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The Impact of External Factors on the Sustainability of Rice-Livestock Integrated Farming System in West Java: A Household Economic Approach

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Abstract

The objective of this study was to analyze the impact of external factors on the sustainability of rice-livestock integrated farming system. This study also analyzed the factors that affected the household economic behavior. Data was collected from 199 farmers, consisted of 134 Rice-Livestock Integrated Farming System (RLIFS) farmers and 65 non RLIFS farmers. Simultaneous equations model was used to estimate the household economic behavior. The result showed that the household economic behavior of the farmer's production activities was positively affected by several factors such as rice seeds, rice straw, grass, bran, labor, credit, rice and livestock production as well as ricefield area. The consumption expenditure was positively affected by family members, schoolchildren and the total household income. The result also showed that RLIFS farmers were unresponsive to the increase of price such as rice seeds, SP- 36 fertilizer, medications and livestock vitamins as well as wages so that the farmers were relative more sustainable than non RLIFS farmers. Otherwise, RLIFS farmers were responsive to the increase of price such as manure, bran, rice straw, rice as well as livestock so that the farmers were relative more unsustainable than non RLIFS farmers.

Keywords: *Rice-livestock integrated farming system, household economic behavior, sustainability*

1. Introduction

1.1. Background an Issues

The contraction of rice field area requires an agricultural technology that is able to encourage the production increasing without having to increase land area. Intensification of agricultural systems is appropriate to resolve the issue. The problems arise when the use of chemical inputs is disproportionate that causes degradation of soil fertility and declined the income of farmers (Ashby, 2001). Soil fertility improvement requires a systematic and gradual effort in reducing the use of high external input with low external input. One of the efforts in addressing these problems was the implementation of an integrated farming system. Integrated farming system is a system that emphasized the existence of linkages and synergism several units of farming (crops, livestock, fisheries and plantations) through the utilization of farming waste from each unit of farming that aims to increase production (Maudi and Kusnadi, 2011). Integrated farming system is capable of restoring the fertility of the soil and stabilize the incomes of farming (Lightfoot and Minnick, 1991).

Rice-livestock integrated farming system is using the approach of low external input which minimize the use of external input and utilize the available resources in farming enterprise. Rice straw which is waste of rice, used as a livestock feed and livestock droppings that are waste of livestock used as the main material in the production of the manure. Rice-livestock integrated farming system is an environmentally friendly technology and appropriately done for several reasons; (1) support the nature which the integration used the concept of zero waste that minimize waste by recycling process, (2) minimize the use of chemical inputs (Preston, 1990; Mamun *et al*, 2011)

Integrated farming system is one of the farming system that has been developed particularly in the developing countries that the people still rely on agriculture as a source of household income. The implementation of an integrated farming system generally has a positive and negative impact, sustainable and unsustainable. Some research showed the positive impact of integrated farming system and applied in several countries such as Indonesia, Philippine, Thailand, Vietnam, Nigeria, Bangladesh and India. Integrated farming system gave positive impact and was able to increase production and income significantly (Channabasavana *et al*, 2007; Nageswaran, 2009; Jayanthi *et al*, 2009; Ugwumba *et al*, 2010). Integrated farming system gave negative impact which the efficiency of labor and capital usage on the *Minapadi* farming system is lower than the farming of rice monoculture (Dwiyana and Mendoza, 2006). Research by Handayani (2009) showed that the integrated farming system positively impact, but was unsustainable as a rice-cocoa-livestock program at Donggala, Indonesia. This is due to the availability of cocoa rind as the raw material was very low caused by the pests stricken and the difficulty of obtaining probiotics for the making of animal feed (Handayani, 2009). The unsustainable integrated farming system was also found at Majalengka, Indonesia, which there was so difficult to find rice-livestock integrated farming activities (Department of animal husbandry Majalengka, 2013). The research at Zhujian River delta, China suggested that the integrated farming system of sugar cane farming, fisheries, mulberry leaves and silkworm gave negative impact on farmers' profit. The low availability of input was low, causing high production costs so the profit became smaller (Ruddle and Zhong, 1988).

Based on the varying results from integrated farming research in some areas that requires a detailed analysis about what kind of factors that affect rice-livestock integrated farming system in particular the farmers' household economic behavior and then how external factors affect the sustainability of rice-livestock integrated farming system.

The purpose of this study analyzes (1) the factors that affect the household economic behavior of farmers in rice-livestock integrated farming system (2) the impact of external factors on the sustainability of rice-livestock integrated farming system.

1.2. Framework of thought

Integrated farming development is influenced by several factors that are the availability of inputs, carrying waste, fluctuations in market prices and synergistic relationship between farming activities. Integrated farming became one of alternative farming technology primarily due to a decrease in soil fertility, income, fodder policies, the sustainability of long-term production (Russelle *et al*, 2007; Gill *et al*, 2009).

The availability of the input production farming is a factor that affected whether the farmers' rice-livestock integrated farming system can be sustained or not. Sustainability of rice-livestock integrated farming system is affected by a variety of factors from outside the farming or external factors. Sustainability in an integrated farming system can be known from the farming sensitivity to the changes of external factors. External factors include the input and output are related to the farming. Unavailability or lack of input in the farming can be obtained by purchasing from the outside. The availability of input from the outside is affected by the market price that if the demand increased while the availability of input was limited causing the increase of the price. The fluctuations of the input price from outside of the farming affected the structure of expenditures in rice-livestock integrated farming system. The input price increasing lead to farmers should increase expenditure in conducting the activities of farming. Larger expenditure of purchasing the production inputs causes the reducing of integrated farming incentives. The reduced incentives affect the sustainability of rice-livestock integrated farming system. Whether the rice-livestock integrated farming system that is more responsive to the changes of the external factors, it could be said unsustainable farming and so instead.

2. Methodology

2.1. Times of study and Types of Data

Data were collected from May to July 2013. The types of data were cross sectional and time series data, while the data source were primary and secondary data. Primary data were obtained through direct interviews with respondents, whereas secondary data were obtained from the Bureau of Statistics Center (BPS) in West Java, Department of agriculture and animal husbandry, district or sub district as well as the village.

2.2 Research Site

The research conducted in West Java province as one of the provinces that ever implemented rice-livestock integrated farming system development program from Indonesia government. Based on surveys and information from a related department, there were selected three districts consisted of Subang, Sumedang and Tasikmalaya which were representative enough particularly of the characteristics of respondents. The sub-district and village samples were determined using a purposive method based on (1) rice production centers, (2) livestock population centers.

The sample of this study was the Rice-Livestock Integrated Farming System (RLIFS) and non RLIFS farmers. Based on the sampling frame, the sample households were determined using a simple random technique. The number of samples was199 farmers consisted of 134 RLIFS farmers and 65 non RLIFS farmers (Table 1)

2.3. Analysis Methods

The economic model of household behaviour was developed in econometric model in the form of a simultaneous equation system which consisted of 31 equations, i.e. 23 behavioral equations and 8 identity equations. Identification model of simultaneous equations was overidentified criteria, thus estimated by 2SLS (Two Stage Least Square) method. The impact of external factors on the sustainability of rice-livestock integrated farming system was explained by simulation the following scenarios : (1) the price of rice seed, SP-36, medication and vitamins for livestock as well as wages increased by 30% (2) the price of manure, rice straw as well as bran increased by 30% (3) the price rice and livestock increased by 30%.

Table 1. The Distribution of the sample

Districts	Sub Districts	Number of HH Sample	RLIFS Farmers	Non RLIFS Farmers	Total
Subang (Tanjungsiang and Cisalak)	Cikawung	17	55	21	74
	Sindanglaya	5			
	Cimanggu	5			
	Pakuhaji	47			
Sumedang (Tanjungmedar and Tanjungkerta	Sukamukti	6	45	22	67
	Kertamukti	24			
	Awilega	34			
	Kertaharja	3			
Tasikmalaya (Pagerageung and Sukaresik)	Puteran	11	36	22	58
	Tanjungkerta	11			
	Tanjungsari	25			
	Sukaresik	11			
	Sum	199	135	65	199

Source: Primary Data

3. Result and Discussions

3.1. Model Estimation

The Household production in rice-livestock integrated farming system is a function from some inputs that used in farming enterprise both from within and outside of farming. Some production inputs such as rice straw as well as livestock droppings are waste from rice-livestock farming activities and used as inputs for the farming activities in a household so the farming is integrated each other. There were 4 production activities that integrated in the rice-livestock integrated farming system production, which is production of rice, rice straw, livestock as well as manure.

Table 2. Parameters Estimation of RLIFS farmers Household Production Activities

Endogen Variable	Parameter Estimation	t-value	Elasticity	Endogen Variable	Parameter Estimation	t-value	Elasticity
	PRUP				POSA		
Intcp	-0.2729	-1.02		Intcp	-0.5303	-2.03	
JLBP	0.01531	2.37***	0.23	PRJS	0.07011	0.97	0.11
JPUS	0.00022	0.28	0.02	JSRM	0.02478	3.81***	0.81
JTUP	0.00098	2.14***	0.33	JLOT	0.02123	0.49	0.17
JPKA	0.00025	0.7	0.07	JLDK	0.09331	1.58**	0.35
PRPK	0.081	0.93	0.13	KDUS	0.00055	1.4	0.01
KDUP	0.00002	0.62	0.01				
LHAN	2.34731	3.52***	0.31				
R-squared	0.557			R-squared	0.358		
F-stat	22.69			F-stat	14.34		
Prob	0.000			Prob	0.000		
	PRJS				PRPK		
Intcp	0.06355	0.63		Intcp	-0.2657	-0.57	
JPUS	0.00012	0.33	0.003	JTUS	0.00099	3.93***	0.78
PRPK	0.01615	0.55	0.02	POSA	1.3726	6.06***	0.78
PRUP	1.04491	13.92***	0.75				
LHAN	1.93666	5.65***	0.18				
R-squared	0.904			R-squared	0.34		
F-stat	305.34			F-stat	33.86		
Prob	0.000			Prob	0.000		

Source: Primary Data

Note: ******* = sign 5 % ; ****** = sign 10%

The estimation showed that rice production inputs consisted of a number of rice seed, urea and SP-36 fertilizer, labor of rice farming, manure production, manure usage, credit as well as rice field area gave a positive effect overall to rice farming production. A number of inputs such as rice seed, labor of rice farming enterprise and rice field area affected significantly in the rice production (Table 2). Increasing the rice field as well as labor of rice farming enterprise causing the rise of rice production.

The estimation showed that rice production inputs consisted of a number of rice seed, urea and SP-36 fertilizer, labor of rice farming, manure production, manure usage, credit as well as rice field gave a positive effect overall to rice farming production. A number of inputs such as rice seed, labor of rice farming enterprise and rice field area affected significantly in the rice production. Increasing the rice field as well as labor of rice farming enterprise causing the rise of rice production.

Livestock production is a function of some production inputs consists of some fresh rice straw, grass, bran, medications and vitamins, rice straw production, labor of livestock enterprise. The usage of rice straw and grass, the number of credit affected significantly to livestock production. Rice straw is a by product that expected to be one of the major feed requirement fulfillment along with grass. Increasing the amount of rice straw as one of the inputs affected the increase in livestock production, besides the amount of bran and medications and vitamins for livestock.

Rice straw production is a function of the urea and SP-36, fertilizer, manure, rice production and rice field area. Rice straw is a by-product of rice farming. The increase of rice production and the rice field area increased the production of rice straw.

Manure production is a function of labor of livestock enterprise and livestock production. Both of the production inputs that are labor and livestock production gave positive and significant effect on the increasing of manure production. The more livestock production and labor of livestock enterprise causing the increasing of manure production.

The price of rice and the rice field area gave positive and significant effect on the demand of manure. The increase of the rice field area and the price of rice would increase the demand of manure (Table 3). The price of rice gave positive effect and very responsive to the demand of manure. Increasing the prices of rice led the increasing of farmer income, thereby increasing purchasing power to the demand of manure. While the price of manure gave a negative and significant effect on the demand of manure. The demand of manure is very responsive to the price so the changes of price gave major effect on the demand of manure. Decreasing the price 10% were responded by the increasing of manure up to 66%.

Table 3. Parameters Estimation of RLIFS farmers Household Expenditure Activities

Endogen Variable	Parameter Estimation	t-value	Elasticity	Endogen Variable	Parameter Estimation	t-value	Elasticity
	JPKA				PGTR		
Intcp	-14.42	-0.69		Intcp	4232.96	3.36	
HKAN	-0.497	-1.68**	-6.56	JLAK	431.843	1.82**	0.16
HTSP	-0.134	-0.36	-0.94	JLAS	1096.56	2.89***	0.09
HGTP	0.68274	3.29***	7.94	EDUC	132.648	1.00	0.09
KDUP	0.00676	0.33	0.01	PDTR	0.08294	5.4***	0.21
LHAN	570.878	1.77**	0.29				
R-squared	0.116			R-squared	0.273		
F-stat	3.39			F-stat	12.15		
Prob	<0.006			Prob	0.000		

Source: Primary Data

Note: ******* = sign 5 % ; ****** = sign 10%

The number of family members, the number of school children, and the total income of the household gave positive and significant effect on the total household expenditure. The larger the number of family members, the number of school children and the total household income, then the larger the total expenditure of the household.

3.2. The Impact of External Factors to The Sustainability of Rice-Livestock Integrated Farming System

The rice-livestock integrated farming system is the farming which maximizes the usage of farm waste from both rice farming enterprise and livestock enterprise. That farming system in this study was small farming, which managed privately by farmers. Changes of external factors such as the price of input and output affect to the sustainability of rice-livestock integrated farming system. The sustainability can be explained by comparing both of the responsiveness of rice-livestock integrated farming system (RLIFS) and non RLIFS farmers to the rising of some input-output prices.

The raising of input prices such as of seed rice, SP-36, medication and vitamins for livestock as well as wages (scenario 1) gave negative impact on both groups of RLIFS and non RLIFS farmers. It gave larger impact on RLIFS farmers than non RLIFS farmers (Table 4). This indicates that non RLIFS farmers more responsive to the rising of input prices than RLIFS farmers. The raising of input prices such as seed rice, SP-36 fertilizer, medications and vitamins of livestock resulted in a decrease of input demand such as seed rice, SP-36 fertilizer, manure so the changes in price gave impact on the decrease in production and income.

The rising price of input had a significant impact on the use of family labor of the rice farming enterprise. The men labor force had a larger impact than women. This showed that the men labor force of rice farming was more responsive to the rising wage than women. Generally that the more responsive impact suggested that non RLIFS farmers were sensitive to the rising price of input such as seed rice, SP-36, medications and vitamins of livestock as well as wages, so non RLIFS farmers relative unsustainable. The rising of those input prices had a smaller impact on RLIFS farmers than non RLIFS farmers so RLIFS farmers relative sustainable.

The rising price of manure, rice straw and bran (scenario 2) gave negative impact on the rice-livestock integrated farming system production, demand of input, outside men labor force of the rice farming enterprise and income of rice and livestock farming enterprise. The raising of those input prices gave a larger impact on RLIFS farmers than non RLIFS farmers. This indicated that RLIFS farmers were more responsive to the rising price of manure, bran and rice straw. The overall impact was more responsive suggested that RLIFS farmers were sensitive to the rising prices of manure, rice straw and bran so those farmers relative unsustainable than non RLIFS farmers. While the rising price of manure, rice straw and bran provided a smaller impact on non RLIFS farmers so those farmers were assumed to be relative sustainable than RLIFS farmers.

Table 4. Impact of The Rising of Input-Output Prices on the Sustainabityof Rice-Livestock Integrated Farming System

Endogen Variable	Scenario (%)					
	1		2		3	
	RLIFS Farmers	Non RLIFS Farmers	RLIFS Farmers	Non RLIFS Farmers	RLIFS Farmers	Non RLIFS Farmers
PRUP	-11.578	-15.581	-6.534	0.000	27.084	18.535
POSA	-1.065	-1.020	-0.561	-0.018	2.419	1.217
PRJS	-8.925	-11.207	-4.917	0.000	20.380	12.940
PRPK	-0.572	0.000	-0.302	0.000	1.305	0.000
JLBP	-39.936	-44.246	0.000	0.000	46.999	52.622
JLPS	-70.653	-76.967	0.000	0.000	0.000	0.000
JPKA	-18.703	0.000	-64.840	0.000	155.570	0.000
JLJS	-0.148	-0.125	-2.135	-2.087	0.339	0.145
JLOT	-0.475	-0.670	-0.110	-0.090	1.016	0.972
TPDP	8.791	8.994	0.000	0.000	0.000	0.000
TWDP	17.850	17.372	0.000	0.000	0.000	0.000
TPLP	-6.577	-7.248	-3.709	0.000	15.383	8.620
PDUP	-8.497	-10.135	-4.792	0.000	19.876	12.051
PDUS	-0.677	-0.639	-0.357	-0.010	14.396	14.581

Source: Primary Data

Scenario:
1. The price of rice seed, SP-36, medication and vitamins for livestock as well as wages increased by 30%
2. The price of manure, rice straw as well as bran increased by 30%
3 The price rice and livestock increased by 30%.

The rising price of output such as rice and livestock (scenario 3) gave a larger impact on RLIFS farmers than non RLIFS farmers. This indicated that RLIFS farmers were more responsive to the rising price of rice and livestock. In general the more responsive impact could show that RLIFS farmers were sensitive to the changes of output price so RLIFS farmers relative unsustainable.

4. Conclusions and Policy Implications

The conclusions of this study are:

- The decision of the rice-livestock integrated farming system farmer household in the production and expenditure activities was affected by a number of factors on the rice-livestock integrated farming system. Rice production was affected significantly by the amount of rice seed, labor and rice field area. Livestock production was affected significantly by the use of rice straw, grass as well as the amount of bran. Rice straw production was affected significantly by the rice production and rice field area. Manure production was affected significantly by the labor of livestock enterprise and livestock production.

The price of rice and rice field affected significantly on demand of manure. The number of family members, the number of school children, and the total income of the household affected significantly on the total expenditure of household.

- The rising prices of input such as of seed rice, SP-36, medication and vitamins for livestock as well as wages gave negative impact on farmers, but RLIFS farmers were not more responsive than non RLIFS farmers so RLIFS farmers relative sustainable.

The rising price of manure, rice straw and bran gave negative impact on farmers, but RLIFS farmers were more responsive to the rising prices so RLIFS farmers relative unsustainable.

The rising price of output such as rice and livestock gave positive impact on farmers, but RLIFS farmers were more responsive to the rising prices so RLIFS farmers relative unsustainable to the fluctuation of the output price

The policy implications:The Rice-livestock integrated farming system can be one of the alternative Government policies to be developed in the countryside, but need a comprehensive attention related to the impact of external factors that affect the sustainability of the integrated farming system .

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Appendix:

PRUP : Production of rice (ton/ha)
POSA : Production of livestock (animal units/year)
JLBP : The use of rice seed (kg/year)

JPUS : The use of urea and SP-36 fertilizer (kg/year)
JTUP : The use of laborforce in rice farming enterprise (hours/year)
JPKA : The use of manure (kg/year)
PRPK : Production of manure (ton/year)
KDUP : Credit for rice farming enterprise (IDR)
LHAN : Rice field area (Ha)
PRJS : Production of rice straw (ton/ha)
JSRM : The use of rice straw and grass (ton/year)
JLJS : The use of rice straw (ton/year)
JLOT : The use of medications and vitamins (tablet/year)
JLDK : The use of bran (ku/year)
TPDP : The use of family men labor force in rice farming enterprise (hours/year)
TWDP : The use of family women labor force in rice farming enterprise (hours/year)
TPLP : The use of men labor force from outside in rice farming enterprise (hours/year)
PDUP : Income of rice farming enterprise (IDR)
PDUS : Income of livestock enterprise (IDR)
KDUS : Credit for livestock enterprise (IDR)
JTUS : The use of labor force in livestock enterprise (hours/year)
HKAN : The price of manure (IDR)
HTSP : The price of SP-36 fertilizer (IDR)
HGTP : The price of rice (IDR)
PGTR : Total household expenditure (IDR)
JLAK : The number of family members (person)
JLAS : The number of school children (person)
EDUC : Education (year)
PDTR : Total household income (IDR)