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Development of Organic Rice Cultivation through Dual System of Azolla microphylla in Gentungan, Mojogedang, Karanganyar, Indonesia

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ABSTRACT

The use of *Azolla microphylla* (Azolla) as organic fertilizer or green manure is not yet known by the Farmer Group (FG) of Tani Mulyo 1 and Tani Mulyo 5. Moreover, a dual system of Azolla is applied to organic rice cultivation. The dual system of Azolla uses Azolla as a fertilizer and as a deterrent to the growth of weeds that interfere with rice plants. This partnership program aims to increase partners' knowledge about the dual system of Azolla, assistance, and also practice of Azolla application on cultivated organic paddy fields. The stages of activities are socialization, counseling, mentoring, practice of Azolla application, and monitoring-evaluation. The results showed that the participants' knowledge about Azolla before the activity was 25% very not know, 45% not know, and 15% know enough. There was an increase in participants' understanding of Azolla dual system after the activity, 65% know and 25% very know or increased up to 100% compared to before the activity. The results of participant satisfaction showed that 65% of participants were satisfied and 10% are very satisfied with the activities carried out. As many as 70% of the partners stated that they would apply the dual system of Azolla in organic rice cultivation. The increasing understanding and awareness of partners will affect the development of organic rice cultivation.

Keywords**:** farmer group, green manure, organic fertilizer, organic paddy field.

INTRODUCTION

Rice is a staple food for almost everyone in Indonesia, needs per capita are 1,504 kg per week or 78.21 kg in 2019 (Badan Pusat Statistik, 2020). This also makes rice production as a producer of rice one of the indicators of national food security. Increasing rice production is carried out with various programs by the government, but problems often arise repeatedly. One of the problems is the limited fertilizer supply produced by chemical fertilizer. Many farmers are trying to switch to using organic fertilizers from inorganic fertilizers because of the unavailability of stock and price. Organic fertilizers are used as a substitute for inorganic fertilizers in organic rice cultivation with a higher economic value. Organic fertilizers, such as cow dung, are generally made from animal manure, so organic rice cultivation is often integrated with animal husbandry. However, for farmers with narrow paddy fields and little capital, integrating with cattle farming is often an obstacle. This effort is in line with integrated agriculture which encourages the development of organic rice. However, many small farmers do not have paddy fields and capital, so the organic fertilizer they need depends on other people.

Organic rice cultivation is cultivation that uses fertilizers, irrigation, and land management that is free from chemical products. An easy alternative to providing organic fertilizer is through the application of Azolla. Azolla has a high nutrient content, it can be an alternative to organic fertilizers and green manures that are cheap and easy to get. Farmers Group (FG) Tani Mulyo 1 and Tani Mulyo 5 have integrated organic rice with cattle. More organic fertilizer is needed to increase rice cultivation in a wider area so that cattle capital is also more significant. Finding alternative sources of organic fertilizer besides cow dung is necessary.

One alternative solution for organic fertilizer sources is Azolla (Syamsiyah, Sunarminto, & Mujiyo, 2018). Azolla is a source of organic fertilizer that can reduce inorganic fertilizers, especially for nitrogen (Syamsiyah, Herdiansyah, & Hartati, 2021), the biomass of Azolla contains essential nutrients such as total wet N drain 2.80 – 3.04 %, P_2O_5 2.02 – 2.10 %;

K_2O 9.06 – 9.72 %, and total organic C 40.75 – 42.88 % (Sambodo, Sudadi, & Sumarno, 2014; Sudadi, Sumarno, & Handi, 2015; Syarif, Widijanto, & Sumarno, 2013). Previous research stated that *Azolla pinnata* also contains various nutrients, including N (1.96-5.30%), P (0.16-1.59%), Si (0.16-3,35%), Ca (0.31- 5.97%), Fe (0.04-0.59%), Mg (0.22-0.66%), Zn (26-989 ppm), Mn (66 – 2944 ppm) (Indarmawan, 2012), and dry matter (89.73%), organic matter (75.73-82.66%), crude protein (22.48-35.49%), crude fiber (14.7%), *ether extract* (3.7-4.5%) (Yanshi & Rahal, 2019).

Much research has been done to investigate the benefits of Azolla. The results showed that compost enriched with *Azolla microphylla* had a significant effect on the growth of king grass (Qohar et al., 2020), Azolla can be used as an alternative feed for livestock or as a raw ingredient for making bio-organic fertilizers (Widianingrum, Dewi, Fanata, & Sholikhah, 2021), application of Azolla and chicken manure showed the best growth in plant height and number of tillers in rice plants and increase the nitrogen and phosphate uptake (Syamsiyah et al., 2018), Azolla-bacterial consortium is able to reduce the residue concentration of As up to 25% in soil and reduce As uptake in grains (Agnihotri et al., 2022), the application of liquid organic fertilizer of *Azolla microphylla* with a concentration 1% (200 ml dilute by 20 liters of water) showed the best vegetative of soybean growth and productivity (Yaqiin et al., 2022), and Azolla compost does not increase carbon emissions at a dose of 8 tons ha^{-1} (Rosalina & Kahar, 2018).

Using Azolla as an organic fertilizer will encourage the development of organic rice because farmers get alternative organic fertilizers that have multiple benefits. Utilization of dual system Azolla will significantly assist farmers in developing organic rice, because it is able to inhibit weeds in the fields and provides benefits as organic fertilizer so that for the expansion of organic rice cultivation, it is not too dependent on organic fertilizers derived from livestock manure (Thapa & Poudel, 2021). However, the knowledge of applying dual system Azolla has not been understood by the majority of farmers. The purpose of this activity is to increase the understanding of partners, Farmer Groups Tani Mulyo 1 and 5 on Azolla cultivation through mentoring and direct practice of Azolla application with a dual system in organic rice cultivation.

METHODS

This activity was carried out in Gentungan Village, Mojogedang District, Karanganyar Regency, Indonesia, located at 7º32'57" S and 111º0'47" E. Partners are members of the Farmer Group Tani Mulyo 1 and Tani Mulyo 5. The activity was held from April until November 2021. The step of activities include:

Preparation

Preparation begins with coordination between teams to arrange the plans regarding what will be done until the completion of the activity. After discussing the detailed plans in the final, coordination with partners will continue so that these activities can be aligned with conditions in the field.

Counseling on the cultivation and utilization of Azolla

Counseling is a learning process for partners so that they are willing and able to access information technology to increase their productivity, income and welfare (Vintarno et al., 2019). The counseling material is Azolla's benefits, which are delivered to partner of FG. Tani Mulyo 1 and Tani Mulyo 5. The partner's role is to provide meeting place facilities.

Assistance of Azolla cultivation

Azolla assistance was carried out in 2 stages: Azolla propagation in the ponds and Azolla cultivation from propagated in the paddy fields. Azolla propagation aims in the ponds to provide partners with knowledge about how to propagate Azolla in a simple way. Meanwhile, Azolla cultivation in paddy fields aims to provide partners with knowledge about applying the Azolla dual system in paddy fields.

Monitoring and evaluation

The last step is monitoring and evaluation which is carried out together with the partner. Monitoring and evaluation is intended to determine deficiencies so that improvements can be made so that the activity's objectives can be achieved and to measure the achievement of activity objectives. Evaluation is measured by the results of the questionnaire filled out by the participants.

RESULT AND DISCUSSION

Preparation

The activity plans designed by the team are submitted to the core management of the

farmer groups through a Focus Group Discussion (FGD) meeting. The step of this FGD is to collect opinions and wishes from members of farmer groups in accordance with the topic and step of the service activities that will be held. In addition, a survey was also carried out to illustrate the suitability between the planning and the conditions in the field.

The results of the meeting were agreed upon for the implementation of counseling and training activities, especially the application to rice field demonstration plots to be carried out in planting season III around July 2021 because planting season II has already started so it will be less optimal if it is carried out in planting season II. The location of the demonstration plot is in the upstream part because the water supply is usually less, so to prevent drought or failure it will be carried out at that location to prevent drought or failure.

Counseling on the cultivation and utilization of Azolla

The next step was counseling on cultivating and utilizing Azolla as a source of organic matter for agriculture. In this activity, soil fertility is explained as additional knowledge to members of farmer groups. Next is described about Azolla and how to cultivate it. The more important part is the discussion session about the benefits, advantages, and obstacles during cultivation (Fig. 1).

At the end of the meeting, a training plan and practice on a demonstration plot of rice fields and ponds that became Azolla cultivation was discussed. The initial plan for the location will be carried out in a more upstream part, finally agreed on in an area with easier access to attract the attention of other communities. This is due to the consideration that the weather conditions have entered a wet-dry season so that water availability for irrigation is felt to be sufficient, especially since the application of Azolla in paddy fields does not always have to be inundated.

Figure 1. The situation of counseling on the cultivation and utilization of Azolla

Assistance of Azolla cultivation

Assistance of Azolla cultivation is a step to practice cultivating Azolla through planting/propagation in the ponds and spreading it in paddy fields. The first stage is the cultivation of Azolla in a tarpaulin pond which aims to propagate Azolla. The pool is made of plastic with a 3 m x 2 x 1 m pool size. The pool is filled with water to a height of about 75 cm. The bottom of the pond is given soil and manure which is useful for reducing heat and as a source of Azolla nutrition. Azolla seeds were spread evenly on the surface of the water (Fig. 2). For a pond 3 x 2 x 1 m, the estimated need for Azolla seeds is around 1 kg of wet Azolla. After 2 weeks, Azolla can be harvested (Fig. 3).

The second step is spreading the harvested Azolla from the pond to the paddy fields. Azolla is spread evenly on paddy fields before planting. Planting or stocking of Azolla is done at the beginning of the growing season when the fields are flooded (Fig. 4).

Figure 2. Azolla propagation using plastic ponds

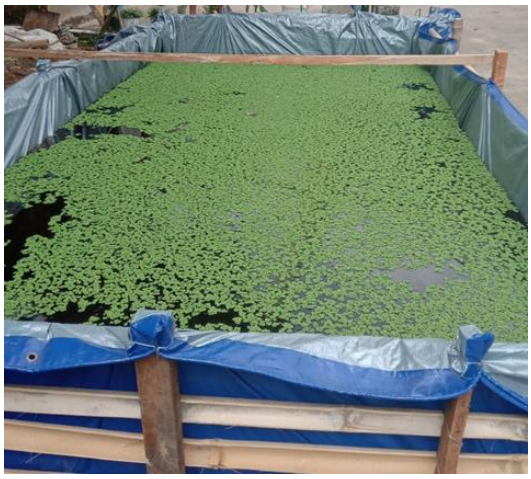

Figure 3. Azolla growth after 1 week after spreading

Figure 4. Spreading the harvested Azolla from the pond to the paddy fields

Figure 5. Azolla spread on the surface water

Two techniques for spreading Azolla in paddy fields are called dual system of Azolla. The first is that Azolla is spread on the surface of the water (Fig. 5) and the second is by immersing it in the soil. Azolla spread on the surface of the water functions as a free N-fixation from the air, while Azolla immersed in the soil functions as organic matter as a source of nutrients for plants. Azolla was also immersed in the soil to show partners that Azolla could be used as organic fertilizer and applied easily. Apart from these activities, there was also a discussion regarding utilizing Azolla for catfish feed. It was stated that Azolla also has the potential to be a catfish feed and can increase the economic value of selling catfish (Sudadi, 2017; Sudadi & Suryono, 2016). Based on these practices and discussions, farmers are interested in developing Azolla as a source of organic fertilizer.

Azolla which spreads in paddy fields, can be applied when the rice is 20-25 days after planting. At this time, Azolla is estimated to have reached around 7-10 tons or has covered paddy fields. Azolla application is carried out by immersing the Azolla to paddy fields together with weeding. About 2 tonnes ha-1 or 200 g m-2 of fresh Azolla was evenly immersed in mixed water conditions. The method for immersing Azolla is as follows: if the rice fields are flooded, water is drained from the rice fields until the soil is not flooded, and then Azolla is leveled on the ground, then stepped on along with the weeds. Apart from being stepped on, rice-weeding tools, such as porcupines, can also be used. After the Azolla and weeds were immersed, the water was irrigated back to a 5-8 cm height. Azolla can also be given during the second rice weeding similarly.

Monitoring dan evaluation

Monitoring is carried out incidentally by visiting the locations. Monitoring aims to monitor and provide quick solutions when the activity process does not run with a plan and target. In contrast, the evaluation aims to evaluate the results of activities and determine the factors that inhibit them. Evaluation is carried out after harvest. Evaluation of activities is carried out by taking sample data from partners through a questionnaire. Questionnaires were distributed before and after the activity to find out the changes. This step-by-step measurement aims to compare the measurement results, whether there is an increase in understanding of participants from before and after participating in the activity so that the achievement evaluation becomes measurable. Questionnaires before and after the activity were filled out by all participants, with a total of 30 respondents. The profile of the participant has a non-productive age (above 50 years old) with an average education is elementary school and junior high school, influencing the thinking power and ability to adopt new knowledge. In addition to using a questionnaire, evaluation is also conducted through discussion. Farmers conveyed their experiences and obstacles encountered in applying Azolla as organic fertilizer in growing season I.

Table 1. The result of questionnaires before the activities

Questions	Before the activities					
	Very Not	Not Know	Know enough	Know	Very Know	Total (%)
Do you know *Azolla microphylla*?	25.00	45.00	15.00	15.00	0.00	100.00
Do you know how to apply Azolla as organic fertilizer?	35.00	35.00	30.00	0.00	0.00	100.00

Table 2. The result of questionnaires after the activities

Questions	After the activities					
	Very Not	Not Know	Know enough	Know	Very Know	Total (%)
Do you know *Azolla microphylla*?	0	0.00	25.00	65.00	10.00	100.00
Do you knew how to apply Azolla as organic fertilizer?	0.00	0.00	25.00	75.00	0.00	100.00
Do you understand the material presented by the speaker?	0.00	0.00	16.00	59.00	25.00	100.00
Are you satisfied with the speakers presented?	0.00	0.00	31.00	64.00	5.00	100.00
Are you satisfied with the counseling activities?	0.00	0.00	25.00	65.00	10.00	100.00
Was the counseling useful for you?	0.00	0.00	10.00	67.00	23.00	100.00
Will you always apply the dual system of Azolla in organic rice cultivation?	0.00	5.00	25.00	70.00	0.00	100.00

The results of the questionnaire evaluation showed that before the activity was carried out, farmers' knowledge about Azolla was still very low, as many as 25% of participants said they really did not know, 45% of participants said they did not know enough, 15% of participants said they knew enough, and 15% of participants said they knew well (Table. 1). Other results, before the activity was carried out, data obtained that as many as 35% of the participants did not understand how to apply Azolla for organic fertilizer at all, 35% stated that they did not understand enough, and 30% stated that they quite understood the application of Azolla (Table 1). The results of the questionnaire before the activity showed that the participants' level of knowledge and understanding of Azolla and its cultivation was still very low.

After carrying out counseling activities, cultivation practices, and application of Azolla in a dual system (Table. 2), the evaluation results showed that 25% of participants stated they knew enough, 65% know, and 10% very know. As many as 25% know enough and 75% of participants know how to apply of Azolla as an organic fertilizer in rice cultivation. Evaluation regarding the understanding and quality of the resource persons showed that 59% of the participants stated that they understood the material presented by the speaker well, 64% of the participants were satisfied with the speaker, 65% of the participants stated that they were satisfied with all activities, and as many as 65% stated that the activities were useful and 10% of participants stated that the activities were very useful. Regarding the question of the

sustainability of using Azolla in rice cultivation, as many as 70% of participants stated that they were good or would always use Azolla in rice cultivation. The un-optimal result is the worry of farmers if there is no supply of Azolla during the new planting season. Azolla was depleted and died just before the rice harvest. The farmers' worries were finally reduced when the servant explained that Azolla could grow again in the fields where Azolla had previously been applied. So that in the next growing season, Azolla can grow by itself. It makes it more attractive for farmers to develop Azolla as an alternative to organic fertilizer in paddy fields. There was an increase in the percentage of understanding participants from very low understanding (before the activity) of 0% to 70% after the activity, and the level of good-very good understanding increased to 75% after the activity was carried out.

CONCLUSION

The development of organic rice through the application of Azolla microphylla with a dual system is an attempt to provide an alternative to organic fertilizers. Farmers have not known about the benefits of Azolla as organic fertilizer. The steps of the activity were carried out well. The activity begins with socialization to introduce the team and the activities carried out. Furthermore, counseling was conducted about the benefits and how to apply Azolla in paddy fields. After the participants understand the material provided, the next step is assistance on how to cultivate Azolla. If the cultivated Azolla is ready, the next step is the practice of applying Azolla to paddy fields. The steps of the activity do well. The results of the activity were able to increase understanding of the use of Azolla as organic fertilizer through a dual system. As many as 25% of the participants stated that they did not know, 45% did not know, and 15% knew enough about Azolla before the activity was carried out. There was an increase in participants' understanding after participating in the activity, namely 65% of participants said they knew and 25% very knew or an increase of 100% compared to before the activity was carried out. The results of participant satisfaction show that 65% of participants are satisfied and 10% are very satisfied with the activities carried out. There was a decrease in the percentage of understanding participants from very poor understanding (before the activity) of 70% to 0% after the activity, and the level of good-very good understanding increased to 75% after the activity was carried out. As many as 70% of the participants stated that they would apply the dual Azolla system in organic rice cultivation.

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