic rice farming. To determine the structural model, the linkages among sub-elements in organic rice farming system must be known first. The results of the ISM method were key elements, hierarchical structure of elements and element grouping based on the driver power and dependency levels. The steps in ISM methods (Marimin, 2008) are as follows:

1) Identify and list the elements of the system
2) Construct a contextual relationship among elements
3) Construct *Structural Self Interaction Matrix*/SSIM that represents respondent's perception element on the intended element relationship using the following symbols:
   V : Relationship between element E_i on E_j, not otherwise
   A : Relationship between element E_j on E_i, not otherwise
   X : Interrelationship between E_i and E_j (otherwise)
   O : Indicate that E_i and E_j has no relationship
4) Construct *Reachability Matrix* (RM); that is change SSIM symbol into biner matrix with rules as follow:
   - If relationship between E_i on E_j = V in SSIM, then element E_{ij} = 1 and E_{ji} = 0 in RM
   - If relationship between E_i on E_j = A in SSIM, then element E_{ij} = 0 and E_{ji} = 1 in RM
   - If relationship between E_i on E_j = X in SSIM, then element E_{ij} = 1 and E_{ji} = 1 in RM
   - If relationship between E_i on E_j = O in SSIM, then element E_{ij} = 0 and E_{ji} = 0 in RM

   The initial RM modified to show all of *direct* and *indirect Reachability*, that is if E_{ij} = 1 and E_{jk} = 1 then E_{ik} = 1.
5) Classify elements in different levels of ISM structure. For this purpose, two devices are associated with each element E_i of the system : Reachability Set (Ri) that is a set of all elements that can be reached from elements Ei, and antecedent set (Ai) that is a set of all elements in which the elements Ei can be reached. In the first iteration of all elements, where $R_i = R_i \cap A_i$, is elements of level 1. In the next iteration, elements identified as level elements in the

previous iteration-iteration are eliminated, and new elements are selected for the next level using the same rules. Furthermore, all elements of the system are grouped into different levels

6) Develop Canonical Matrix by grouping the elements in the same level
7) Develop Diagraph, that is a graph of the elements that are interconnected directly with hierarchy levels. Initial diagraph is prepared in canonical matrix which is further cut by removing all transitive components to form the final diagraph
8) Generate ISM by moving the entire number of elements with description of actual element.

According to Eriyatno (1999), ISM methodologies and techniques are divided into two, namely hierarchy preparation and sub element classification. Sub-element classification refers to the results of Reachability Matrix (RM) which have met transitivity rules to obtain the value of Driver-Power (DP) and the value of Dependence (D). Sub-elements are classified into 4 quadrants, namely :

1) AUTONOMOUS (*weak driver-weak dependent variables*), that is sub element with DP value < 0.5 X and D value <0.5 X where X is the number of sub-elements. Generally, sub-elements in this sector are not associated with the system, and may have low relationship even though the relationship can be strong.
2) DEPENDENT (*weak driver-strongly dependent variables*) that is sub element with DP value $\leq$ 0.5 X and D value > 0.5 X . Sub-elements in this sector is dependent.
3) LINKAGE (*strong driver-strongly dependent variables*) that is sub element with DP value > 0.5 X and D value > 0.5 X. Sub-elements in this sector should be studied carefully because relationship among sub-elements is unstable. Every action on the sub elements will have impact on other sub-elements and the feedback effects can magnify the impact.
4) INDEPENDENT (*strong driver-weak dependent variables*) that is sub element with DP value > 0.5 X and D value <0.5 X. Sub-elements in this sector are the rest of the system and are called as independent variables.

Results and Discussion

According to the Saxena theory 1994 in Eriyatno (1999) were applied in organic rice farming problems, based on the survey and expert opinion, the organic rice farming development program is divided into six elements : (1) Affected community sector, (2) Program requirement, (3) The main constraints, (4) The purpose of the program, (5) Required activity, and (6) Involved institutions in the implementation of the program. Furthermore, each element is broken down into sub-elements and each sub-element is confirmed by experts' opinion. Here are the results of the structural analysis of organic rice farming development program in each subsystem namely input, farming, processing and marketing, and supporting subsystem.

Input Subsystem

1) Element of Affected Community Sector

There are 8 affected communities in input subsystem as can be seen in Table 1.

Table 1 Calculation Result of ISM Method for Input Subsystem on Affected Community Sector

No.	Sub Element of Affected Community Sector	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Farmer	5	8	Linkage	1
E2	Input trader	5	8	Linkage	1
E3	Equipment & machinery trader	5	8	Linkage	1
E4	Breeder	6	1	Independent	2
E5	Farm labor	5	8	Linkage	1
E6	Seed breeder	5	8	Linkage	1
E7	Field Extension Staff (PPL)	7	1	Independent	3
E8	Public figure	6	2	Independent	2

Based on the driver power and dependency value, sub-elements for affected communities can be divided into 4 quadrants, and described in a hierarchical structure as shown in Figure 1 and Figure 2.

Figure 1 Driver Power-Dependence Matrix for Input Subsystem on Affected Community Sector

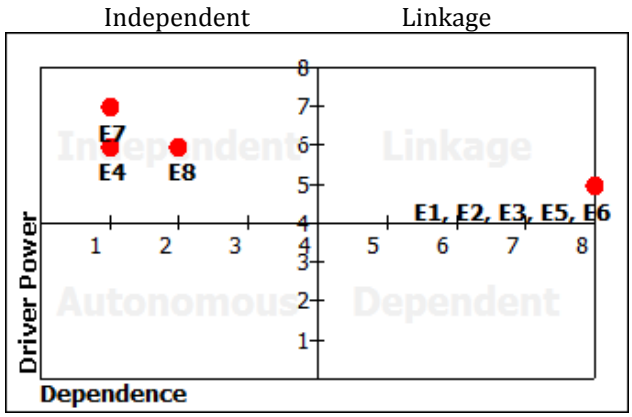
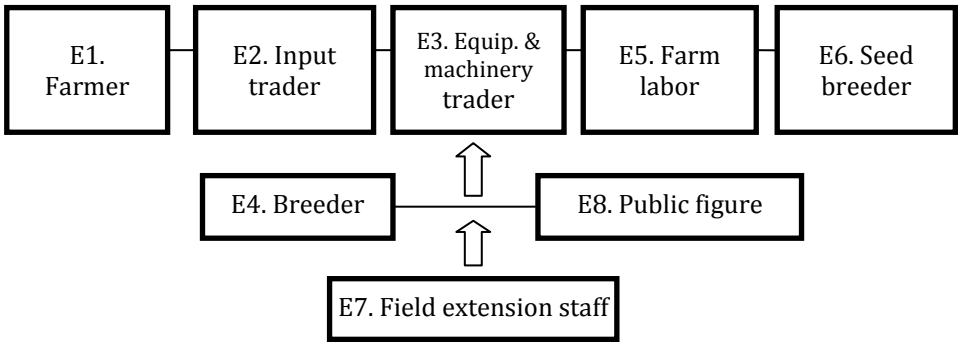


Figure 2 Hierarchical Structure of Input Subsiystem from Affected Community Sector



These results show that the most responsible drivers from the community sector on input subsystem were breeders as providers of organic fertilizer (E4), Field Extension Staff (PPL) to convey information about the use of organic fertilizers (E7) and public figures as role models in the delivery of information and the use of organic fertilizers (E8) which are independent quadrant.

Based on the hierarchical structure, the key element of community sector is field extension staff (E7), meaning that PPL is a stimulus for other sectors to achieve organic rice farming development program.

2) Element of Program Requirement

Elements of program requirement in input subsystem include 8 requirements (Table 2). The most driver requirement in input subsystem are capital to purchase manure because most farmers do not have livestock (E4), the quality of farmer's human resource on awareness of environmental sustainability (E5), farmer groups self sufficiency to produce organic fertilizers (E6) and PPL quality to manage organic input technology (E7).

Based on the hierarchical structure, the key element is the quality of PPL (E7). Improvement of PPL quality will encourage the fulfillment of other requirements for the achievement of organic rice farming development program.

Table 2 Calculation Result of ISM Method for Input Subsystem on Program Requirement Element

No.	Sub Element of Program Requirement	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Organic input	1	8	Dependent	1
E2	Farm equipment & machinery	3	5	Dependent	3
E3	Labor	2	7	Dependent	2
E4	Capital	6	2	Independent	5
E5	Farmer's human resources	6	2	Independent	5
E6	Farmer groups self sufficiency	5	4	Independent	4
E7	PPL quality	8	1	Independent	6
E8	Consistency	3	5	Dependent	3

3) The Main Constraint Element

The input subsystem elements have 6 main constraints (Table 3). The constraints that drive other problems are capital because most farmers have small-sized farms, namely of 0.10 -0.25 ha on average, and around 80% of them are tillers (E2), limited farmer human resources due to lower education (E5) and organic rice farming technology because it requires a relatively high amount of manure (E6).

The hierarchical structure shows that the key element of the main constraint is lack of human resources (HR) (E5). Improvement of human resource quality will be able to overcome other constraints in the development program of organic rice farming.

Table 3 Calculation Result of ISM Method for Input Subsystem on the Main Constraint Element

No.	The Main Constraint Sub Element	Value		Quadrant	L vl
		Driver Power	Depen-dency		
E1	Availability of organic matter	1	5	Dependent	1
E2	Lack of capital	5	2	Independent	4
E3	Labor availability	2	4	Dependent	2
E4	Organic input price	1	4	Dependent	1
E5	Lack of farmer human resources	6	1	Independent	5
E6	Organic farming technology	4	3	Independent	3

4) Element of the Purpose of the Program

There are 6 goals in the element of the purpose of the program (Table 4). The most contributive goal that drives the achievement of other goals are improving soil structure (E1) and preserving ecosystems (E2) due to reactivation of micro-organisms in the soil as a result of the use of organic fertilizers and pesticides.

Table 4 Calculation Result of ISM Method for Input Subsystem on Element of the Purpose of the Program

No.	Sub Element of the Purpose of the Program	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Soil structure improvement	5	1	Independent	4
E2	Preserving ecosystems	4	2	Independent	3
E3	Product health improvement	1	3	Autonomous	1
E4	Reduce production cost	1	5	Dependent	1
E5	Improve farmer self-dependency	3	1	Autonomous	3
E6	Water efficiency	2	4	Dependent	2

According to the hierarchical structure, the key element of the purposes is soil structure improvement (E1). Good soil structure will be able to achieve other purposes in organic rice farming development program.

5) Required Activity Element

There are 10 required activities in the input subsystem (Table 5). The most influential driving forces are extension of the importance of organic inputs use (E5), training on the manufacture of organic inputs (E6), assistance to farmer applying initial organic rice farming (E7), field monitoring to keep farmer using organic inputs (E8) and increasing the number and quality of PPL as farmer advisor (E10).

The hierarchical structure shows that the key element of required activities is increasing the number and quality of PPL (E10) as a driver for other activities to achieve organic rice farming development program.

Table 5 Calculation Result of ISM Method for Input Subsystem on Required Activity Element

No	Sub Element of Required Activity	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Provision of organic production	4	10	Dependent	1
E2	Provision of equipment and machinery	4	10	Dependent	1
E3	Provision of capital	4	10	Dependent	1
E4	Labor procurement	4	10	Dependent	1
E5	Extension	9	3	Independent	5
E6	Training	9	3	Independent	5
E7	Assistance	7	4	Independent	4
E8	Field monitoring	6	5	Independent	3
E9	Farmer group empowerment	5	6	Dependent	2
E10	Improving the number and quality of extension staff	10	1	Independent	6

6) Involved Institution Element

There are 11 involved institutions in the implementation of the program on input subsystem (Table 6). The most influential institutions are research institutions/universities to create organic inputs technology (E4), education and training institutions for technology transfer (E5), the extension services to disseminate information about organic inputs technology (E6), pest and disease institution to prevent and control plant pests and diseases using organic pesticides (E7), bank to assist capital in organic inputs provision (E8) and non-government organizations to improve awareness on the importance to use organic inputs (E9).

The hierarchical structure shows that the key elements are education and training institutions (E5) and non-governmental organizations (E9) which will encourage other institutions to achieve organic rice farming development program.

Table 6 Calculation result of ISM Method for Input Subsystem on Involved Institution Element

No.	Sub Element of Involved Institution	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Local government	5	9	Dependent	3
E2	Agriculture office	5	9	Dependent	3
E3	Livestock office	5	9	Dependent	3
E4	Research institution/university	8	3	Independent	5
E5	Education and training institution	9	1	Independent	6
E6	Extension services	7	5	Autonomous	4
E7	Pest and disease institution	7	5	Independent	4
E8	Banking	6	1	Independent	4
E9	Non-government organization	9	1	Independent	6
E10	Farmer group	2	10	Dependent	2
E11	Organic farmer group	1	11	Dependent	1

Farming Subsystem

1) Element of Affected Community Sector

There are 13 communities of affected community elements in farming subsystem as can be seen in Table 7.

Table 7 Calculation Result of ISM Method for Farming Subsystem on Affected Community Sector

No.	Sub Element of Affected Community Sector	Value		Quadrant	Lvl
		Driver Power	Depen -dency		
E1	Farmer	2	12	Dependent	2
E2	Farm labor	3	2	Autonomous	3
E3	Input trader	5	3	Autonomous	5
E4	Equipment & machinery trader	4	4	Autonomous	4
E5	Seed breeder	3	9	Dependent	3
E6	Breeder	4	2	Autonomous	4
E7	Product trader	3	1	Autonomous	3
E8	Field Extension Staff (PPL)	8	2	Independent	6
E9	Irrigation manager	4	4	Autonomous	4
E10	Pest observer	4	3	Autonomous	4
E11	Researcher	10	1	Independent	7
E12	Consumer	1	13	Dependent	1
E13	Public figure	6	1	Autonomous	5

These results show the most responsible drivers from community sector on farming subsystem are researchers who invented organic rice cultivation technology (E11) and Field Extension Staff (PPL) (E8) that delivered information technology to farmers.

The hierarchical structure shows that the key element of community sector is researchers (E11). The role of researchers in inventing organic rice cultivation technology will encourage other public sectors in organic rice farming development program.

2) Element of Program Requirement

Elements of program requirement in farming subsystem include 12 requirements (Table 8). The main driver requirements in farming subsystem are the awareness and skills of human resources in organic rice cultivation (E2), agricultural equipment and machinery for organic rice cultivation (E4), capital cost to maintain organic farming (E7), government policy on organic rice farming development (E10), government's commitment to provide assistance to farmer (E11) as well as the coordination and support of all relevant agencies (E12).

Based on the hierarchical structure, the key elements of farming subsystem on program requirement element are government policy (E10), the government's commitment (E11) and coordination of relevant agencies (E12) which will encourage the fulfillment of the other requirements for the achievement of organic rice farming development program.

Table 8 Calculation Result of ISM Method for Farming Subsystem on Element of the Program Requirement

No.	Sub Element of the Program Requirement	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Rice field	1	12	Dependent	1
E2	Farmer human resources	9	4	Independent	6
E3	Organic production facilities	6	10	Dependent	3
E4	Agricultural equipment and machinery	7	6	Independent	4
E5	Farm labor	6	10	Dependent	3
E6	Irrigation	2	11	Dependent	2
E7	Capital	8	5	Independent	5
E8	Appropriate technology	6	10	Dependent	3
E9	Farmer group self dependency	6	10	Dependent	3
E10	Government policy	12	3	Independent	7
E11	Government commitment	12	3	Independent	7
E12	Coordination among relevant agencies	12	3	Independent	7

3) The Main Constraint Element

The farming subsystem has 13 main constraints (Table 9). Constraints that drive other problems are limited farmer human resources namely lack of awareness about environmental sustainability and skills (E2), narrow-sized farms (E3), capital constraints (E6), limited assistance due to lack of government commitment (E10), lack of PPL number as assistants (E11) and land conversion because of less profitable rice farm (E13).

Hierarchical structure shows that the key element of the main constraint is lack of government commitment (E10). The government commitment to provide assistance to farmers will be able to overcome other constraints.

Table 9 Calculation Result of ISM Method for Farming Subsystem on the Main Constraint Element

No.	The Main Constraint Sub Element	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Rice field layout	4	7	Dependent	3
E2	Lack of farmer human resources	12	6	Independent	4
E3	Narrow farm size	12	6	Independent	4
E4	Land status	1	7	Dependent	1
E5	Lack of farm labor	1	7	Dependent	1
E6	Lack of capital	12	6	Independent	4
E7	Pest and disease control	1	10	Dependent	1
E8	Irrigation	3	9	Dependent	2
E9	Lack of government support	4	7	Dependent	3
E10	Lack of government commitment	13	1	Independent	5
E11	Lack of assistance staff	12	6	Independent	4
E12	Issues of production decrease	1	10	Dependent	1
E13	Land conversion	12	6	Independent	4

4) Element of the Purpose of the Program

There are 10 goals in the element of the purpose of the program (Table 10). The most contributive purpose that drives to the achievement of other goals are improving soil fertility (E1) and environment sustainability (E4) as a result of improved soil structure with the use of organic fertilizers.

Due to the hierarchical structure, the key element of the goal is improving soil fertility (E1), which becomes the driving force for the achievement of other objectives in organic rice farming development program.

Table 10 Calculation Result of ISM Method for Farming Subsystem on Element of the Purpose of the Program

No.	Sub Element of the Purpose of the Program	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Improving soil fertility	10	1	Independent	4
E2	Increasing production	8	9	Linkage	2
E3	Improving product quality	8	9	Linkage	2
E4	Environment sustainability	9	2	Independent	3
E5	Reduce production cost	8	9	Linkage	2
E6	Improving self dependency	8	9	Linkage	2
E7	Improving farmer's income	8	9	Linkage	2
E8	Improving public health	8	9	Linkage	2
E9	Reducing climate change impact	8	9	Linkage	2
E10	Facing the free market	1	10	Dependent	1

5) Required Activity Element

The farming subsystem contains 10 required activities (Table 11). The most influential driving force is organic rice cultivation training (E2).

Table 11 Calculation Result of ISM Method for Farming Subsystem on Required Activity Element

No.	Sub Element of Required Activity	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Extension	9	8	Linkage	3
E2	Training	10	1	Independent	4
E3	Assistance	9	8	Linkage	3
E4	Input provision	9	8	Linkage	3
E5	Equipment and machinery provision	9	8	Linkage	3
E6	Capital assistance	9	8	Linkage	3
E7	Irrigation water provision and management	2	9	Dependent	2
E8	Pest and disease control	1	10	Dependent	1
E9	Farmer group empowerment	9	8	Linkage	3
E10	Cooperative establishment	9	8	Linkage	3

Based on the hierarchical structure, the key element of activity is training (E2) which will encourage other activities for the achievement of organic rice farming development program.

6) Involved Institution Element

In farming subsystem, there are 13 involved institutions (Table 12). The main drivers are central government to establish organic rice cultivation policy (E1), research institutions/universities to create organic rice cultivation technology (E5), bank to assist capital in organic rice cultivation (E10), education and training institutions of organic rice cultivation (E12) and non-governmental organizations to help spread the organic rice cultivation technology (E13).

Based on the hierarchical structure, the key element of institution is bank (E10). The support of the banking institutions will encourage other institutions to achieve organic rice farming development program.

Table 12 Calculation Result of ISM Method for Farming Subsystem on Involved Institution Element

No.	Sub Element of Involved Institution	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Center government	10	1	Independent	7
E2	Agriculture office	4	8	Dependent	4
E3	Water resources management office	5	5	Autonomous	5
E4	Extension service	3	7	Dependent	3
E5	Research institution/university	10	3	Independent	7
E6	Plant protection agency	6	6	Autonomous	5
E7	Farmer group	2	12	Dependent	2
E8	Cooperative	3	5	Autonomous	3
E9	Organic rice farmer organization	1	13	Dependent	1
E10	Bank	12	1	Independent	9
E11	Village institution	3	9	Dependent	3
E12	Education and training institution	7	5	Independent	6
E13	Non-government organization	11	2	Independent	8

Processing and Marketing Subsystem

1) Element of Affected Community Sector

There are 7 sectors of affected communities on processing and marketing subsystem as can be seen in Table 13.

The main drivers in processing and marketing subsystem are labor for processing and marketing of organic rice (E3) and transportation entrepreneurs of organic rice (E7).

The hierarchical structure shows that the key elements of community sector are labor (E3) and transportation entrepreneurs (E7). The availability of labor and transportation entrepreneurs of organic rice will encourage other public sector for the achievement of organic rice farming development program.

Table 13 Calculation Result of ISM Method for Processing and Marketing Subsystem on Affected Community Sector

No.	Sub Element of Affected Community Sector	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Farmer	5	7	Linkage	1
E2	Rice milling entrepreneur	5	7	Linkage	1
E3	Labor	6	1	Independent	2
E4	Rice trader	5	7	Linkage	1
E5	Consumer	5	7	Linkage	1
E6	Partner entrepreneur	5	7	Linkage	1
E7	Transportation entrepreneur	6	1	Independent	2

2) Element of Program Requirement

Elements of program requirement in processing and marketing subsystem include 8 requirements (Table 14). The main drivers requirement in this subsystem are promotion of organic rice (E2) and public awareness of health to consume organic rice (E7).

Based on the hierarchical structure, the key elements of processing and marketing subsystem are promotion (E2) and public awareness of health (E7) which will drive the fulfillment of the other requirements for the achievement of organic rice farming development program.

Table 14 Calculation Result of ISM Method for Processing and Marketing Subsystem on Program Requirement Element

No.	Sub Element of Program Requirement	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Certification	6	5	Linkage	4
E2	Promotion	7	1	Independent	5
E3	Capital	6	5	Linkage	4
E4	Farmer human resources	2	7	Dependent	2
E5	Market guarantee	3	6	Dependent	3
E6	Marketing facilities	1	8	Dependent	1
E7	Public awareness on health	7	1	Independent	5
E8	Government policy on marketing	6	5	Linkage	4

3) The Main Constraint Element

The processing and marketing subsystem has 9 main constraints (Table 15). Constraints that drive other problems are lack of public awareness on health so that the demand for organic rice is still relatively limited (E2), lack of farmer marketing ability due to lack of skills and capital (E4), lack of equipment and infrastructure for the processing and marketing of organic rice (E5) and famer capital constraints in the marketing (E6).

The hierarchical structure shows that the key element of the main constraint is lack of capital (E6). By overcoming this constraint other constraints to the achievement of organic rice farming development program can be overcome.

Table 15 Calculation Result of ISM Method for Processing and Marketing Subsystem on the Main Constraint Element

No.	Sub Element of Main Constraint	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Low purchasing power	5	7	Linkage	3
E2	Lack of public awareness on health	6	1	Independent	4
E3	Limited consumer trust	2	8	Dependent	2
E4	Lack of farmer marketing ability	6	3	Independent	4
E5	Limited equipment and facilities	7	2	Independent	5
E6	Lack of capital	8	1	Independent	6
E7	Absence of certification	5	7	Linkage	3
E8	Lack of guaranteed market and price	5	7	Linkage	3
E9	Lack of government support	1	9	Dependent	1

4) Element of the Purpose of the Program

The purpose of the program in processing and marketing subsystem consists of 4 goals (Table 16). The most contributive purpose that drives to the achievement of other goals is expanding market because farmers are able to market organic rice to upper middle class society, and even export it (E4).

Table 16 Calculation Result of ISM Method for Processing and Marketing Subsystem on Element of the Purpose of the Program

No.	Sub Element of the Purpose of the Program	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Improving public health	3	4	Linkage	1
E2	Increasing selling price	3	4	Linkage	1
E3	Improving farmer's income	3	4	Linkage	1
E4	Expanding the market	4	1	Independent	2

Due to the hierarchical structure, the key element of the goal is expanding the market (E4), which becomes the driving force for the achievement of other goals in organic rice farming development program.

5) Required Activity Element

The processing and marketing subsystem consists of 11 required activities (Table 17). Activities that become the most influential driving forces are the provision of market information concerning organic rice demand (E2) and the formation of cooperatives for joint marketing of organic rice (E11).

Based on the hierarchical structure, the key elements of activity are the provision of market information (E2) and cooperative establishment (E11) as a driving force for other activities for the achievement of organic rice farming development program.

Table 17 Calculation Result of ISM Method for Processing and Marketing Subsystem on Required Activity Element

No.	Sub Element of Required Activity	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Certification	9	10	Linkage	2
E2	Provision of market information	10	1	Independent	3
E3	Price guarantee	9	10	Linkage	2
E4	Promotion	9	10	Linkage	2
E5	Partnership	9	10	Linkage	2
E6	Monitoring	9	10	Linkage	2
E7	Provision of capital assistance	1	11	Dependent	1
E8	Farmer group empowerment	9	10	Linkage	2
E9	Establishment of organic outlet	9	10	Linkage	2
E10	Fixing transportation facilities	9	10	Linkage	2
E11	Cooperative establishment	10	1	Independent	3

6) Involved Institution Element

There are 10 involved institutions in the implementation of the program on the processing and marketing subsystem (Table 18). The main driver institutions are bank to support farmer capital in marketing (E6) and non-governmental organizations that assist in the marketing of organic rice (E7).

Table 18 Calculation Result of ISM Method for Processing and Marketing Subsystem on Involved Institution Element

No.	Sub Element of Involved Institution	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Agriculture office	5	4	Autonomous	3
E2	Industry and Trade office	5	4	Autonomous	3
E3	Health office	1	7	Dependent	1
E4	Extension service	2	2	Autonomous	2
E5	Organic certification agency	2	7	Dependent	2
E6	Bank	8	1	Independent	5
E7	Non government organization	8	1	Independent	4
E8	Partner	4	4	Autonomous	3
E9	Farmer group	1	9	Dependent	1
E10	Cooperative	5	2	Autonomous	4

Based on the hierarchical structure, the key element of institution is bank (E6). The support of the banking institutions will encourage other institutions to achieve organic rice farming development program.

Supporting Subsystem

1) Element of Affected Community Sector

There are 6 sectors of affected communities on supporting subsystem as can be seen in Table 19. The main driver in supporting subsystem is researcher to invent appropriate organic rice farming technology for the farmers (E6).

Table 19 Calculation Result of ISM Method for Supporting Subsystem on Affected Community Sector

No.	Sub Element of Affected Community Sector	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Health care community	2	5	Dependent	2
E2	Farming contact	1	6	Dependent	1
E3	Field Extension Staff (PPL)	3	2	Autonomous	3
E4	Public figure	3	1	Autonomous	3
E5	Investor	3	1	Autonomous	3
E6	Researcher	4	1	Independent	4

The hierarchical structure shows that the key element of community sector is researcher (E6) as driver for other community sector for the achievement of organic rice farming development program.

2) Element of Program Requirement

Elements of program requirement in supporting subsystem include 5 requirements (Table 20). The main drivers in this subsystem are government's commitment to provide assistance to farmer (E1), banks support to provide capital assistance for farmer (E2), and information about organic rice cultivation technology, capital and markets for organic rice (E4).

Based on the hierarchical structure, the key element of supporting subsystem is information about technology, capital and market (E4) which will drive the fulfillment of the other requirements for the achievement of organic rice farming development program.

Table 20 Calculation Result of ISM Method for Supporting Subsystem on Program Requirement Element

No.	Sub Element of Program Requirement	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Government's commitment	3	2	Independent	2
E2	Bank support	3	2	Independent	2
E3	Certification	1	4	Dependent	1
E4	Information about technology, capital and market	5	1	Independent	3
E5	Facilities (irrigation, marketing, transportation)	1	4	Dependent	1

3) The Main Constraint Element

There are 11 main constraints in the supporting subsystem (Table 21). Constraints that drive other problems are lack of government's commitment to provide assistance (E1), high cost for organic certification (E3), lack of public figure as role models for farmer in organic rice farming (E8), lack of role of universities to contribute directly as farmer advisor (E9) and lack of coordination among agencies because differences in perception and interest in the development of organic rice farming (E11).

The hierarchical structure shows that key element of the main constraint is high cost of certification (E3). By overcoming this obstacle other obstacles to the achievement of organic rice farming development program will be overcome.

Table 21 Calculation Result of ISM Method for Supporting Subsystem on the Main Constraint Element

No.	Sub Element of Main Constraint	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Lack of government's commitment	8	3	Independent	5
E2	Limited facilities	1	5	Autonomous	1
E3	High cost for certification	10	1	Independent	7
E4	Limited market information	3	8	Dependent	2
E5	Financial institution not supported yet	1	10	Dependent	1
E6	Limited number and quality of extension staff	5	6	Dependent	3
E7	Weak farmer group	4	9	Dependent	2
E8	Lack of public figure role	6	1	Independent	4
E9	Lack of university role	7	4	Independent	4
E10	Organic technology has not spread to the PPL and farmer	4	9	Dependent	2
E11	Lack of coordination among agencies	9	2	Independent	6

4) Element of the Purpose of the Program

There are 7 goals in the element of the purpose of the program (Table 22). The most contributive purposes that drive to the achievement of other goals are natural conservation to maintain soil fertility (E1), increased farmer independence for not dependent on chemical fertilizers and pesticides (E2) and improved farm efficiency to save production cost (E3).

Table 22 Calculation Result of ISM Method for Supporting Subsystem on Element of the Purpose of the Program

No.	Sub Element of the Purpose of the Program	Value		Quadrant	Lvl
		Driver Power	Depen-dency		
E1	Natural conservation	7	1	Independent	6
E2	Increasing farmer self dependency	5	2	Independent	5
E3	Increasing efficiency	4	3	Independent	4
E4	Improving farmer's income	3	4	Dependent	3
E5	Improving quality competitiveness	3	2	Autonomous	3
E6	Food security	2	6	Dependent	2
E7	Improving public health	1	7	Dependent	1

According to the hierarchical structure, key element of the purposes is natural conservation (E1), which becomes the driving force for the achievement of other purpose in organic rice farming development program.

5) Required Activity Element

The supporting subsystem contains 12 required activities (Table 23). The most influential driving forces are the preparation of organic rice development program by Department of Agriculture as development priority (E1), coordination

among agencies and institutions to share the same perception and supported by the entire institution (E2) and research on organic rice appropriate technologies for farmer (E3).

The hierarchical structure shows that the key element of required activity is the preparation of organic rice development program (E1) as driver for other activities to the achievement of organic rice farming development program.

Table 23 Calculation Result of ISM Method for Supporting Subsystem on Required Activity Element

No.	Sub Elemen of Required Activity	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Preparation of organic rice development program	12	1	Independent	9
E2	Coordination among agencies and institutions	10	3	Independent	7
E3	Research	11	2	Independent	8
E4	Extension	5	4	Autonomous	5
E5	Training	4	5	Autonomous	4
E6	Assistance	3	6	Autonomous	3
E7	Provision of facilities	6	4	Autonomous	6
E8	Capital assistance	3	7	Dependent	3
E9	Partnership	4	6	Autonomous	4
E10	Promotion	5	5	Autonomous	5
E11	Farmer group empowerment	1	12	Dependent	1
E12	Cooperative establishment	2	11	Dependent	2

6) Involved Institution Element

Table 24 Calculation Result of ISM Method for Supporting Subsystem on Involved Institution Element

No.	Sub Element of Involved Institution	Value		Quadrant	Level
		Driver Power	Depen-dency		
E1	Department of Agriculture	9	9	Linkage	4
E2	Agriculture office	9	9	Linkage	4
E3	Relevant local offices	9	9	Linkage	4
E4	Research institution/university	13	3	Independent	5
E5	Extension service	3	4	Autonomous	3
E6	Education and training institution	13	3	Independent	5
E7	Organic certification institution	9	9	Linkage	4
E8	Financial institution	9	9	Linkage	4
E9	Village institution	3	10	Dependent	3
E10	Non government organization	13	3	Independent	5
E11	Farmer group	1	13	Autonomous	1
E12	Organic rice organization	2	12	Autonomous	2
E13	Cooperative	9	9	Linkage	4

There are 13 involved institutions in the implementation of the program on supporting subsystem (Table 24). The most influential institutions are research

institutions/universities to invent appropriate organic rice technology (E4), educational and training institutions for technology transfer to farmer (E6) and non-governmental organizations to help develop organic rice farming (E10).

Based on the hierarchical structure, the key element institutions are research institutions/universities (E4), education and training institutions (E6) and non-governmental organizations (E10) which will encourage other institutions to achieve organic rice farming development program.

3.5 Structural Model of Organic Rice Farming System

According to the results of structural analysis on organic rice farming system, the structural model of organic rice farming system can be constructed based on the strategic elements of the system (Figure 3).

Conclusions and Recommendations

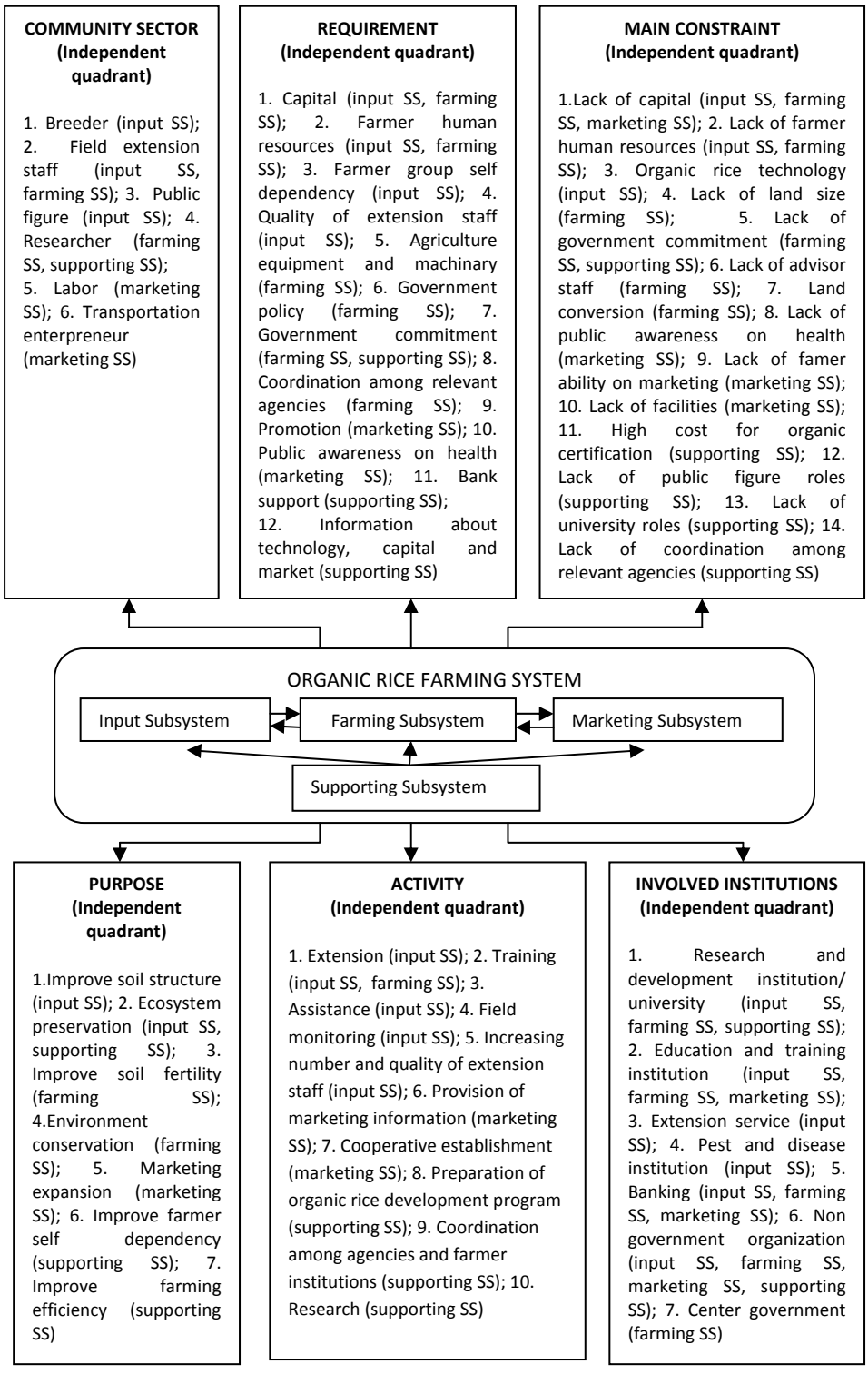
Conclusions

1. The structure of organic rice farming system consists of four subsystems, namely input, farming, processing and marketing, and supporting subsystems. Each subsystem consists of 6 elements namely sector of affected communities, program requirement, main constraint, the purpose of the program, required activities, and involved institutions in the implementation of the program. The structure of organic rice farming system consists of 223 sub-elements namely 30 sub-elements in autonomous quadrant, 70 sub-elements in dependent quadrant, 47 sub-elements in linkage quadrant and 76 sub element in independent quadrant, as well as 32 key elements.
2. In input subsystem, the key elements that drive on each of the elements are field extension staff (PPL); PPL quality; lack of farmer human resources; improve soil structure; increase the number and quality of PPL; education and training institutions as well as non-governmental organizations.
3. In farming subsystem, the key elements as a driver on each element are researcher; government policy, government commitment, coordination of relevant agencies; lack of government commitment; improve soil fertility; training; and banking.
4. In processing and marketing subsystem, the key elements are labor, transportation entrepreneur; promotion, public awareness of health; capital constraints; expand marketing; provision of market information, establishment of cooperatives; bank.
5. In supporting subsystem, the key elements are researcher; information about technology, capital and markets; high cost of certification; natural preservation; preparation of organic rice development programs; research institutions/universities, education and training institutions, and non-governmental organizations.

Recommendations

In order to develop organic rice farming, it is suggested that the government need to make development priorities through strategic elements in the system based on the results of the structural analysis of organic rice farming system (independent quadrant and key elements). The government commitment and coordination among related agencies are needed for all subsystems in organic rice farming in the implementation of organic rice farming development.

Figure 3 Structural Model of Organic Rice Farming System



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