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Innovation of Organic Fertilizer and Pesticides Technology Based on Local-Natural Resources to Support Food Self-Sufficiency Sustainibility

Ida Ekawati[1], Hari Sudarmadji, Isdiantoni dan Zasli Purwanto
Agriculture Faculty, Wiraraja University, Indonesia

Abstract: *The condition of soil fertility in the Village Patean and Gedungan is decreasing due to farmers behavior in using excessive inorganic fertilizer. It cause decreasing of the rice yield that can be threatening the sustainibility of food self-sufficiency. A dissemination activities of organic fertilizer and pesticides is needed to change the behavior of farmers. The aims of dissemination are: a) increasing the knowledge of organic fertilizers and pesticides by the members of Sumber Hasil and Aruma Jaya farmer groups, b) developing knowledge of utilizing of local resources for producing organic fertilizer and pesticides c) applying organic fertilizers and pesticides to improve soil fertility and stabilizing the rice production. The activities that conducted to namely: a) Extension of organic fertilizer and pesticide use to improve soil fertility and crop production in a sustainable manner, b) Training of fertilizers and organic pesticides using by utilizing local resources, c) demonstration plots of the application of various kinds of organic fertilizers and organic pesticides on rice cultivation, d) field meeting to discuss the results of demonstration plots of organic fertilizer and pesticide application, e) mentoring the farmers of rice cultivation using organic fertilizers and pesticides from planting to harvesting preparation (tillage, application of organic fertilizer, seed selection, planting system SRI, fertilization, pest and disease control, harvesting). The results showed that the farmer realized that the dosage of inorganic fertilizer used in rice farming was excessive, farmers were full-awared and skilled in the technology of organic fertilizers and pesticides as much as 70% of total local farmers, and more than 3% of local farmers have been applied the organic pesticides and fertilizer on the rice cultivation.*

Keywords: *dissemination, innovation, organic pesticides, organic fertilizers, rice cultivation*

I. Introduction

The introduction of green revolution technologies to farmers brings a highly dependent and over-dosed using inorganic fertilizers and chemical pesticides to producing food. Nowadays, mostly of the farmers is leaving the habit to incorporate the organic matters to the soil, it causes the soil degradation and worsen environmental quality. Soil organic matter content is decreased, data of organic matter content on paddy field in Sumenep regency is less than 1 %. As a result, food production is decreased and the food product is less healthy. This condition begin to be actual problem for farmer groups in Patean village and Gedungan village. In rice field cultivation, demand of chemical fertilizer and pesticide is high, and the availability of fertilizers in the area is limited. They have to find the pesticide and fertilizer products in the other area, even the price is higher. Within this condition, the average of rice production had decreased comparing with the previous years that produced 6,2 ton/acre (farmers interview result).

Nowadays, the climate change lead the increasing of pests and diseases in rice plants in the village Patean and Gedungan (preliminary observations result). Farmers attempted to resolve this problem with using chemical pesticides as they usually do. However, farmers do not aware the impact of its use that could lead extinction of natural enemies and other beneficial organisms, as well as the disruption of the balance of the ecosystem. It could be leading the emergence of new pests and diseases explosion, the new variant of pest and disease resistance that could threaten the food production [1]. Contrary with this condition, food supply have to produce higher amount.

The other hand, the potential of local resources has not been used by the farmers, including to improve the soil fertility, increasing production, and uses of organic pesticide as raw materials.Abundant of rice straw was burned in the land or sold. Usually, leguminosae plants waste are also not fully utilized, farmers used them as animal feed. Similarly, cattle dung is burned so as not to pollute the environment. The potential herbs as botanical pesticides such as neem, soursop, sugar apple, bitter, galangal, mahogany that are growing around their house, but it was not used yet [2].

The problems of soil fertility degradation and production declining as described earlier, actually could be solved by utilizing the local resources as organic fertilizers and pesticides. Organic fertilizers increases soil organic matter, that is a key role in the improvement of the physical, chemical and biological soil [3-5]. Mixing the crop residues and cattle dung compost by following giving EM solution of 30 L per hectare improved

biological, physical, and chemical soil [6]. The rice production was increased by rice straw application on the rice field up to 32% [7]. Other research showed that incorporating immature rice straw compost followed by application at *Azolla pinata* could increased the rice production [8]. Application of organic pesticides also suppress the pest populations [9-11]. Controlling pests and diseases populations by increasing soil fertility would have the impact on increasing food production. Furthermore, household food security of farmers in the village could be reached, agro-ecosystem balance could be maintained and the food production could be sustained.To achieve thus conditions, farmers need to be involved in dissemination activities, in order to be more aware, understand and able to apply the new technology of organic fertilizer and pesticides.

Aims of dissemination of technological innovation organic fertilizers and pesticides are farmers able to produce and apply the organic fertilizers and pesticides on farm, and there are farmers whom applied the organic rice cultivation.

II. Methods

Location and Time

Dissemination of technological innovation organic fertilizers and pesticides in rice cultivation was conducted in the Patean village and Gedungan village of Batuan District in the Sumenep regency during 8 months, March to November 2014.

Description of Target Group

The target of the farmer groups are "*SumberHasil*" and "Aruma Jaya" that consist of 36 members and 32 members respectively. The main activity of the farmer group is cultivating rice, the main contributor of household food.Usually, farmers used excessive fertilizers, urea at a dose of 500-600 kg/ha, SP-36 at a dose of 200-300 kg/ha, and ZA as much as 200-300 kg/ha. The cropping pattern in the paddy field that applied in one year: paddy-paddy-paddy, paddy-tobacco-legumes, paddy-paddy-fallow, and paddy-paddy-legumes.

Dissemination Programs

Implementation of dissemination activities include:

a) extension of organic fertilizer and pesticide uses to improve soil fertility and crop production in a sustainable manner,

b) farmers training, to produce the organic fertilizers and pesticides by utilizing local resources.
The training was conducted in the form of demonstrations. First, showing the farmers produceable materials for organic fertilizer and pesticides. Second, showing the procedures and inviting the farmers to produce EM starter solution, solid organic fertilizer (*bokhasi*), organic liquid fertilizer, and organic pesticides. Demonstration of producing solid organic fertilizer with steps as follow: a) starter EM-4, shrimp paste, sugar was dissolved with water for 12 hours to growing the starter of bacteria. b) 100 kg of straw was chopped to 3 cm, then mixed with other ingredients (ash, white leadtree leaf, rice bran, and manure) and starter solution. c) the mix of all ingredients was put in the plastic bag then sealed tightly and incubated for 45 days. Every week the mixture all of ingredients was stirred. d) the characteristic of mature compost had, dark colour, odorless, and all ingredients deformed, to check the mature compost is mixing the compost with the soil (1:1 ratio), then plant 100 mung beans onto it dan do observation the percentage of growing mung beans. Compost has mature if growing mung beans is 90% of total.
Here inafter follows process of producing of liquid organic fertilizers and organic pesticides that were demonstrated:

1. Liquid organic fertilizer was produced with the following steps: a) starter EM-4, molasses, shrimp paste was dissolved with coconut water for 24 hours incubation. b) then mix the solution with cow dung, green leaf of leguminosae and add 200 litre of water and stir. c) the mix of all ingredients was put in the drum and sealed tightly and put the rubber tube in the drum that connected to the water-filled bottle to avoid the contamination and incubated for 7-14 days. Every day, open the cover of the drum and stir for 15 min.
2. For producing organic pesticides that was demonstrated to the farmer with the following steps: crushing all the ingredients (soursop, tobacco, mahogany, turmeric, ginger, galangal, betel, neem leaf, papaya leaf) and 1 litre of water was added into it. 2 tbs of sugar and 10 ml of EM-4 was added. Close incubated for one week for the fermentation process and strain to take the liquid phase.

c) demonstration plot of many variant of organic fertilizers application on rice cultivation.
Demplot was conducting on 0.3 ha of land in Gedungan village, Batuan for 100 days. It was used Ciherang variety for semi-organic cultivation. Solid organic fertilizer were used Petroganik and Kuda Laut, organic fertilizer which are sold in the market, and bokhasi that was produced by the farmer. In this semi-organic cultivation demonstration plot tried three treatments i.e:

Table 1. Treatments of semi-organic cultivation demonstration plot

Treatment	Organic Fertilizer	Inorganic fertilizer
1	Petroganik	SP36+ phonska+Urea+ZA
2	Kuda Laut	SP36+ phonska+Urea+ZA
3	Bokhasi	SP36+ phonska+Urea+ZA

Solid organic fertilizer applied as basic fertilizer at dose 2 ton/ha with SP36 inorganic fertilizer as much as 100 kg/ha and phonska 50 kg/ha. Further fertilization was added at the age of 15 days and 35 days after planting, each fertilizer using a doses 100 kg/ha urea, 50 kg SP36, and 50 kg ZA. In the age of 35 days after planting, immature rice straw compost 2 tons/ha also incorporated among the paddy rows. In addition to solid organic fertilizer, also organic liquid fertilizer and organic pesticides were sprayed at intervals of one weeks from the age of two weeks until the age of 60 days after planting. Solid organic fertilizer (Bokashi), liquid organic fertilizer, and organic pesticides used was produced in the manner described previously.

d) mentoring the farmers, regarding to rice cultivation that using organic fertilizers and pesticides. This activities start from planting to harvesting preparation (tillage, application of organic fertilizer, seed selection, planting system SRI, fertilization, pest and disease control, harvesting). First mentoring is organic cultivation that was conducted on 0.35 ha of farmer land by applying organic fertilizer as much as 6 tons/ha and liquid organic fertilizer every two weeks, organic pesticides, application EM4 solution to accelerating the straw decompotition, and application of immature rice straw comppost on 35 days after planting. Beside solid organic fertilizer, liquid organic fertilizer and organic pesticides were applied also. Second mentoring is semi-organic rice cultivation that was conducted on 0.45 ha of land. Fertilizer used include solid organic fertilizer 2 ton/ha, urea fertilizer 200 kg/ha, SP 36 100 kg/ha, KCl 100 kg/ha, and immature rice straw compost 2 ton/ha immersed among the paddy rows at age of 35 days after planting. Organic and semi-organic cultivation compared with inorganic cultivation that done by farmers on 0.35 ha. Farmers used to use fertilizer in high doses, ie urea 400 kg/ha, SP36 200 g/ha, and ZA 100 kg/ha.

e) discussing with the farmers, by field meeting to discuss he results of the demonstration plot of organic fertilizers and pesticides application.

Data Collection and Analysis Techniques

The data of responses in the dissemination activities are collected by interviews and observations techniques, while the crop yield data were collected through direct observation in the field with a tile of 2.5m x2.5 m and subsequently converted into units of hectar. The effectiveness of extention and training activities were analyzed by using an indicator of knowledge and ability of farmers to make organic fertilizers and pesticides. Amudavi et al. [12] used the indicator to see the effectiveness of push and pull technology education to control insects and weeds. Demonstration plot and mentoring activities of organic fertilizers and pesticides were analysed by comparing the production yields among technology were used on the demonstration plot and mentoring plot, also comparing it with the production yields of farmers that planted around the demonstration plot area.

III. Results And Discussion

To maximize the eco-friendly agro-ecosystem service function, agricultural technology innovation efforts are needed. Extention and training activities of technological innovationis needed to improve the understanding and skills of farmers, included the farmers behavior regarding of chemical fertilizers uses.

Farmer Respones to Extension and Training Activites

This extension, is expected to increases the level of knowledge,skills, abilities, attitudes, and motivations of farmers on sustainable rice farming activities.Farmers responded positively, it showed by the level of attendance of farmers in the activity is reached 95 % and farmers were actively joined in the discussion during the implementation of extension activities. The farmers were interested with the activivity and it showed by many questions were raised by farmers in the discussion, regarding to the technology of organic fertilizers and pesticides. Farmers were interested to specific location-organic fertilizers and pesticides uses, it because the material was easily to find out. The technology would easily adopted by farmer if it had a simple procedure, not complicated, and easy to conduct [13].

Farmers realized that their farm is degraded, declining in soil fertility and ecosystem were disrupted, causing increasingly uncontrollable pests and diseases such as stem borers, rats, and blast. This is evidenced by the statement of one of the farmers and other farmers is justified by: "*Yeah, so less fertile rice fields, if fertilizer doses does not give more than previous season so the production will decrease. Now a lot of pests, such as caterpillar in rice straw and blast*".

The best solution to improve the condition of the land is using a solution of Effective Microorganism (EM), rice straw compost, organic fertilizers and pesticides that can be made by utilizing the materials around the house as well as farmers' fields. The solution based on the research results of the use of straw and Effective Microorganism (EM) to improve soil fertility either the physical, chemical and biological [6, 8, 14, 15].

Farmers showed the positive response to the training activities, which farmers are very enthusiastic in asking questions and discussion. As many as 62% of farmers actively asked and expressed their opinions. Questions that arise related to some of the benefits of each of the materials used for producing organic fertilizers, organic pesticides to control pest populations, reducing the doses of chemical fertilizers by using Bokashi fertilizer. It showed that the knowledge and skills of the farmers were increased. It could be used to measure the success rate of technology dissemination [12].

Organic Fertilizer Demonstration Plot

Demplot results indicated that grain production is higher than farmers production around demonstration plots that using inorganic fertilizer technology and higher than grain production that reported by the Badan Pusat Statistik Kabupaten Sumenep (Central Bureau of Statistics) in 2013, which is 6.05 tons / ha. Additionally, grain production is still higher when compared with uses immature rice straw compost between the rows and Azolla cultivation, the production reached 6.17 tons / ha (Ekawati et al., 2014). Table 2 showed that all variants of organic fertilizers could be used to increasing the rice production. Bokhasi fertilizer produced higher production yield compared with organic fertilizers on the market. Demonstration is effective way to conduct the extension activities on agricultural technology and easy to farmers to see the positive results of the method [16].

Table 2. Rice Production of Application of Organic Fertilizers and Pesticides Demonstration Plot in Gedungan Village, Batuan District

Types of Organic Fertilizer	Production (ton/ha)
1. Petroganik(product sold in the market)	7,36
2. KudaLaut(product sold in the market)	7,68
3. Bokashi made by farmers	8,16

Mentoring of Organic Rice Cultivation

Mentoring activitiy was conducted on three members of Sumber Hasil Farmer Group in Patean village. Technological innovation of organic fertilizers and pesticides applied on rice cultivation with an area of approximately 1.5 hectares. One of the farmers applied organic rice cultivation, semi-organic and no organic fertilizer (pure inorganic) at a nearby location. Both other farmers applied only semi-organic rice cultivation. Mentoring activity was conducted starting from planting preparation to harvest. Details of the activities listed in Table 3.

Table 3. Types of Mentoring activities in rice cultivation in Patean Village

No.	Types of Activity	Details
1.	Produce of bokhasi	3 ton
2.	Produce of rice straw compost in the field	Volume 3 x2 x0,8 m^3
3.	EM4 solution spraying to rice straw in the field	3 places
4.	Soil tillage	hand traktor used
5.	Basic fertilization (bokhasi + anorganic fertilizer)	bokhasi 6 ton/ha
6.	Planting, row spacing 25 x 25 cm	
7.	Making Liquid organic fertilizer and organic pesticides	30 liter
8.	Application of liquid organic fertilizer and organic pesticides to rice plant age of 2 weeks until 10 weeks	Every week in the morning
9.	Application of rice straw compost at age 35 after planting and supplementary fertilization	Compost used was the result of in-field composting
10.	Observation of plant growth and development of pests and diseases	
11.	Harvesting	

Table 4 shows that the high rice production is obtained by organic cultivation. Its supported by the positive habits of farmers that leaving the straw at harvest about 40 cm height remained in the land, and return it in a fresh at the same time of tillage. But farmers did not realized that their behavior impacts on the improvement of soil fertility.

Table 4. Rice Production

Cultivation	Rice production (tons/ha)
Organic	8.32
Semi-organic	7.84
Inorganic	7.57

The results of field observation showed that the habits of fresh hay returns simultaneously tilling resulted in the early growth of rice plants become yellow as a result of N-immobilization. This is temporary only, then the rice plants grow well. Returns straw resulting in immobilization of N-fertilization through turnover microorganisms [17]. It is actually a process of formation of the pool which can mineralize immediately to supply N for plants. To reduce the impact of immobilizing N, it needs to be balanced with N fertilization or cultivation of Azolla among the rows of rice plants [8]. Incorporating straw habits need to be preserved, due to the return of straw in the longterm contribute to improve soil fertility [18].

To implement a package of pure organic rice cultivation technology, by utilizing organic fertilizer (Bokashi) and rice straw compost among the rows, the farmers found some of difficulties. The problem are the distance between location of Bokashi production to the land is a bit far, it caused need transportation and more labor to apply the bokashi. This problem is solved by applying the maximum utilization of rice straw for composted on the field, based on the specific location- liquid organic fertilizers and organic pesticides. In order to quickly decomposing rice straw and not interfere with the growth of plants, needed the application of EM solution or a solution of beneficial microorganisms consortium one week before tillage. Consortium of cellulolytic and N fixing bacterias proven to accelerate the decomposition of rice straw [19].

Production yield were increased to average of 1, 62 tons/ha significantly by the application of organic technology. The results of integrated crop management technology application that included the return of organic matter in Indonesia might also increased the grain yield at the farm level average 1 ton of dry milled grain/ha [20]. This high production yield would support the realization of food self-sufficiency farming household, increasing the grain production. Household needs, secondary needs and farming costs would be solved.

Technology Adoption

Evaluation of counseling and training activities showed that approximately 70 % of farmers had the knowledge regarding to the benefits of organic fertilizers and pesticides, detail step to produce the organic fertilizers and pesticides. However, only four farmers who were willing and able to produce organic fertilizers and pesticides independently and had plan to apply it to the next rice planting season in a sustainable manner .While the rest of farmers were considered to apply this technology, regarding to their limited-work hour to produce and apply the organic fertilizers and pesticides on their field.

Response of the farmer to the demonstration plot activities could be seen from field meeting andtheir participate in the observation of plant growth and development on the field. Two farmers were involved in demplot activities and convinced that the application of organic fertilizers could improve the rice production, although the dose of urea is reduced by up to 60 % of 500-600 kg/haper dose. The number of farmers that convinced by this technology were increased, and hope their field would begrow more lush.The similar result were found in the adoption of organic farming by Wollni and Anderssen, [21].

Farmers that were involved in the implementation of the pilot project and mentoring are prepared as extension agents to disseminate technology organic fertilizers and pesticides to other farmers .The extension farmershould be upgraded by training and more experiences on the field demonstrations [12]. Extension farmershad an important role and high potential agent to spread the disseminating technological innovations to other farmer [22]. The uses of organic pesticides to control plant pests was well-accepted by the farmer. It was showed by application of organic pesticides on the rice and tobacco field. Farmers adopted the technology because the organic pesticides couldreduce the risk of production yield loss. In this case, financial factors became into consideration to the farmers, as well as the research results that conducted by Upadhyay et al. [23] regarding to the adoption of conservation techniques . In this program, there is information transfer between one farmer to the other. The application of technological innovation organic fertilizers and pesticides on the rice farming could produce higher production yield and the growth of rice on demonstration plots were better than the rice crop in the vicinity. With the good result by the application of this technology, the farmers would concern to apply the organic fertilizer and pesticide on their field.

IV. Conclusion

Dissemination of technological innovation organic fertilizer and pesticides to achieve sustainable food independent village , can be summed up as follows :

1. Farmers realized that they used inorganic fertilizer in excessive doses,
2. Farmers were skillful, understand the objective and apply the technological innovations organic fertilizers and pesticides in rice farming as much as 70 % of total member, and there are farmers who apply the organic rice cultivation technology independently,
3. Organic fertilizer and pesticides inovation that were disseminated could increased the production yield of grain of 1.62 tonnes/ha by average in order to support the self-sufficiency of farm households.

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