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ANALYSIS OF INCOME AND FACTORS DETERMINING THE ADOPTION OF INTEGRATED RICE-FISH FARMING SYSTEM IN SEYEGAN DISTRICT, SLEMAN REGENCY, YOGYAKARTA, INDONESIA

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ABSTRACT

Integrated rice-fish farming is a potential alternative farming to increase farmers' income in overcoming increasingly competitive land use. Rice-fish farming has been applied in Margoluwih Village, Seyegan District, Sleman Regency, Yogyakarta Province for a few years. This study aims to analyze the use of inputs and production costs in rice-fish (*minapadi*) farming compared to monoculture rice farming, to estimate the income of rice-fish farming and monoculture rice farming, and to identify factors that influence farmers' decision in adopting the integrated rice-fish farming. The study was conducted at Margoluwih Village, Sayegan District, Sleman Regency, Yogyakarta in March 2017. A total of 50 farmers were surveyed, comprising of 25 rice-fish farmers and 25 monoculture rice farmers. The methods used to achieve these objectives are descriptive analysis, income analysis, and logistic regression analysis. The results show that rice-fish farming requires inputs such as fish seeds, fish feed, prebiotics, and molasses of sugarcane while monoculture farming does not require such inputs, but monoculture farming uses pesticides and herbicides to overcome pest attacks and applies more chemical fertilizers than rice-fish farming. The labor time devoted to rice-fish farming is also higher than in monoculture farming. The total cost of rice-fish farming per hectare in one production season is Rp 63.47 million, while the total cost of monoculture rice farming amounted to Rp 17.55 million. However, rice-fish farming significantly earn more income compared to monoculture farming with an average value of Rp 28.45 and Rp 3.19 million per hectare in one growing season, respectively. Income is believed to be the main factor in determining the adoption, while social factors that influence farmer's decision to adopt rice-fish farming are age of farmer and experience of rice cultivation.

Key words: monoculture rice farming, *minapadi, jajar legowo*, farm income, logistic regression

INTRODUCTION

Demand for rice and fish is increasing overtime due to high population growth, economic development and urbanization. On the other hand, the supply is threatened because of the conversion of agricultural land, climate change and the environmental impact of overuse of fertilizer and pesticides during the green revolution period (Islam, 2016). Thus, there is an urgent need for a sustainable option which can produce rice and fish in a sustainable manner. Integrated rice-fish farming system (IRFFS) seems to be such an option, producing more rice and fish with less use of land and water in a sustainable way. IRFFS has been practiced in many countries, particularly in Asia. In China, rice-fish culture has been practiced for at least 1,700 years (Cai et al. 1995) and is listed by the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) as one of the Globally Important

Ingenious Agricultural Heritage Systems (GIAHS) in 2005, owing to its long history and diversified patterns and techniques (Halwart and Gupta, 2004).

Saikia and Das (2008) and Halwart (1998) reported that presently, the rice-fish system is being practiced in Bangladesh, Cambodia, China, Egypt, Indonesia, Republic of Korea, Madagascar, Thailand and Vietnam. The practice supports a large share of the rural population in South, Southeast and East Asia and in parts of West Africa. In these places, rain-fed rice fields are designed to store water for extended periods, creating aquatic ecosystems with many similarities to natural floodplains (Heckman, 1979). These floodplain habitats of rice are later stocked by fish and grown throughout the wet season. Fishing from these rice-based farming systems is often carried out on regular, occasional or part-time basis, making a significant contribution to livelihoods of poor farmers. Rice-fish farming is a low-cost sustainable practice to obtain high value protein food and minerals (Saikia and Das, 2008). At the farm level rice-fish integration reduces use of fertilizer, pesticides and herbicides in the field. Such reduction of costs lowers farmer's economic load and increases their additional income from fish sale. With such savings and additional income, the net productivity from rice-fish farming are reported to be higher than monoculture rice farming (hereinafter referred to as monocrop). Halwart (1998) reported that from the practice of fish culture in rice-field with a total gain from savings of pesticides and earning from fish sales, the net income that a farmer obtains up to 65% higher than monocrop. On the contrary, the rice-fish culture increases the yield of rice (up to 25-30%) besides providing extra income to farmers. In addition, Newton (2002) argued that rice-fish integration is an important area for farmers who are marginalized, cultivate under difficult conditions and find the cost of pesticides and fertilizer financially burdensome.

Halwart and Gupta (2004) reported that IRFFS has been recognized globally in helping combat malnutrition and poverty. However, IRFFS has not been fully explored in many countries. Islam (2016) reported that though the potentiality of this technology has been widely documented, rice-fish farming systems are still not widespread in Bangladesh. The same condition also occurs in Indonesia. IRFSS in Indonesia is known as *minapadi* farming system (*mina* means fish and *padi* means rice). The prospect of developing *minapadi* in Indonesia is actually very large, since the *minapadi* system is currently only 142,122 hectares or about 1 percent of the total area of paddy fields in Indonesia. The *minapadi* system is believed to be an effective way to improve welfare and realize food sovereignty. The rice plant production is more qualified because it allows the creation of environmentally friendly organic farming and healthier products for consumption. The *minapadi* system will also increase fish production which in 2016 is targeted to reach 19.5 million tons[1].

Special Territory (Province) of Yogyakarta is one of the provinces that has developed the *minapadi* farming, with Sleman Regency as one of its development centers. At present, around 17 districts in Sleman Regency have developed this *minapadi* farming. Until 2018, it is estimated that the *minapadi* farming area has reached 128 hectares, while the potential land area suitable for the development of *minapadi* reaches 2,000 hectares[2.] The areas targeted for development were *dusun* (hamlet) Cibluk Kidul, Margoluwih Village, Seyegan District at the Sleman Regency. The paddy-field pilot rice yields an increase in rice harvest from an average of 6.5 tons/ha to 9.3 tons/ha with better quality rice, so farmers can sell it as 'healthy rice'. In addition, the sale of fish can also reach around

1 M Fajar Marta, "Sistem Mina Padi Indonesia Ditiru Negara lain", https://ekonomi.kompas.com/read/2016/09/28/150259426/sistem.mina.padi.indonesia.ditiru.negara.lain. (accessed at Febryary 5, 2019).

2 Gaya Lufityanti. Tribunjogja 11 Januari 2018. "Tahun 2018 Ini, Luas Minapadi di Sleman Ditargetkan Bertambah 20 Hektare", http://jogja.tribunnews.com/2018/01/11/tahun-2018-ini-luas-minapadi-di-sleman-ditargetkan-bertambah-20-hektare.

Rp 42 million/hectare/season[3]. The innovation of *minapadi* uses an 'ecosystem approach' through zero pesticides, and significantly reduces the level of use of chemical fertilizers. Besides that, *minapadi's* farming benefits rural life through passionate economic activities, and improves access to nutritious food. Lantarsih (2016) and Fausayana and Rosmarlinasiah (2008) argued that farming with the *minapadi* system as a form of intercropping of fish in rice fields together with rice cultivation is a cultivation technology capable of contributing positive for rice farmers, namely in increasing land productivity and rice production, also can increase farmers' income. Margoluwih Village is one of the areas in Sleman Regency that applies the *minapadi* farming system. According to the Department of Agriculture, Fisheries and Forestry of Sleman Regency (2016) the development of deep pond *minapadi* cultivation in Margoluwih Village is aimed at increasing land productivity, optimizing land use, increasing farmers' income, improving the quality of community nutrition, and achieving rice and fish production that can meet community's food needs.

Minapadi farming uses different inputs than monocrop, because in addition to inputs in the rice production process, *minapadi* farming also requires inputs in the fish production process. Farmers who implement *minapadi* farming will obtain greater revenues compared to the ones of farmers who do monocrop. However, *minapadi* farmers have to spend more production expenses (Rabbani *et al*., 2004; Dwiyana and Mendoza, 2006). The development of *minapadi* farming is a technological innovation of rice farming in a monoculture system to increase farmers' income in using paddy fields, not only because the amount of income received by farmers is even greater, but farming is also more beneficial for farmers when faced with conditions of rice harvest failure, because farmers still get profits from the production of fish in his rice fields (Frei and Becker, 2005; Nnaji et al. 2013; Siregar, 2015). Bosma et al. (2012) in their study showed that the factors that influence farmers' decisions to adopt *minapadi* farming are conditions of irrigated land, access to capital assistance, and knowledge and experience of rice and fish cultivation. Bambang (2003) says that income is the main factor that influences farmers' decisions to do *minapadi* farming.

The above issues give major motivation to properly assessing the potential socio-economic benefit of this *minapadi* system compared to monocrop, as well to identifying the factors which facilitate and hinder rice-fish technology adoption. The specific objectives of this paper are as follows: (1) to identify and estimate the use of inputs and production costs of *minapadi* farming compared to monocrop; (2) to estimate and compare the incomes from the two farming systems; and (3) to identify the factors that affecting the farmers in adopting *minapadi* farming.

RESEARCH METHODOLOGY

Location and time of research. This research was conducted in Margoluwih Village, Seyegan District, Sleman Regency, Yogyakarta. The location of this study was purposively chosen by considering that Seyegan District was a region that had the potential to develop *minapadi* farming in Sleman Regency, and Margoluwih Village was one of the villages that pioneered the commencement of *minapadi* farming in Seyegan District. The survey was conducted in March 2017.

Types and data sources. This study uses both types of data, primary data and secondary data. Primary data is obtained through observation and interviews using questionnaires to respondents who are the object of research, namely farmers who do *minapadi* farming and farmers who carry out monoculture rice (monocrop) farming in Margoluwih Village. Secondary data is supporting data obtained from the Central Statistic Agency, the Agriculture, Fisheries and Forestry Service of Sleman

3 Republika Online, Selasa 24 Jan 2017, "Menengok Mina Padi di Sleman yang Jadi Percontohan Asia Pasifik",https://www.republika.co.id/berita/ekonomi/makro/17/01/24/ok9qzu368-menengok-mina-padi-di-sleman-yang-jadi-percontohan-asia-pasifik

Regency, other agencies related to this research, and using information from various literature reviews. Respondents in this study were farmers who run *minapadi* and monocrop farmings in Margoluwih Village. The number of respondent sampled in this study were 50 farmers, consisting of 25 *minapadi* farmers and 25 monocrop farmers. The method of collecting respondents' data in this study was carried out by the method of total sampling (census) for *minapadi* farmer respondents, because the availability of *minapadi* farmers in the village is only 25 farmers (and they are members of a farmer group who sought the *minapadi* business), while monocrop farmers were carried out by simple random sampling method with a comparable number from about 400 farmers in the village.

Descriptive analysis. Descriptive method is a method used to obtain an overview in analyzing the use of inputs and costs on *minapadi* and monocrop farmings. The results of this analysis are presented based on existing information regarding the use of inputs and the results of cost calculations on *minapadi* farming as well as on monocrop farming.

Farm income analysis. Analysis of farm income is done to compare the income of the *minapadi* and monocrop farmings. Farm income consists of income on cash costs (cash income) and income on total costs (net income). Cash cost is a cost that must be spent directly by the farmer to pay the inputs used. Cash income is the difference between total revenue and total cash costs, while net income is the difference between total revenues and total production costs, including the costs of farmers' inputs used in the production process whose value is used with imputed costs. The components of cash costs in this study consisted of the costs of rice seed, fish seedling, fish feed, prebiotic, sugarcane molases, urea fertilizer, NPK fertilizer, SP-36 fertilizer, phonska fertilizer, organic fertilizer, manure, pesticides, herbicides, irrigation costs, tractor rental fees, land rental fees, land taxes, membership fees, compulsory savings for cooperative members, and costs of non-family labors. The calculated (imputed) costs consist of costs of using family labor and depreciation of farm equipments. The paired samples t test is used to determine whether the incomes from the two farming systems (*minapadi* and monocrop) are significantly different from zero.

Logistic regression analysis. Logistic regression model is used in estimating the factors that influence farmers in making decisions to adopt *minapadi* farming. The model was analyzed using *Stata 15.1* software. The selection of variables for logistic function estimation is based on previous research. The analytical model used to identify the factors that influence farmers in adopting *minapadi* farming is as follows (Pindyck and Rubinfeld 1991, Agresti 2002):

$$ln\left(\frac{P_i}{1-P_i}\right) = Z_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon_i$$

where: P_i = individual farmer's opportunity to adopt *minapadi* farming system; ($1-P_i$) = individual farmer's opportunity to make a decision on non-adopting of *minapadi* farming (i.e., implementing monocrop); Z_i = individual farmer's decision to adopt *minapadi* farming, α = intersept, β_i = regression coefficient parameter for X_i; X_1 = formal education level (year); X_2 = area of farm land (m^2); X_3 = farmer's age (year); X_4 = number of family dependents (person); X_5 = farmer's experience in doing rice cultivation (year); X_6 = distance of paddy fields from water sources (meter); and ε_i = error term.

RESULTS AND DISCUSSION

Input and output of *minapadi* and monocrop farmings.

This section explains the differences in the average input used between *minapadi* farming and monoculture rice farming, as well as comparisons of costs incurred by farmers to implement both types of farming. The total cost is summation of cash costs and imputed costs. *Minapadi* farming uses a different input variable from monoculture rice farming, because in addition to the inputs for rice production process, *minapadi* farming requires other kind of inputs, particularly fish seeds and fish feed, and requires more labor than the monocrop. The difference in the average use of inputs and production costs for *minapadi* and monocrop farming is shown in Table 1.

Table 1. Average input use and cost of production for *minapadi* and monoculture rice farming

Input use	*Minapadi*		Monocrop		Average Price (Rp/unit)
	Input	Cost	Input	Cost	
Cash cost					
Rice seed (kg/ha)	54.4	553,600	41.6	427,600	10,220
Fish seedling (kg/ha)	706.0	19,688,000	0.0	-	27,840
Fish feed (kg/ha)	2190.0	20,373,600	0.0	-	9,307
Prebiotic (liter/ha)	7.6	509,200	0.0	-	67,120
Cane molasses (liter/ha)	10.0	68,800	0.0	-	4,960
Urea fertilizer (kg/ha)	84.0	186,000	282.0	727,000	1,910
NPK fertilizer (kg/ha)	74.0	246,000	198.0	710,000	2,120
SP-36 fertilizer (kg/ha)	0.0	-	48.4	151,000	1,570
Phonska fertilizer (kg/ha)	68.0	187,000	0.0	-	980
Organic fertilizer (kg/ha)	912.0	684,000	658.0	493,500	540
Manure (kg/ha)	0.0	-	102.0	129,000	460
Pesticide (liter/ha)	0.0	-	4,2	345,200	69,040
Herbicide (liter/ha)	0.0	-	3.0	286,000	57,200
Irrigation fee (Rp/ha/season)		420,000		264,000	342,000
Tractor rent (Rp/ha/season)		708,000		644,000	676,000
Land rent (Rp/ha/season)		3,360,000		2,333,333	2,846,667
Land tax (Rp/ha/season)		186,667		198,667	192,667
Farmer group fee (Rp/season)		20,000		12,000	16,000
Co-operative saving (Rp/season)		-		20,000	20,000
Non-family labor (man-days)	24	9,520,760	18	6,411,350	376,442
Sub Total Cash Cost		**56,711,627**		**13,152,650**	
Imputed cost					
Family labor (man-days)	62.8	4,972,000	23	4,108,000	128,890
Tool depreciation (Rp/season)		1,785,467		293,600	1,039,533
Sub Total Imputed Cost		**6,757,467**		**4,401,600**	
Total Cost (Rp/ha/season)		**63,469,094**		**17,554,250**	

Minapadi farming uses more rice seed compared to rice-monoculture farming, which is 54.4 kg/ha compared to 41.6 kg/ha. This happened because of differences in rice planting patterns between *minapadi* and monocrop farming. In monocrop farming, tiled or rectangular patterns (such as tiles) are used in paddy farming, while in *minapadi* farming, a total of 80% of the total area is used to grow rice and the remaining 20% is used as deep ponds for fish. The rice cropping pattern generally uses "*jajar legowo*" 2:1. *Jajar Legowo* is one of the rice planting systems in Indonesia which is basically done by adjusting the distance between seeds during planting. This system has been proven to improve rice yield compared to the use of traditional systems. *Jajar legowo* 2:1 is a planting method that has 2 rows then interspersed by 1 empty row. *Jajar legowo* 2:1 cropping pattern applied by *minapadi* farmers aims to maximize land use, and the *jajar legowo* 2:1 cropping pattern requires more rice seeds than the tile planting pattern. In *minapadi* farming in Margoluwih Village, red tilapia fish (*Oreochromis niloticus*) is one of the farming products that usually grown by the farmers. Filling of water and stocking of tilapia seeds in *minapadi* farming was carried out after 14 days of rice planting. The average tilapia seed grown by *minapadi* farmers is as much as 706 kg/ha or spread 2 to 3 seeds per m^2 and the weight of fish seeds is around 25 gr/head. The average price of rice seeds is Rp 10,220 per kg, while the average price of red tilapia seeds is Rp 27,840 per kg (note: the exchange rate is USD 1 = Rp 14,000).

The type of fertilizer used in *minapadi* farming is not much different from the type of monocrop farming fertilizer. Urea, NPK and organic fertilizer were used as fertilizers by both *minapadi* and monocrop farming, but on *minapadi* farming phonska fertilizers were also used, while in monocrop farming SP-36 fertilizers and manure were used. The are different types and amount of fertilizers on *minapadi* and monocrop farmings. These occur because in monocrop farming there are three fertilization phases, whereas in *minapadi* farming there is only one fertilization phase, since the next fertilization is done naturally from feces and fish food. Monocrop farms still use pesticides and herbicides to overcome pests and weeds, but these inputs are not used in *minapadi* farming. However, *minapadi* farming uses more labor workdays compared to monocrop farming. This is because *minapadi* requires more labor time in land preparation to make deep ponds and canals, the installation of mulch and pool nets, and feeding of fish. Fish feeding is twice a day, morning and evening, starting from the time the fish seeds are stocked (14 days after rice is planted) until the fish is harvested (up to 14 days before rice is harvested). In total, *minapadi* and monocrop farmings require about 86.8 and 41.0 working days. The average time spent by worker in one working day (*hari orang kerja* or HOK) is about five hours. The output of *minapadi* farming consists of rice and fish, while the output of monocrop farming is only rice. Rice in *minapadi* farming yields a higher output of 7,612 kg/ha compared to monocrop farming which only produces 5,652 kg/ha, both in the forms of paddy (husked rice) (Table 2). Based on the research results, this happened because the *jajar legowo* 2:1 cropping pattern on *minapadi* farming produced more paddy than the monocrop farming which used tiled cropping patterns. In addition, with the cultivation of fish in the paddy fields, fish feed and fish feces can help grow rice and produce more rice tillers. *Minapadi* farming also produces red tilapia as much as 2,548 kg/ha.

Table 2. Productivity and revenue of *minapadi* and monoculture rice farming

Commodity	*Minapadi* farming	Monocrop farming
Productivity (kg/ha):		
- Rice	7,612	5,652
- Fish	2,548	0
Revenue (Rp/ha/season):		
- Rice	29,635,200	20,750,800
- Fish	62,284,000	0
Total revenue	**91,919,200**	**20,750,800**

Income of *minapadi* and monoculture rice farming

***Minapadi* and monocrop production costs**. The cost of *minapadi* and monocrop farming in this study is divided into cash costs and calculated (imputed) costs. Based on Table 1, the total costs incurred by the *minapadi* farmers are Rp 63,469,093, while the total costs for monocrop are Rp 17,554,250 per hectare per planting season. The cost for paddy seeds in *minapadi* farming is Rp 553,600 while monocrop farming is Rp 427,600. This is because there are different planting patterns on *minapadi* and monocrop farming, where the use of rice seeds for *minapadi* farming is more than the alternative. Other costs incurre by *minapadi* farmers but not issue by monocrop farmers are fish seed costs of Rp 19,688,000 and fish feed costs of Rp 20,373,600, including costs for prebiotics and sugarcane molasses. Monocrop farming uses more types and amounts of fertilizers, which results in greater costs of fertilizers. The costs of pesticides and herbicides to overcome pests and weeds on monocrop farming are also high. The total costs of labor in *minapadi* farming is greater than in monocrop farming, because more workdays is spent on the labor for land preparation in making deep ponds and canals, the installation of mulch and pool nets, and feeding fish (twice a day). This cost of labor includes both family and non-family labor. The agricultural tools used in the farming of *minapadi* and monocrop are also different. In general, monocrop farming uses only hoes, sickles and hand sprayers. *Minapadi* farming uses more equipment, including hoes and sickles, also drains, pool nets, mulch, and feed buckets. The more variety of equipment used in *minapadi* farming caused larger farm depreciation costs, Rp 1,785,467 compared to Rp 293,600 for monocrop farm.

Farm revenues. Farm revenue is the amount of farm output multiplied by the selling price of the product. Comparison between the average revenue of *minapadi* farming and monocrop farming is shown in Table 2 which shows that the average farmer revenue from *minapadi* farming is higher than the average farmer revenue from monoculture rice farming. The average farmer revenue per hectare per planting season on *minapadi* farming is Rp 91,919,200 while the total farmer revenue from monocrop farming is Rp 20,750,800. This is because there are differences in the output produced on *minapadi* and monocrop farmings. *Minapadi* farming produces rice and fish with an average price of paddy (husked rice) at Rp 3,896 per kg and the average price of red tilapia is Rp 24,480 per kg, while monocrop farming produces only rice with a slightly lower average price, which is Rp 3,668 per kg. The average price of *minapadi* rice is more expensive than monoculture rice because based on the results of research in the village, rice from *minapadi* farming has been considered to be more qualified by the society, since there is no pesticides and herbicide, and more flaky than monoculture rice.

Farm income. The incomes of *minapadi* and monocrop farmings in this study are analyzed based on income on cash costs (referred as cash income) and income on total costs (referred as net income). The net income will be lower than the cash income because in the analysis of total income has calculated all costs, including the cost of using family labor and depreciation of tools, while in the analysis of cash income both cost components are not taken into account. Farming incomes [both (5) and (6)] obtained by both *minapadi* farmers and monoculture rice farmers are positive, which means that the two farming systems are profitable, but the net income from *minapadi* farming is higher, Rp 28,270,106 compared to Rp 2,914,150 per hectare per season (Table 3). Profitability of *minapadi* and monocrop farmings can also be seen from the Revenue/Cost (R/C) ratio. Based on this criteria, the average value of R/C for the total cost perspective for *minapadi* farming per hectare per planting season is 1.45 while for monocrop farming is 1.18; meaning that the level of profit of the two types of farming systems are 45% and 18% from the total farming (production) costs, respectively. In general, the value of R/C for the cash costs and total cost perspective for *minapadi* farming is greater than monocrop farming, so it can be said that *minapadi* farming is economically more profitable than the alternative.

Table 3. Income of *minapadi* and monoculture rice farmings

Component	*Minapadi* farming	Monocrop farming	Difference
Revenue (1)	91,919,200	20,750,800	71,168,400
Cash cost (2)	56,891,626	13,435,050	43,456,576
Imputed cost (3)	6,757,467	4,401,600	2,355,867
Total cost (4)=(2)+(3)	63,469,094	17,554,250	45,914,844
Cash Income (5)=(1)-(2)	35,027,573	7,315,150	27,711,823
Net Income (6)=(1)-(4)	28,270,106	2,914,150	25,355,956
Cash R/C (7)=(1)/(2)	1.60	1.56	0.04
Net R/C (8)=(1)/(4)	1.43	1.15	0.28

Significance test of the mean outcomes. Significance test of the outcome values is conducted to determine whether there is statistical evidence that the mean difference between paired observations (*minapadi* and monocrop) on a particular outcome is significantly different from zero. The paired samples *t* test uses a parametric test. It compares two means that are from the same individual, object, or related units. In this case, the samples are 25 paired-farmers of *minapadi* and monocrop farmings.

The results can be divided into two groups, inputs and outcomes. In term of inputs, the components also can be divided into two: physical inputs and costs. In term of physical inputs, land area and use of organic fertilizer are not significantly different beween *minapadi* and monocrop farmings. However, the use of rice seed, and urea, NPK and organic fertilizers are different significantly between the two. In term of costs, the total imputed cost, total cash cost, and total cost of production are also siginificantly different between the two farmings (Table 4). In term of outcomes, all of the outcomes between *minapadi* and monocrop farmings are significantly different, except for cash R/C. Means of rice production, for example, are statistically difference at 5% significant level, while the other outcomes are statistically difference at 1% significant level. The test results, in general, show that the differences between the mean outcomes of *minapadi* and monocrop farmings are significantly different than zero, indicating that the mean outcomes of *minapadi* farming are significantly higher than those of monocrop farming.

Table 4. Mean input and outcome differences between *minapadi* and monocrop farmings

Variable	**Value of variable**		**Pearson**	**t Stat**	**P value**
	Minapadi	**Monocrop**	**Correlation**		**(2 tails)**
Inputs:					
Land area	1,400.00	1,304.00	0.15445	0.76094	0.45410
Rice seed	54.40	41.60	-0.04216	2.46305	0.02133
Urea fertilizer	84.00	282.00	0.18394	-9.65375	0.00000
NPK fertilizer	74.00	198.00	-0.03852	-3.66827	0.00121
Organic fertilizer	912.00	658.00	0.30014	1.19582	0.24344
Total imputed cost	6,757,466	4,401,600	0.26684	4.15513	0.00036
Total cash cost	56,891,626	13,435,050	-0.11654	10.43927	0.00000
Total cost of production	63,469,094	17,554,250	-0.03157	9.92439	0.00000
Outcomes:					
Rice production	7,612	5,652	-0.05721	2.30556	0.03009
Total revenue	91,919,200	20,750,800	-0.00130	9.89666	0.00000
Cash income	35,027,573	7,315,750	0.13562	8.27787	0.00000
Net income	28,270,106	2,914,150	0.09752	8.81891	0.00000
Cash R/C	1.60	1.57	0.0332	0.3730	0.7124
Net R/C	1.43	1.15	0.0437	4.0649	0.0004

Paired samples correlation shows the bivariate Pearson correlation coefficient for each pair of variables entered (with a two-tailed test of significance). Pearson coefficient measures the statistical relationship and the direction of the relationship between two continuous variables. It can take a range of values from -1 to +1. Based on the results on Table 4, in term of inputs, the use of rice seed, urea and NPK fertilizers, total imputed cost, total cash cost and total cost of production are significantly different, while land area and organic fertilizer use are not significantly different between the two farmings. In term of outcomes, all farming outcomes (rice production, total revenue, cash income, net income, and net R/C) are significantly different between the two farming systems, except for the cash R/C. Cash income and net income of the *minapadi* and monocrop farmings are positively related, implying that as the value of *minapadi* income increases, so does the value of the monocrop income. However, total revenue of the *minapadi* and monocrop farmings have negative values.

Factors affecting the farmers'decision in adopting *minapadi* farming.

Factors that are considered to affect farmers' decision in adopting *minapadi* farming system are analyzed using a logistic regression model, which is processed using the Stata 15.1 program. The independent variables are: formal education level (X_1); farm area (X_2); farmer's age (X_3); number of family dependents (X_4); farmers' experience in doing rice cultivation (X_5); and distance of paddy fields from water sources (X_6). Income variable is not included in the analysis. When the income variable of *minapadi* and monocrop farming is included in the model, there is convergence failure because the maximum profit for monoculture rice farmers does not reach the minimum income of the *minapadi* farmers, so complete separate occurs in the logistic regression model. As an alternative, variable cost is also tested. However, it results in the same problem. The full results of data analysis to estimate the factors that influence farmers' decisions in adopting *minapadi* farming is presented in Table 5. The dependent variable in this model is the farmer's decision to implement (adopt) *minapadi* farming (value "one") and the farmer's decision not to adopt *minapadi* farming or implementing monoculture rice farming (value "zero"). The Log-Likelihood value was -23.759, the G value was 21.80 and the P value was 0.0013. The resulting P value is below the 5% real level ($\alpha = 5\%$), it can be concluded that the overall logistic regression model can explain the farmers' decision in adopting *minapadi* farming. Detailed outputs of the regression analysis are presented in the Appendix 1.

Table 5. Factors affecting the farmers' decision in adopting *minapadi* farming

Predictor	Coef	P	Odds Ratio	Marginal Effect
Constant	8.48079	0.0660	4821.29	
Education level (X_1)	0.21169	0.3610	1.2357	0.05292
Paddy-field area (X_2)	-0.00011	0.8960	0.9998	-0.00003
Farmer age (X_3)	-0.21106	0.0030*	0.8097	-0.05276
Number of family member (X_4)	-0.22380	0.5590	0.7994	-0.05595
Experience in rice farming (X_5)	0.10296	0.0290*	1.1084	0.02574
Distance of rice field to water source (X_6)	-0.00097	0.3220	0.9990	-0.00024

The regression results indicate that there are two significant variables in the logistic regression model, namely the age of the farmers (X_3) and farmers' experience in doing rice cultivation (X_5). The age of the farmer variable is statistically significant. The older the farmer, the probability of adopting the *minapadi* farm declines. The odd ratio is 0.81, which means that every increase in the age of farmers by one year, the opportunity to implement (adopt) *minapadi* farming is 0.81 times less than the opportunity not to farm *minapadi*, cateris paribus. Likewise, marginal effect of the farmer age variable is -0.052, implying that when the farmer is one year older, the probability of the farmer in adopting *minapadi* farming reduced by 0.052 (5.2%), ceteris paribus. The age of *minapadi* farmers who less than 35 years was 16% and those with ages 35 to 44 years were 32%; whereas in monocrop farming there were no farmers who were under 44 years old, most monocrop farmers were in the age range of 45 to 54 years (48%) and ages 55 to 64 years (48%). Thus, *minapadi* farmers tends to be younger than the monoculture rice farmers, indicating that younger farmers have the desire and ability to implement the *minapadi* farm. Farmers' experience in doing rice cultivation (X_5) variable has a statistically significant value. The coefficient value is positive, indicating that the longer the experience of the farmer in cultivating rice will increase the probability to adopt *minapadi* farming. An odd ratio of 1.11 means that for every one year longer of rice cultivation experience, the probability of farmers to practice *minapadi* farming is 1.11 times greater than the probability of practicing the alternative, cateris paribus. Similarly, the marginal effect coefficient is 0.0257, indicating that as the farmer's experience in cultivating rice increases by one year, it will increase his probability in adopting the *minapadi* farming by 0.0257 (2.57%). These conditions indicate that when farmers' experience in doing rice cultivation is increasing, there is a tendency that the farmer will adopt *minapadi* farming.

The results of the regression analysis show that there are four non-significant variables, namely the farmer education (X_1), paddy field area (X_2), number of family dependents (X_4), and distance of paddy fields from water sources (X_6). Educational variable (X_1) is statistically not significant with a P value of 0.361 which is greater than the real level of 5% (α = 5%). Based on the field conditions, the education level of most *minapadi* farmers and monocrop farmers tends to be the same, namely graduating from junior high and high school, so there is no significant difference in the level of education between the two groups of farmers. Thus, the level of education does not have a tendency in determining farmers' decisions to adopting *minapadi* farming. Variable paddy field area (X_2) is also not significant because it has a P value of 0.896 which is greater than the real level of 5% (α = 5%). Field conditions indicate that most of respondents (both *minapadi* and monocrop farmers) manage a land of no more than 0.2 hectares, so that the rice field area managed by the *minapadi* farmers is statistically not different from those of monocrop farmers. Therefore, paddy field area is also not a factor in farmers' decision making to adopt *minapadi* farming.

Number of family dependents (X_4) variable is statistically not significant with the value of P equal to 0.559. Conditions in the field indicate that *minapadi* farmers and monocrop farmers have an average of 3 dependents in their families, 52% of *minapadi* farmers and 36% of monoculture farmers have 3 family dependents and no farmers have more than 5 family members, thus the number of family dependents does not have a tendency in making farmers' decisions to practice *minapadi* farming. Another variable that is not significant is variable of the distance of paddy fields from water sources (X_6) with a P value of 0.322. The distance from paddy fields to water sources represents the availability of irrigation water to the farmers in implementing *minapadi* farming, because water availability is the most important factor in the success of *minapadi* farming. Based on the results of the study, the Mataram irrigation channel that passes through Margoluwih Village is the source of water that irrigates all paddy fields in the village. Both rice fields for *minapadi* and monocrop farming can be irrigated well with a technical irrigation system from Mataram channel. **T**he distance between *minapadi* and monocrop lands from the water sources is not significantly different because the distance is not more than 2000 meters from paddy fields. Thus, it can be concluded that the distance between paddy fields and water sources that represent water availability does not influence farmers' decisions adopt *minapadi* farming.

CONCLUSIONS

There are differences in the type and amount of input use in *minapadi* farming and monoculture rice farming in Margoluwih Village. On the *minapadi* farm, fish seed, fish feed, prebiotics, and sugar cane molasses are needed; whereas monoculture rice farming (monocrop) does not require these inputs, but uses pesticides and herbicides that are not used in *minapadi* farming. Monocrop farming uses more fertilizers than *minapadi* farming, whereas *minapadi* farming uses more quantity of labor compared to the monocrop farming. The biggest costs incurred by the *minapadi* farmers are the costs of fish and fish feed each valued at Rp 19.68 million and Rp 20.37 million per hectare per planting season, so the total costs incurred by the farmers are Rp 63.47 million per hectare per planting season; while for monocrop farmers the total costs are only Rp 17.55 million. Comparison of income between *minapadi* and monocrop farming in Margoluwih Village shows that *minapadi* farming that carries out rice and fish cultivation jointly in paddy fields is statistically significantly more profitable than monocrop farming which only grows rice. The net income earned by the farmer per hectare during one planting season is Rp 28.45 million, while that of monoculture rice farming is only Rp 3.19 million. The profitability of *minapadi* farming reaches 45%, while monoculture rice farming is only 18% of the total cost of production of each type of farm. Both the cash income and net income of *minapadi* farming are significantly different than those of monocrop farming. Socio-economic factors are important in influencing farmers' decisions in adopting *minapadi* farming in Margoluwih Village. Income of *minapadi* farming is significantly higher than the monocrop farming and irrigation water is not limited factor to the farmers in adopting *minapadi* farming. However, adoption of *minapadi* farming is still limited. The results indicate that the farmers' age and experience in doing rice cultivation are the two significant social factors in adopting the minapadi farming. There should be other important factors that determining the adoption process, but not included in this analysis, for example availability of funding, since adoption of *minapadi* farming requires a high amount of funding.

RECOMMENDATION

Farmers pay a large amount of money in conducting *minapadi* farming to purchase fish seed and feed. To take advantage of the potential major expenditure, the role of farmer groups can be increased by making it as an institution capable of organizing farmers' capacity to produce fish seed and feed. The Sleman Regency of Agriculture, Fisheries and Forestry Service together with the field extension workers should provide technical and financial support, so that farmer groups can conduct business in making fish feed and fish hatcheries independently, thereby reducing the cost of purchasing both types of inputs and maintain their availability. *Minapadi* farming will be more profitable if farmers can increase the sale value of their farming products by increasing the role of *minapadi* farmer groups in promoting *minapadi* rice. *Minapadi* rice also has the potential to become a new icon for Sleman Regency. The Sleman Regency Government and its stakeholders are expected to conduct a laboratory research for *minapadi* rice content in order to ensure that *minapadi* rice has better quality compared to conventional (monoculture) rice, because it is pesticide free. In addition, improvement in marketing of *minapadi* rice and fish is also needed. The local government should motivate and facilitate the current adopters, who are mostly relatively young farmers, in developing *minapadi* farming intensively, since it generates more income, food and nutrition, and sustainability. Government should also extensively attract other potential farmers to practice *minapadi* farming, since the required irrigation water is still available in the locality. Government facilitation could be in term of socialization and training programs, provision of working capital, and improvement of marketing system and facilities.

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REFERENCES

Abuasir, S., N. Hakim, and Y. Sumitro. 2004. Faktor-faktor yang mempengaruhi adopsi sistem usahatani mina padi di Desa Pujo Rahayu Kecamatan Belitang Kabupaten Ogan Komering Ulu. *Jurnal KPM* 1(1):30-3.

Agresti, A. 2002. *Categorical Data Analysis.* Florida (US): Wiley Interscience

BPS [Badan Pusat Statistik]. 2015. [Internet]. Indonesia (ID). [disadur. 2016 Juni 10]. Tersedia pada https://www.bps.go.id/linkTabelStatis/view/id/1199

BPS [Badan Pusat Statistik]. 2015. *Daerah Istimewa Yogyakarta dalam Angka 2015*. DIY (ID): Badan Pusat Statistik DIY.

Bambang. 2003. Sistem usahatani mina padi ikan mas studi kasus di Desa Totap Majawa Tanah Jawa Kabupaten Simalungun [tesis]. Medan (ID): Universitas Sumatera Utara.

Berg, H., C. Berg, and T. Nguyen. 2012. Integrated rice-fish farming: safe guarding biodiversity and ecosystem services for sustainable food production in the Mekong Delta. *Journal of Sustainable Agriculture* 36:859-872.

Bosma, R.H., D.K. Nhan, H.M.J. Udo, and U. Kaymak. 2012. Factors affecting farmers' adoption of integrated rice - fish farming systems in the Mekong delta, Vietnam. *Reviews in Aquaculture* 4:178-190.

Cai, R., D. Ni, and J. Wang. 1995. Rice-fish culture in China: the past, present, and future. In: MacKay, K.T. (ed) *Rice-fish culture in China*. International Development Research Centre (IDRC), Ottawa, pp 3–14

Dinas Pertanian, Perikanan, dan Kehutanan Kabupaten Sleman. 2016. *Profil Perikanan Sleman Tahun 2015*. DIY (ID): Dinas Pertanian, Perikanan, dan Kehutanan Kabupaten Sleman

Dwiyana, E., and T.C. Mendoza. 2006. Comparative productivity, profitability, and efficiency of rice monoculture and rice-fish culture systems. *J. Sustainable Agriculture* 29(1):145-166.

FAO. 1957. Fish culture in rice fields, p. 193-206. ***In*** A preliminary review and annotated bibliography from Section II and III of Proc. Indo-Pacif. Fish. Con. 7. FAO, Rome.

Fausayana, I. and Rosmarlinasiah. 2008. Usaha minapadi organik pada kawasan agribisnis berwawasan kesehatan di Kabupaten Konawe. *Jurnal Wiptek* 16(2): 87-94.

Frei M. and K. Becker. 2005. Integrated rice-fish culture: coupled production saves resources. *Natural Resources Forum* 29:135-143.

Halwart, M. 1998. Trends in rice-fish farming. *FAO Aquaculture Newsletter* **18**, 3-11.

Halwart, M. and M.V. Gupta (eds.) 2004. *Culture of fish in rice fields*. FAO and The World Fish Center, 83 p.

Lantarsih, R. 2016. Pengembangan "minapadi kolam dalam" Di Kabupaten Sleman. *Jurnal Agraris* 2(1):17-26.

Nnaji, J.C., C.T. Madu, and A. Raji. 2013. Profitability of rice-fish farming in Bida, North Central Nigeria. *J. Fisheries and Aquatic Science* 8(1):148-153.

Pindyck, R.S. and D.L Rubinfeld. 1991. *Econometric Models and Economic Forecasts*. McGraw-Hill Book Co., Singapore, 596 p.

Rabbani, M.G., M.S. Islam, M.I. Hossain, T.M.B. Hossain, and M.E.A. Begum. 2004. An economic study on alternate rice-fish culture in selected areas of Mymensingh District in Bangladesh. Pakistan J. Biological Sciences 7(5):685-688.

Saikia, S.K. and D.N. Das. 2008. Rice-fish culture and its potential in rural development: A Lesson from Apatani farmers, Arunachal Pradesh, India. *J. Agriculture and Rural Development 6:125-131.*

Siregar, A.Z. 2015. Sistem mina padi di Desa Manik Rembung mendukung ketahanan pangan Sumatera Utara. *Jurnal Pertanian Tropik* 2(21):165-177.

Soekartawi. 1995. Analisis Usahatani. Jakarta (ID): Universitas Indonesia, 165 p.

Attachment 1. Outputs of Regression Analysis

```
 ___  ____  ____  ____  ____ (R)
/__    /   ____/   /   ____/
___/   /   /___/   /   /___/      15.1   Copyright 1985-2017 StataCorp LLC
    Statistics/Data Analysis            StataCorp
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      979-696-4601 (fax)

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Notes:
     1.  Unicode is supported; see help unicode_advice.
. *(7 variables, 50 observations pasted into data editor)
```

1. Output of Logit Regression

```
. logit y x1 x2 x3 x4 x5 x6

Iteration 0:   log likelihood = -34.657359
Iteration 1:   log likelihood = -23.848181
Iteration 2:   log likelihood = -23.759413
Iteration 3:   log likelihood = -23.759028
Iteration 4:   log likelihood = -23.759028

Logistic regression                     Number of obs   =         50
                                        LR chi2(6)      =      21.80
                                        Prob > chi2     =     0.0013
Log likelihood = -23.759028             Pseudo R2       =     0.3145

------------------------------------------------------------------------------
           y |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------------------------------------------------------------------------
          x1 |   .2116947   .2318503     0.91   0.361    -.2427236     .666113
          x2 |  -.0001182      .0009    -0.13   0.896    -.0018821    .0016458
          x3 |  -.2110643   .0698243    -3.02   0.003    -.3479175   -.0742112
          x4 |  -.2238019   .3829721    -0.58   0.559    -.9744134    .5268095
          x5 |   .1029556   .0470943     2.19   0.029     .0106524    .1952588
          x6 |  -.0009743   .0009834    -0.99   0.322    -.0029018    .0009532
       _cons |   8.480797   4.618126     1.84   0.066    -.5705638    17.53216
------------------------------------------------------------------------------

. logistic y x1 x2 x3 x4 x5 x6

Logistic regression                     Number of obs   = 50
                                        LR chi2(6)      = 21.80
                                        Prob > chi2     = 0.0013
```

Log likelihood = -23.759028 Pseudo R2 = 0.3145

y	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf. Interval]	
x1	1.235771	.2865138	0.91	0.361	.7844883	1.946656
x2	.9998819	.0008999	-0.13	0.896	.9981197	1.001647
x3	.809722	.0565383	-3.02	0.003	.7061572	.9284756
x4	.7994735	.306176	-0.58	0.559	.3774137	1.693521
x5	1.108442	.0522014	2.19	0.029	1.010709	1.215626
x6	.9990262	.0009825	-0.99	0.322	.9971025	1.000954
_cons	4821.291	22265.33	1.84	0.066	.5652067	4.11e+07

---

2. Output of Marginal Effect

. margins, dydx(*) atmeans
Conditional marginal effects Number of obs = 50
Model VCE : OIM

Expression : Pr(y), predict()
dy/dx w.r.t. : x1 x2 x3 x4 x5 x6
at : x1 = 11.18 (mean)
x2 = 1352 (mean)
x3 = 50.68 (mean)
x4 = 2.9 (mean)
x5 = 20.34 (mean)
x6 = 1470 (mean)

	Delta-method					
	dy/dx	Std. Err.	z	P>|z|	[95% Conf. Interval]	
x1	.0529235	.0579635	0.91	0.361	-.0606828	.1665298
x2	-.0000295	.000225	-0.13	0.896	-.0004705	.0004114
x3	**-.0527659**	**.0174585**	**-3.02**	**0.003***	**-.0869838**	**-.0185479**
x4	-.0559503	.0957382	-0.58	0.559	-.2435937	.1316932
x5	**.0257388**	**.0117774**	**2.19**	**0.029***	**.0026556**	**.048822**
x6	-.0002436	.0002459	-0.99	0.322	-.0007254	.0002383

*** signifikan pada tingkat kepercayaan 5%**

Notes:
X1 = Education level
X2 = Paddy-field area
X3 = Farmer age
X4 = Number of family member
X5 = Experience in rice farming
X6 = Distance of rice field to water source