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Assessment of Rice-based Integrated Farming Model in Banten Province

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Abstract. Integrated farming is an ideal agricultural system with the principle of management and utilization of agriculture biomass and organic waste. The objectives of this study were to build a model of rice-based integrated farming as well as to calculate its economic feasibility. The research was conducted at Sabana Mandiri Farmers' Group, Sukatani Village, Rajeg Sub-district, Tangerang District in Banten Province. The location was determined using agro-ecosystem, agribusiness, participatory and integrated approaches in order to discover potentials and problems with regards to agriculture systems. Whereas, the integrated farming model was developed to improve farmers' technology and socio-economic conditions. Primary data were collected from focus group discussion (FGD) and analysis of cost and profit of improved farming systems. Secondary data were collected through literature studies. Data were calculated and analyzed descriptively. The results showed that Sukatani Village fulfills the requirements of the integrated farming model (rice, cattle, mushroom). Through the application of technology, the profits derived from rice, cattle, and mushrooms were respectively IDR. 11,298,000 (B/C ratio 1.14); IDR. 6,300,000 (B/C ratio 0.17) and IDR. 1,898,500 (B/C ratio 1.02). Implementation of rice-based integrated farming may reduce agriculture waste and increase farmers' income by using rice straw to produce more economic agriculture products such as mushrooms, feed, and organic fertilizer.

Keywords. *cattle, integrated farming system, rice*

1. Introduction

The challenge of future agricultural development will be more severe, where the adequacy of food for both vegetable and animal foods will experience various constraints in increasing production and productivity. Food needs will increase along with the increase of population, while food availability will be more limited due to several factors such as 1) narrowing of agricultural area due to land conversion, 2) decreasing of soil fertility due to declining quality of land, 3) pests and diseases of plants, and 4) management of plants that are not environmentally based.

Agricultural development has a vast and critical dimension because there are components of food security, environmental sustainability and poverty reduction. Agricultural development has a strategic role in the regional and national economy, including the provision of food, feed and bioenergy, employability, sources of public income, and sources of foreign exchange.

Future agriculture should be designed in the form of environment-based agriculture by integrating various existing resources. An integrated farming system (IFS) is a strategic step in combining different farms (crops, livestock, fish) to generate greater profits for farmers and maintaining the sustainability of agroecosystems. As mentioned by Manjunatha *et al.*[1], the system implies a set of interrelated practices and processes are organized into functional entities, that is the arrangement of components or parts that interact according to some processes and transforms inputs into outputs. It refers to a more integrated agricultural approach than the monoculture system. Furthermore, to build a small scale IFS that is able to produce something more substantial and sustainable, it is needed to define the emergent factor (Soni *et al.* [2]). IFS is always characterized by a combination of crop and animal components where the product and by-product of one component can be used for another component. Compared with a monoculture system, IFS benefits more in terms of economic return (Jayanthi *et al.* [3]; Jaishankar *et al.* [4]).

In this research, the IFS was conducted by integrating rice *(Oryza sativa)* cultivation, cattle production (Ongole cattle) and straw mushroom *(Volvariella volvacea)* cultivation in Tangerang District in Banten Province. The objectives of the present study were to build a model of rice-based integrated farming as well as to calculate its economic feasibility.

2. Materials and Methods

Research using participatory research method based on the study of Jayanthi *et al.*[3] was conducted in Sabana Mandiri Farmers' Group, Sukatani Village, Rajeg Sub-District, Tangerang District of Banten Province in period 2015 to 2017. The urban area covers 169 ha of land (26.04%), 85 ha (13.10%), 392 ha (60.40%) and 3 ha (0.46% ha) plantations. The cultivation pattern developed is *"Padi-Padi-Palawija"* integrated with cattle production and mushroom cultivation.

2.1. Agricultural System Components

2.1.1. Rice Cultivation

Rice farming is the primary/dominant business for farmers in Kecamatan Rajeg. Rice cultivation activity was done by applying an integrated crop management (ICM) concept on 25 ha of land with 22 cooperative farmers. Components of ICM applied include: 1) implementation of new superior varieties Inpari 32 and Inpari 33; 2) planting system Jajar Legowo (Jarwo) 2: 1 and Jarwo 4: 1; 3) planting young seedlings 17 days after seedling and 4) fertilizer recommendation per hectare based on soil analysis that is 200 kg of Urea, 225 kg of NPK Phonska and 50 kg of KCl.

2.1.2. Cattle Production

An intensive cattle production was introduced by applying a cage system. To make a comparison between the existing technology and the improved technology, six Ongole cattle, with average 20 months old, were divided into two groups. The first group was fed in the usual way that farmers do. In this case, the feed composition per head per day consists of 70 kg grass, 0.75 kg cassava peels and 25 kg tofu dregs. As the improved feed management, the feed composition for the second group per head per day consists of 30 kg grass, 4 kg rice bran and 4 kg commercial feed. The use of rice straw to substitute grass as forage source in the cattle feed was applied during rice harvesting period. In this case, during the first year of IFS implementation, rice straw mainly used for straw mushroom cultivation while the rest was used as cattle feed.

2.1.3. Straw Mushroom Cultivation

The cultivation of straw mushroom was done semi-intensively in the fungus house, with size area 4 m X 6 m X 6 m. Rice straw was placed on top of bamboo shelves and planted with mushroom seeds. Materials used for mushrooms cultivation were: dry rice straw (1000 kg), dry cotton waste (200 kg), rice bran (100 kg), lime (30 kg), rice polish (100 kg) and mushroom seeds (70 Log).

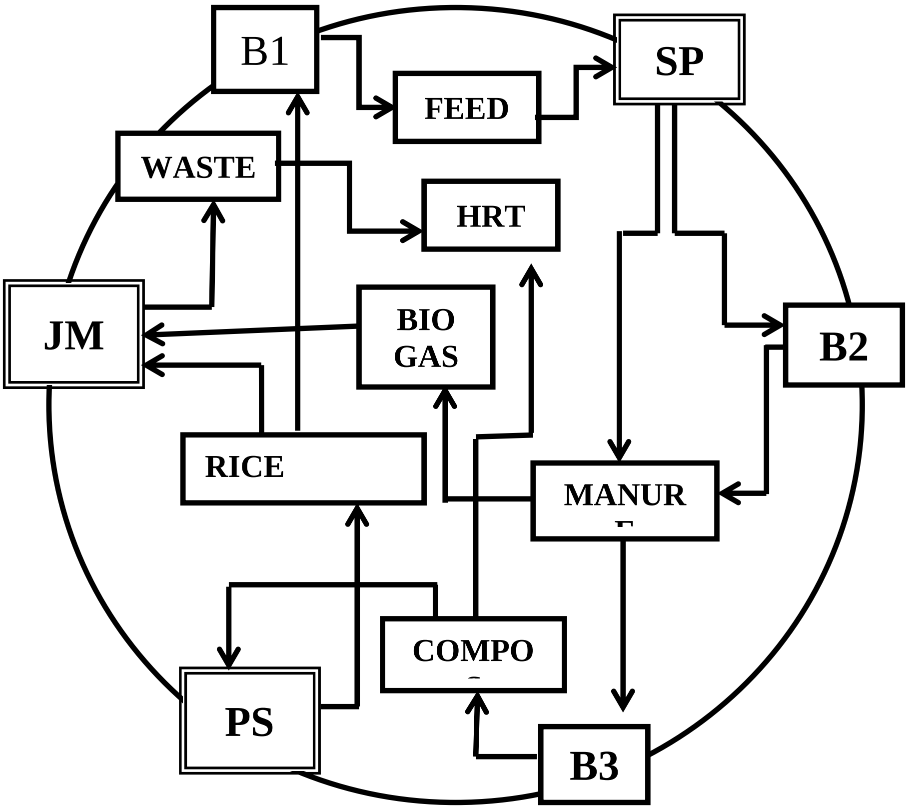
3. Data analysis

The production data collected consist of rice productivity, the average of cattle daily weight gain, and mushroom productivity. Furthermore, socio-economic aspects of IFS were analyzed descriptively based on cost and profit ratio of B / C ratio.

4. Results and Discussion

4.1. Model Design of IFS in Sabana Mandiri Farmers' Group

The pattern of IFS in Sabana Mandiri farmers' group was made by integrating rice field cultivation with cattle production. Various activities that can support the utilization of waste of rice and cattle rearing were initiated to fit the concept of zero waste such as rice straw utilization for mushroom production and cattle feed. The IFS design in Sabana Mandiri farmers' group is described in Figure 1.



PS : Rice field cultivation
SP : Cattle production
JM : Straw mushroom production
Hrt : Horticulture cultivation
B1 : Waste processing unit
B2 : Cattle processing unit
B3 : Compost processing unit

Figure 1. The cycle of bioindustry-based rice-based activities in Sabana Mandiri farmers' group

Rice cultivation and cattle production are the two core activities in the IFS. They are supported by various supporting farming activities such as mushroom and horticulture cultivation. The supporting activities are focused on the use of the by-products of core activities, namely rice straw and manure. Waste management is implemented in the form of an active unit consist of a sewage treatment unit, a livestock processing unit, as well as a composting unit (straw and mushroom waste). Implementation of IFS model in Sabana Mandiri farmers' group is expected to deliver a good impact especially related with sustainability aspects. As mentioned by previous studies, that IFS patterns with crop-livestock system (CLS) systems will ensure the sustainability of existing natural resources so that the productivity of land and plants can be guaranteed (Diwyanto and Hariyanto, [5]; Basuni *et al.*[6]).

Since it provides value-added benefits for farmers and preserves the environment, the IFS is a future agricultural system that can be developed in urban farming systems of small land, poor farming systems, as well as on the marginal agricultural farming system (Manjunatha *et al.* [1]; Jaishankar *et al.*[4]).

4.2. Rice Cultivation

Rice cultivation was done on a 10 ha land area involving 22 members of the farmer group. The rice varieties are Inpari 32 and 33 derived from Indonesian Centre for Rice Research (ICRR). Observations were made for both vegetative morphological and yield components. Characters observed include number of tillers, plant height, and productivity.

Table 1. Inpari 32 and Inpari 33 crops in 22 of IFS cooperative farmers

No.	Observation variables	Varieties	
		Inpari 32	Inpari 33
1.	Land area (ha)	12.5	12.5
2.	Average amount of tillers (cm)	33.86±2.19	28.52±2.66
3.	Crops height (cm)	90.93±3.47	99.4±6.38
4.	Productivity harvested dry grain (ton)	4.51±0.35	4.14±0.685

Different crops differ between Inpari 32 and Inpari 33 on high plant variables, number of tillers and productivity (Table 1). Differences in plant performance are the genetic influences as well as the optimal growing environment for the development of the plant (Al Salim *et al.*[7]; Haryanto *et al.*[8]; Ebdon and Gauch [9]). The highest production rate achieved by Inpari 32 reached 4.51 tons/ha, while Inpari 33 only reached 4.14 tons/ha of dry milled grain (GKG).

The production cost of rice cultivation was IDR. 9.899.000/ha with revenue up to IDR. 21.197.000/ha, and gained a profit of IDR. 11.298.000/ha. Economically, the rice cultivation was profitable with the value of B/C ratio of 1.14. This value indicates that every capital of IDR. 1 will generate a profit of IDR 1.14. According to Khai and Yabe [10], B/C ratio will be profitable if the value is greater than zero.

4.3. Cattle Production

Table 2. Existing Versus Improved Feed Management

Parameter	Existing Feed Management	Improved Feed Management
Breed	Ongole cattle	Ongole cattle
Number of cattle (heads)	3	3
Cattle age (months)	20	20
Feed composition (head/day)	70 kg grass, 0.75 kg cassava peels, 25 kg tofu dregs and dried rice straw (if available)	30 kg grass, 4 kg rice bran, 4 kg commercial feed, 2 kg fermented rice straw (if available)
Average daily weight gain (g/head/day)	570.37 ± 62.96	713.58 ± 14.97
Total cost (IDR)	34,000,000	37,700,000
Revenue (IDR)	36,000,000	44,000,000
Benefit (IDR)	2,000,000	6,300,000
B/C ratio	0.06	0.17

Cattle production is a sideline for Sabana Mandiri farmers' group. The average cattle ownership per farmer in Sabana Mandiri farmers' group is 1-3 heads. Cattle were reared semi-intensively. In the morning cattle were kept on a common or wasteland in the village area to find grass or other forages. In the night, it was kept in its cage. With regard to feeding management, the use of rice straw is usually done in rice harvesting period. Rice straw was only dried before it given to the cow. In the present study, farmers were introduced to rice straw fermentation technology, in order to increase its nutrient and palatability. Since the rice straw was mainly used as the ingredients of straw mushrooms cultivation, the used of fermented rice straw as cattle feed was applied only if the stock was available. The result of cattle daily weight gain and economic parameter in applying the existing and the improved feed management is described in Table 2.

The B/C ratio of improved feed management (0.17) was lower than the B/C ratio of rice cultivation (1.14), but it still gave an economic benefit for farmers (Khai and Yabe [10]). Moreover, the IFS implementation in Sabana Mandiri farmers' group has motivated the farmers to change their way of keeping cattle from semi-intensive rearing to intensive rearing. By doing so, manure as the by-products of cattle production could be used to make organic fertilizer for horticulture commodity and biogas. The shifting of cattle rearing also gave another impact with regard to social acceptance. In this case, by keeping cattle intensively the hygiene of settlements in the village area was increased. It also reduced the damage of rice cultivation and other commodities kept by farmers due to being eaten by cattle.

4.4. Straw Mushroom Cultivation

One type of mushroom that is widely cultivated in Indonesia is the straw mushroom *(Volvariella volvacea)*. Straw mushroom is one type of edible mushrooms (can be consumed) are nutritious and high flavor and has become part of a culinary dish in Indonesia since the first. Straw mushroom production is very prospective in IFS, in addition, utilization of rice straw can also increase farmers' income. According to Haryanto *et al.*[11], a hectare of rice cultivation produces fresh rice straw as much as 12-15 tons/ha or equivalent to 5-8 tons/ha of fermented straw which can be used for cattle feed as much as 2-3 head/year. In the present study, the potential of straw production in Sabana Mandiri farmers' group reached 125-175 tons of fresh straw/season.

The production of mushroom is strongly influenced by the environment such as temperature, humidity, medium thickness, and seed quality (Riduwan *et al.* [12]). Average straw mushroom production reached 121 kg/production cycle. One cycle of mushroom production lasts for 30-35 days. So that the production of straw mushroom in a year can be done 6-9 times.

Financial components in mushroom cultivation consist of the cost of media materials, fungi seeds, and labor costs. In general, the total revenue from straw mushroom cultivation with 121 kg of mushroom production gained IDR. 3,751,000 (Table 3). From the result, the straw mushroom production was economically profitable with B/C ratio of 1.02 (Khai and Yabe [10]).

Table 3. Financial Analysis of Straw Mushroom Production

Items	Value
Materials cost (IDR)	802.500
Straw mushroom bacterium (60 logs)	300.000
Labour cost (IDR)	750.000
a. Total Cost	1.852.500
b. Revenue (121 kg, IDR 31.000/kg; IDR)	3.751.000
c. Benefit (IDR)	1.898.500
d. B/C	1,02

5. Conclusion

From the aforementioned points, the IFS in Sabana Mandiri farmers' group has successfully optimized all existing resources with the concept of "Zero Waste". The rice-based integrated farming model has potential not only for its economically profitable and environmentally friendly, but also its social impacts for farmers of Sabana Mandiri.

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