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Center of Excellence for Food Safety Research (CEFSR)
Faculty of Food Science and Technology,
Universiti Putra Malaysia (UPM)

SELAMAT sustainable network (SS-NW)

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PREFACE

Proceedings of the International Conference on Food Safety and Security under Changing Climate 2010 (FCC2010) are the compilation of papers presented at FCC2010 on December 6 – 7, 2010, at Parkroyal Hotel, Penang, Malaysia. The keynote speaker and invited speakers have enriched us with the latest issue and development in global climate change. There are 64 local and oversea presenters from various universities, institutions and industry players, they came to FCC2010 to share their findings and experience.

Objectives of this conference are to provide a platform for learning and discussion among local and foreign researchers on policies, issues, prospects, strategies and other relevant activities, to create awareness among the citizens of the Earth about the global climate change and also to enhance efforts in reducing the impact of destruction to the Earth especially those affecting the food safety and security.

We would like to thank all presenters who have contributed their papers in these proceedings. It is hoped these proceedings will benefit the food industry stakeholders from all around the world.

We would like to inform that all the papers are camera ready from the authors.

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FCC2010

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CHEMICAL USE IN TIDAL LOWLAND AGRICULTURE

Muhammad Yazid*[1], Mad Nasir Shamsudin[2], Khalid Abdul Rahim[3],

Alias Radam[3], Azizi Muda[4]

[1]Faculty of Agriculture, Sriwijaya University, Indralaya, South Sumatra, Indonesia.

Email: yazid_ppmal@yahoo.com

[2]Faculty of Environmental Studies, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[3]Faculty of Economics and Management, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[4]Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak, Malaysia

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Despite continuing debates over the use of chemicals in agriculture, the use of pesticides in food crop production in tidal lowlands has been unavoidable partly due to the uncertainty caused by climate change. The reason behind this is to maintain current productivity and to prevent loss due to pest and disease threats caused by a shift in planting season. A survey has been conducted to study the cost (including environmental cost) of chemical use in rice production in tidal lowland. A random sample of 500 farm-households was drawn to prove whether the use of chemicals has an economic support. The result indicates that the use of chemical has significant effect on rice production. However, chemical use has caused externality and the cost required to recover this externality is higher than the external cost itself. Therefore, reducing the use of chemicals would possibly be a choice for rational farmers.

Keywords: chemicals, agriculture, tidal lowland

INTRODUCTION

Tidal lowland development in Indonesia aimed at supporting transmigration program and increasing rice production to compensate the conversion of irrigated farm land in Java (Suprianto et al., 2009; Schultz et al., 2005; Suriadikarta et al., 2001). Farm land conversion to non-agriculture was estimated 40,000 to 50,000 ha per year. In order to maintain current level of rice production, each ha lost of irrigated farm land must be replaced by more than 3 ha upland or rain-fed lowland.

Tidal lowland development was carried out through reclamation. Reclamation of lowlands in Sumatra has reached 692,000 ha, of which 373,000 ha is located in South Sumatra Province (Directorate of Lowland and Coasts, 2007). In spite of this large reclaimed area, its utilization for agriculture production is considered low. In addition, its productivity is yet considered lower than that of irrigated areas (Simatupang and Rusastra, 2003). This is due to the limited knowledge and information regarding agro-physical and chemical characteristics of tidal soil as well as the implementation of water management strategy on tidal lowlands.

The objective to increase rice production in tidal lowlands was restated after severe droughts in 1991, 1994, and 1997 which resulted in import of rice up to 4.5 million tons in each of these years. The objective to increase rice production by pushing up the productivity of rice in tidal lowlands was adopted as the objective of tidal lowland development which previously was focused on transmigration. Further development in tidal lowlands is aimed at increasing productive capacity of tidal lowlands to accommodate recent development in agriculture technology, including the introduction of new varieties, use of equipments, fertilizers, and pesticides, and improvement of water management. Recent climate change that shifts planting season has increased the risk of pest and disease threats and confirmed the use of chemicals.

As a result, about 30 percent of the area suitable for rice has reached the productivity above 5 tons per ha. In addition, 10 percent of the area can be cultivated twice to three times a year. However, the negative impact of modern input use has emerged. As a consequence of chemical use, canal water which was previously used for various domestic needs is no longer safe, raising externality among farmers themselves.

The objective of this study was to examine the chemical use in food crop production in tidal lowlands and to consider the cost (including environmental cost) of chemical use in rice cultivation. This study is expected to provide inputs for reconsidering chemical use in tidal lowland rice production.

METHODS

This study was carried out in Telang, a rice production center in tidal lowland area of South Sumatra, through a survey. This deltaic area is administratively located in Sub-district Muara Telang, District Banyuasin, South Sumatra Province. This area was selected as research area since it was among the most productive reclaimed tidal lowland areas due to the use of modern inputs (high-yielding varieties, chemicals) and supported by relatively better water management system.

Research sample of 500 farm households were randomly drawn from some 10,000 farm households, covering 12 secondary blocks of approximately 3,072 ha. Data were collected through field observation and structured interview with the farmers.

Data were mostly quantitative in nature. Therefore, data analysis was carried out using some statistical tools. The effect of chemical use on rice production was analyzed using linear regression based on a Cobb-Douglas production function (Hair et al., 2010; Coelli, 1995) as the following:

$$\ln Y_i = \beta_0 + \beta_1 \ln SEED + \beta_2 \ln CHEM + \beta_3 \ln FERT + \beta_4 \ln LABOR + \beta_5 D_{ws} + \varepsilon_i \qquad (1)$$

where Y_i = total rice production in tons

SEED = seed used in kg

CHEM = chemical used in Rupiah

FERT = fertilizers used in Rupiah

LABOR = labor used in man days

D_{ws} = dummy variable water service for 1 = with water service 0 = without

RESULTS AND DISCUSSION

As a primary process, rice cultivation employs primary inputs such as seed, fertilizers of several kinds, some types of pesticides, labor and some basic equipments. Three kinds of fertilizers are used, namely Nitrogen, Phosphorous, and Potassium fertilizer. The first two were recommended, whereas the third was used according to particular need. Pesticide consisted of three types, namely herbicides, insecticides, and fungicides. The following result described the cost of rice cultivation (including chemical cost), production, and productivity of rice.

The costs of rice cultivation were presented in Table 1. These costs were estimated based on per hectare rice cultivation in the first planting season. The cost of each input was derived from the whole research sample based on its average value (mean). The cost of pesticides accounts for 10.57 percent of the total cost, excluding the labor cost of pesticide application. Among three types of pesticide, the cost of herbicide was the highest and accounted for 65.76 percent of total pesticide cost. Herbicides were used during pre and post planting to control weed.

Table 1. Cost of rice cultivation per hectare in the study area

Inputs	Types of Inputs	Unit	Volume	Unit Cost (Rp)	Total Cost (Rp)
Seed	Rice seed	Kg	63.5	6,000	381,000
Pesticides	Herbicides[1]	n.a	n.a	n.a	344,770
	Insecticides[1]	n.a	n.a	n.a	72,480
	Fungicides[1]	n.a	n.a	n.a	107,000
Fertilizers	Nitrogen	Kg	220	1,300	286,000
	Phosphorus	Kg	121	2,300	278,300
	Potassium[2]	Kg	n.a	n.a	13,910
Labor	Land preparation	Man day	10	50,000	500,000
	Planting	Man day	4.5	50,000	225,000
	Fertilizing	Man day	2	50,000	100,000
	Controlling	Man day	2	50,000	100,000
	Harvesting[3]	Man day	51	50,000	2,550,000
Total					4,958,460

[1]Various types with various unit (l, ml, kg, gram) such that only total cost was applied.

[2]Only few samples used this type of fertilizer such that average volume was not relevant.

[3] Consists of harvesting and threshing. Harvesting cost was in shared product with the ratio 1:7 (12.5% for labor, 87.5% for owner). Threshing cost was Rp 50 per Kg output. All of these expenses were made equivalent to man day.

n.a not applicable

Production is the output of farming activities as the result of employing several inputs such as seed, pesticides, fertilizers and labor. The amount of production depends on the acreage of the cultivation such that it varies among farmers with different land holding. In order to measure a standard output of farming activities, a measure of productivity is employed. Besides its independency on the use of inputs, measure of productivity uses cultivation acreage as a reference. Therefore, productivity refers to the output per unit land cultivated. In the study area, reference for the acreage of cultivation is hectare.

Analysis on the data on rice production among respondents of this research indicated that rice production varied from as low as 1.5 tons to as high as 79.2 tons of on-farm dried paddy due to the variation in area cultivated from as low as 0.25 hectare to as high as 12 hectares. The average production was 9.75 tons (standard deviation = 5.70 tons) and the average cultivation area was 1.84 hectares (standard deviation = 0.99 hectare). Whilst, the average productivity was 5.35 tons per hectare on-farm dried paddy (standard deviation = 0.88 ton).

Rice production is a function of several input factors such as seed, chemicals (herbicides, insecticides, and fungicides), fertilizers (Nitrogen, Phosphorous and Potassium fertilizers), and labor for various activities during the whole process of rice cultivation starting from land preparation, planting, fertilizer application, pests and diseases control until harvesting. In order to estimate the effect of these variables including the effect of chemical used, a regression analysis was performed with all of the independent variables considered in the model.

Cobb-Douglas production function was estimated using multiple regression analysis. This model was robust based on the R^2 statistics. Model fit analysis for the Cobb-Douglas production function indicated that the overall model was statistically significant at 95 percent confidence interval.

Analysis on the effect of each of the independent variable was performed using t-test and the results of the analysis were presented in Table 2. Among all of the independent variables assumed to affect rice production, all but seed have significant effect on the dependent variable.

All coefficients were positive as expected. The coefficient of chemicals was positive and significant. Chemicals consist of herbicides, insecticides, and fungicides. Herbicides were used during land preparation as pre-planting weeding and during growth stage as post-planting weeding. Insecticides were used incidentally according to the existence and intensity of insect attacks. Fungicides were used to control fungus and to enhance growth. These three types of chemicals have been consistently used by farmers in the study area and became part of farming practices regardless their effects on the environment. As indicated by its coefficient, one unit increase in chemical used associated with 0.034 unit increase in rice production. The effect of chemicals on rice production was proved to be statistically significant.

Table 2. Regression coefficients and the value of t-test statistics

Variables	Coefficients	Std. Error	t	Sig.
(Constant)	-3.910	.212	-18.449	.000
Seed	.023	.026	.901	.368
Chemicals	.034	.018	1.828	.068*
Fertilizer	.128	.026	5.030	.000***
Labor	.782	.028	28.374	.000***
Water service (dummy variable: 0 = without; 1 = with)	.040	.013	3.026	.003***

Dependent variable was total rice production.

All variables were in logarithmic, except water service.

R Square = 0.936; F-test = 57.083; Sig. of F-test = 0.000

*Significant at 10% **Significant at 5%; ***Significant at 1%

The environmental impact of chemical use in rice production was observed through its impact on canal water. Being the main domestic water source, visible change in canal water has shifted household need for drinking water to bottled water. Therefore, environmental cost of chemical use was estimated using avoidance cost. In this case, avoidance cost was the cost of bottled water purchased to avoid contaminated canal water during cultivation period which was Rp 11,520,000 per secondary block of 256 ha (one water management unit).

Based on the above calculation, the external cost of chemical use was estimated to be Rp 45,000 per ha. Assuming farmers were responsible for this external cost according to polluters pay principle, this cost was expected to be recovered through the increase in production. Taking the local price of Rp 2,250 per kg on-farm dried paddy, the required increase in production was equivalent with 20 kg on-farm dried paddy per ha. This was also equivalent to 0.37 percent increase in productivity, considering the average productivity was 5.35 tons per ha.

Based on the value of elasticity, 0.37 percent change in production was associated with 10.88 percent change in chemical use. Since the average cost of chemical use was Rp 524,250 per ha, the required change in chemical cost was Rp 57,038. Therefore, to recover the external cost of Rp 45,000 per ha requires Rp 57,000 additional cost of chemical per ha. This meant that the cost to recover the external cost of chemical use was higher than the externality itself. As such, reducing the use of chemical would possibly be a choice of rational farmers.

CONCLUSION

It can be concluded from the study that

1. The use of chemical was currently unavoidable in tidal lowland rice cultivation due to present threat of pests and diseases and the increasing risk of pest and disease attacks due to the shift in planting season caused by climate change.

2. Despite undervaluing the economic cost of chemical contamination in canal water, the use of avoidance cost is considered the most tangible since majority of farm households experienced this impact in tidal lowlands.

3. The use of chemicals, especially herbicide, should be reduced and replaced by mechanical practice to control weed during pre and post planting.

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Chemical Use in Tidal Lowland Agriculture

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Introduction

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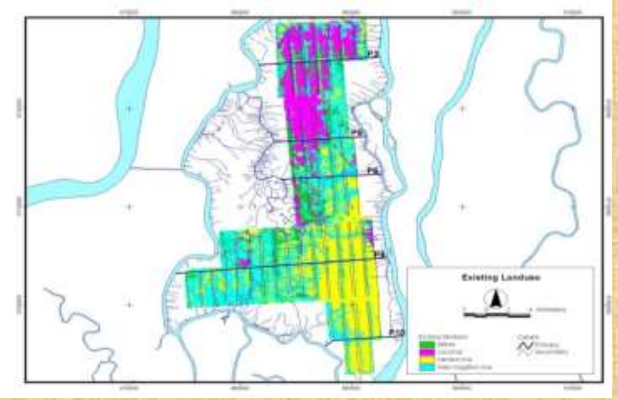

Methodology

- This study was carried out in Telang, a rice production center in tidal lowland area of South Sumatra, through a survey.
- Research sample of 500 farm households were randomly drawn from some 10,000 farm households, covering 12 secondary blocks (approximately 3,072 ha).
- Data were collected through field observation and structured interview.
- The effect of chemical use on rice production was analyzed using linear regression based on a Cobb-Douglas production function (Hair et al., 2010; Coelli, 1995) as the following:

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where *Yi* = total rice production in tons
SEED = seed used in kg
CHEM = chemical used in Rupiah
FERT = fertilizers used in Rupiah
LABOR = labor used in man days
Dws = dummy variable for 0 = without and 1 = with water service

Results and Discussion

- The costs of rice cultivation were estimated based on per hectare rice cultivation in the first planting season (Table 1). The cost of pesticides accounts for 10.57 percent of the total cost. Among three types of pesticide, the cost of herbicide was the highest and accounted for 65.76 percent of total pesticide cost.

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- The average productivity was 5.35 tons per hectare on-farm dried paddy (standard deviation = 0.88 ton).

- Results of multiple regression analyses were presented in Table 2. The Cobb-Douglas model was robust based on the R2 statistics (Gujarati, 2003) and the overall model was statistically significant at 95 percent confidence interval.

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- All coefficients are positive as expected. The coefficient of chemicals is positive and significant.
- As indicated by its coefficient, one unit increase in chemical used associated with 0.034 unit increase in rice production.
- Environmental cost of chemical use was estimated using avoidance cost (the cost of bottled water purchased to avoid contaminated canal water) which was Rp 11,520,000 per secondary block or Rp 45,000 per ha.
- This cost was expected to be recovered through the increase in production of 20 kg on-farm dried paddy per ha, assuming the price of Rp 2,250 per kg.
- This was equivalent to 0.37 percent increase in productivity, considering the average productivity was 5.35 tons per ha.
- Based on the value of elasticity, 0.37 percent change in production was associated with 10.88 percent change in chemical use. Since the average cost of chemical use was Rp 524,250 per ha, the required change in chemical cost was Rp 57,038.
- Therefore, to recover the external cost of Rp 45,000 per ha requires Rp 57,000 additional cost of chemical per ha. This meant that the cost to recover the external cost of chemical use was higher than the externality itself.

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