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Production and Application of Organic Fertilizer for White Leg Shrimp and Milkfish Cultivation

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Abstract The slow growth of white leg shrimp and milkfish cultivation became a concern in the location of community service activity (PKM). This was mainly due to food limitation, especially concerning the difficulty in natural food development. The purpose of this endeavor is to apply the production technology and application of organic fertilizer for the cultivation of white leg shrimp and milkfish along the marginal embankments. This endeavor was carried out in April to November 2019 in Mondoe Village, Konawe Selatan District, Southeast Sulawesi. This activity was manifested by providing production facilities, training, production of organic fertilizer, the use of organic fertilizer, white leg shrimp and milkfish cultivation, monitoring, and activities evaluation. The implementation of this activity was able to increase the knowledge, perception, and skills of participants as partners in producing fermented organic fertilizer. The application of the use of organic fertilizer was able to provide alternatives and overcome the limitation of fertilizer for aquaculture businesses in embankments. The results of this PKM were proven to be able to improve partners' knowledge and skills and provide solutions in overcoming the limitation of fertilizer especially in terms of aquaculture businesses in embankments.

1. INTRODUCTION

The embankment area which is located in Mondoe Village, South Palangga District, South Konawe Regency, Southeast Sulawesi was classified as a suitable area for fish cultivation. However, the production of shrimp or fish farming in the embankments was particularly not optimal, and farmers often failed to harvest, especially the white leg shrimp or milkfish. It was an irony as shrimp culture is a product with a lot of potential, especially with the introduction of white leg shrimp whose productivity could reach six to ten tons/ha/year (Yasin, 2013).

A lack of natural food which grows in the embankments could affect the rearing period of milkfish, and it became longer so as to reach a period of five to nine months. The availability of natural food in the form of planktons, clutches, and mosses was very dependent on the presence of nutrients. These constraints can be overcome by planting natural foods through fertilization (Jasmine *et al*., 2011). However, the problem which was experienced by the embankment farming business belonging to the Sitto Mas Group was the limited availability of inorganic fertilizers, especially subsidized fertilizers. Fertilizers were usually only available at the beginning of the rearing period in limited quantities, and they were not supplied continuously. This condition had influenced maintenance period, business success, price of commodities produced, and embankment productivity. Moreover, the use of an organic fertilizer can cause environmental problems if it is side-based continuously in a long term (Mulyani *et al*., 2017).

The use of fermented organic fertilizer had not been applied in the local community because its basic knowledge and skills with regard to organic fertilizer which was technically fermented with probiotics were

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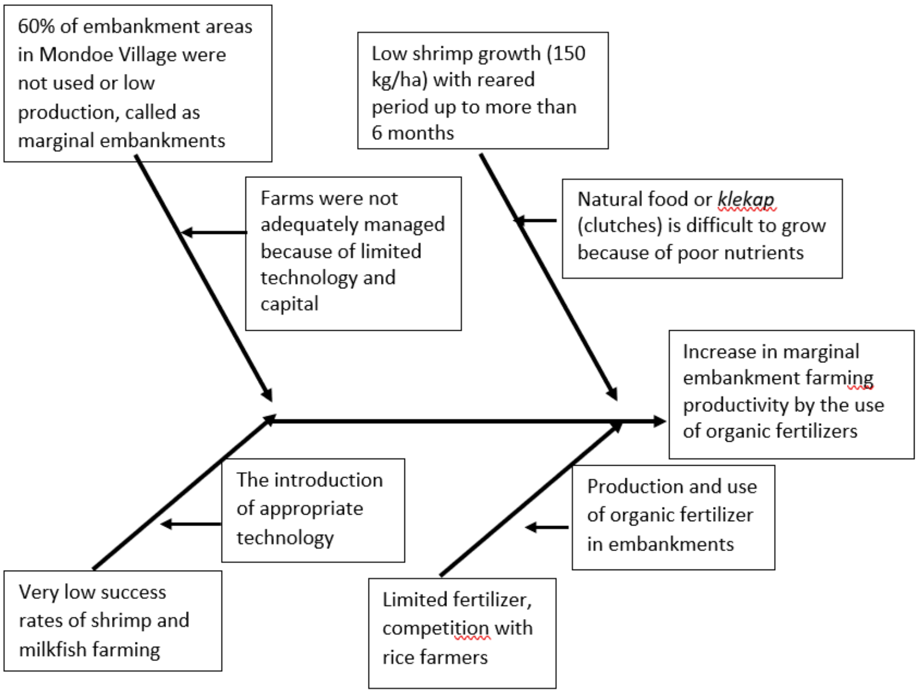

Figure 1. Fishbone analysis of problems and solutions in farming activities of PKM partners

still limited. The community around the area of PKM activities did not yet have comprehensive knowledge about about the method of using fermented organic fertilizer in an embankment for white leg shrimp or milkfish cultivation business activities. In fact, some ponds that used fermented organic fertilizer had been shown to optimally fertilize the waters and support the growth of fish or shrimp (Kifah *et al*., 2020).

Based on field monitoring and problem analysis (as presented in Figure1), problems that had been identified would be resolved through the following approaches: 1) the application of technology and provision of facilities to produce organic fertilizer, 2) application of technology for the use of organic fertilizer in white leg shrimp and milkfish farming in the embankments of the Sitto Mas Group. Hence, the purpose of this activity was to conduct training and introduce production techniques to produce fermented organic fertilizer in embankment cultivation.

The Integrated Multi-Trophic Aquaculture (IMTA) in aquaculture activities (milkfish, white leg shrimp, and seaweed cultivations in embankments) states that the three different commodities can grow well on fertilized embankments (Indrayani & Nur, 2017). A strategic alternative of development in the available fisheries sector involves increasing aquaculture activities in embankments using technology that is easily applied and environmentally friendly. Cultivation activities in embankment areas involve various elements that need to be considered, especially regarding aspects of designing environmentally friendly technology to provide significant economic values on a sustainable basis. The basic principles of environmental protection are to reduce soil and water degradation, reduce water and soil pollution from external factors, optimize biodiversity, and increase productivity.

The application of organic fish farming techniques can maintain the continuity of aquaculture (Smith & Swingle 2011; Diwan & Ayappan 2004), among other things, through the use of organic fertilizer (OF) in embankments. Application OF can increase the amount of chlorophyll significantly (Middleton, 2009). Aquaculture activities should be environmentally friendly, socially acceptable, and have high production (Trivana *et al.*, 2017). Organic fertilizer is fertilizer made from organic materials such as agricultural waste, kitchen waste, or livestock manure (including bat manure). Livestock manure can be used as it contains nutrient contents such as nitrogen (N), phosphorus (P), and potassium (K) (Singh *et al*., 2011). Organic matters play an important role in soil fertility through improving the physical, chemical, and biological properties of the soil (Acquaah 2005; Walsh & McDonnell 2012).

The principle of making the OF is to decompose organic material with the aid of decomposer species such as bacteria so that the organic material is mineralized to form nutrients. Nutrients can then be absorbed and used for the growth of photosynthetic aquatic organisms such as phytoplankton, mosses, and clutches in embankments. Natural foods are needed by white leg shrimp and milkfish, and they also function as producers of oxygen.

The results of the study on white leg shrimp conducted by *L. Vannamei* show that white leg shrimp that were reared in embankments with the use of the OF resulted in increased survival and production. The use of the OF had a significant reduction in the concentration of ammonia-N as well. (Adewumi *et al*., 2011). It is further explained that white leg shrimp production was doubled when given inorganic or organic fertilizer compared to tanks or embankments without fertilizer. This is an indication that the use of organic fertilizers can replace inorganic fertilizers (artificial fertilizers) in the embankments.

The acceleration of growth is the result of a combination of good quality of white leg shrimp larvae, suitable water quality, and an adequate supply of feed for the aquatic organisms. The growth of white leg shrimp and milkfish is very much determined by the availability of their feed. The availability of natural foods such as plankton and moss depends on the availability of nutrients. Therefore, increasing nutrients in the embankment in order that natural foods can flourish by using organic fertilizer can be a solution that can ensure the fulfillment of feed availability for white leg shrimp and milkfish.

The technology of the OF production is readily available and easy to apply. Based on a technical analysis, the use of organic fertilizers fermented with probiotics could be an alternative solution to be applied in the fish cultivation business belonging the community service program's partners by considering of the availability of raw materials in addition to the principle of economic value of environmental sustainability. Another advantage of the OF is that it does not directly decompose or sacks in water, meaning that there is no need to administer the OF every season for shrimp or fish stocking.

2. METHOD

2.1 Time and Location

This activity was carried out in Mondoe Village, South Pallangga Subdistrict, Konawe Selatan Regency from April to November 2019.

2.2 Knowledge Transfer and Training

Some activities which were conducted were in the forms of lectures, discussions followed by training and practice of making organic fertilizer, and application of the use of the produced fertilizer in embankments. The participants consisted of embankment farmers who came from different partner members and other communities who were interested in producing and using fermented organic fertilizer in their aquaculture.

2.3 The Production of Organic Fertilizer

Organic fertilizer (OF) can be made through aerobic and anaerobic methods, whereby the product qualities of the two are relatively the same. In this activity, the method was the anaerobic method, modified from previous methods (Atjo, 2016; Garg & Bhatnagar, 2002; Pantjara & Hendradjat, 2011; Kaur *et al*., 2015) by using probiotics or microorganisms' inoculants as decomposers. In the anaerobic method, high temperature can inhibit pathogenic bacteria, fungi, and weeds that are present in organic matter. The main raw materials which were used here was laying hens manure.

Supporting raw materials provided for the participants were probiotics, granulated sugar instead of molasses, and probiotic growing media. Provision of supporting equipment for making probiotics include hoses, shovels, tarpaulins, buckets, and sprinklers. The mixing process in the production of organic fertilizer was carried out at each partner location.

The production of organic fertilizer involved chicken manure, probiotics, and sugar that were mixed and fermented. Fertilizer production activities were done by participants and were guided directly by the implementing team of this community service activity.

2.4 The Application for Cultivation

Fermented organic fertilizers had been produced through the steps as shown in Figure 2. They were then used in white leg shrimp and milkfish farming. Before the application of organic fertilizer, some improvements were made to dike, sluice gates, draining embankments, and cleaning pests in embankments.

The application of organic fertilizer was carried out in the embankment yard where each embankment was sprinkled with one to two tons of organic fertilizer per ha. After the organic fertilizer was spread, then each embankment was filled with water. The water was poured in to each embankment gradually until reaching a high level. After the natural food such as plankton, moss and clutches developed, the white leg shrimp or milkfish seedlings were spread on each embankment. The activities continued with the period of maintenance, embankment control, and harvest of white leg shrimp and milkfish.

2.5 Evaluation Activities

This stage encompasses a review of the activities involved, such as some aspects which involved during the process along with the evaluation of resulting perception, knowledge, and skills acquired by the participants in terms of technology in making organic fertilizers and the use of organic fertilizers. The yield aspect that was measured was the production of organic fertilizer as well as white leg shrimp and milkfish harvest.

3. RESULT AND DISCUSSION

3.1 Knowledge Transfer, Discussion and Training

We carried out our initial outreach and implementation of the Community Service Program from May until September 2019. The participants were 20 people who earned their living as embankment farmers, orchard farmers, and fishermen. The knowledge of participants in fermented organic fertilizer increased compared with before they were given the knowledge and trained. The perception of participants in using organic fertilizers increased as well.

Participants directly and actively involved in the process of preparation, production, and application of organic fertilizer and subsequently in the raising of white leg shrimp and milkfish. After obtaining the results, most of the participants continued to use the technology even though this activity had ended because the target community had received the benefits from organic fertilizers, which they only received in limited amount due to limited distribution of subsidized inorganic fertilizers before the community service program.

3.2 Production and the Use of Organic Fertilizers

The fermented organic fertilizer was made from raw materials in the forms of chicken manure, probiotics, and sugar. Almost all tools and materials were obtained locally, making the organic fertilizer easier to manufacture. After all the ingredients were mixed well, then these underwent the fermentation process (Figure 3). Fertilizers could be produced up to four tons through the two stages of the process.

The organic fertilizer was produced by the partner company or individuals and then used in their aquaculture farms. A number of stages of the activity that were done comprised embankments and floodgates repair, embankment drying, and extermination of pests that lived in the embankments. The application of organic fertilizer was done by sprinkling 1.5 tons of organic fertilizer per ha. After the organic fertilizer was applied, water was poured into the embankments to a high level gradually.

The growth of natural foods, such as plankton, clutch, and moss took place after the resupply of water in the embankments and lasted for 10 to 20 days. It was characterized by the changing color of the water as well as the aquatic plants on the surface of the water (Figure 4). The use of waste as an organic fertilizer had been applied in several activities that also aimed to improve the quality of soil structure. Various types of biomass waste that had been utilized as organic fertilizer included animal waste, sewage sludge, municipal solid waste, and food waste (Chew *et al*., 2019).

After the development of natural food had taken place, it was followed by the spread of white leg shrimp or milkfish shrimp larvae at each partner's embankment. In the second month of the maintenance, water sampling was done for plankton quantity analysis, and the results showed that there were three dominant genera, namely *Chaetoceros*, *Oscillatoria* and *Protoperidinium* (Yusnaini & Nur, 2020) with large quantity. The control of fish and shrimp rearing, as suggested by Suwoyo (2016), should be done routinely. The monitoring of water quality and the growth of aquatic organisms was at one-month interval. The physiology of white leg shrimp could be disturbed

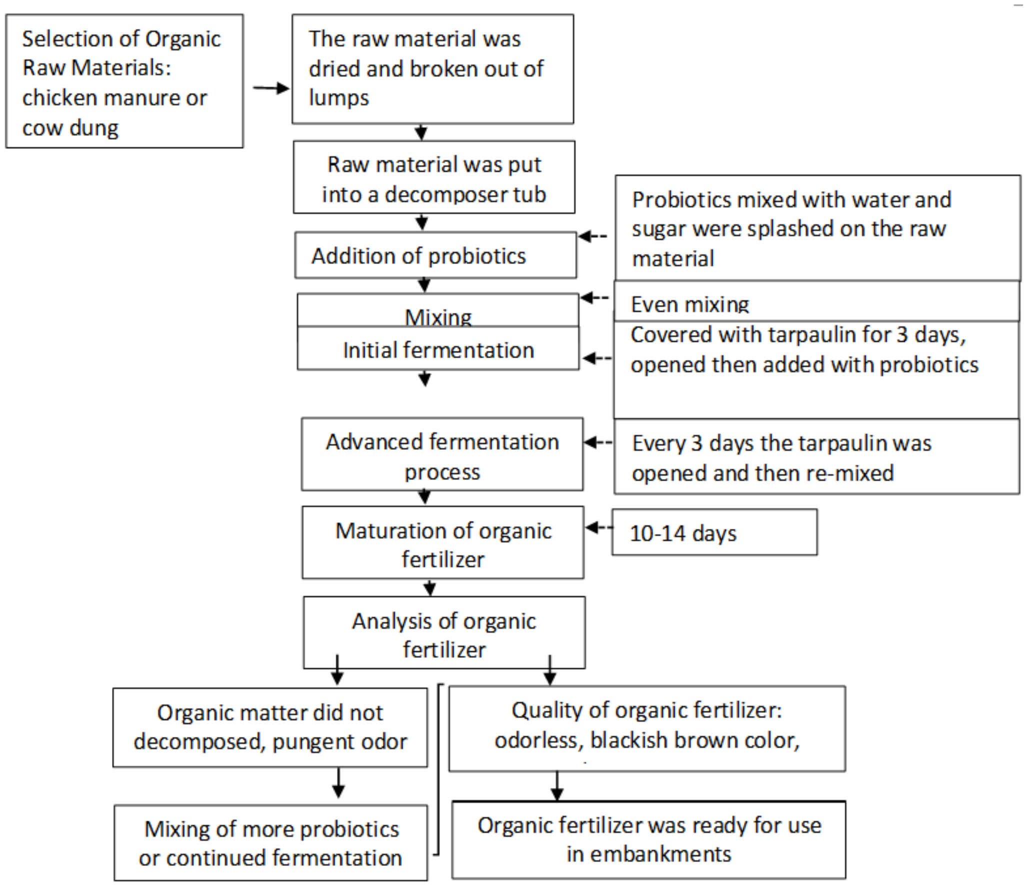

Figure 2. Stages of fermented organic fertilizer production

due to an extreme change of water quality, and this could be detected from the proliferation of hemocytes (Wangi *et al*., 2019). Likewise, if there was toxic in the embankment water, such as heavy metals, they would accumulate in the shrimp's body and affect the growth of the fish (Kumala *et al*., 2019).

Figure 3. Organic fertilizer production

Figure 4. Field of embankments overgrown with aquatic plant

3.3 Embankment Production

The milkfish harvest was carried out about four months after rearing. Generally, the rearing period for milk fish in traditional ponds is four to five months according to the pond fertility level. As Musa *et al.* (2016) stated it, natural feed stocks and milkfish growth are determined by soil condition and water quality. The gains that were obtained in this activity were quite satisfactory. The embankment production was 1.2 tons of healthy conditioned fish per ha with an average weight of 250g and a selling price of IDR14,000 per kg (Figure 5).

The production and the size of milkfish could have been increased by extending the maintenance period since natural food was still available. However, due to the transition from dry season and entry constraints the harvest was executed. In general, many obstacles would be faced if fish rearing was carried out in a transitional season, such as disease and mass mortality.

White leg shrimp harvest was brought in 66 days after rearing with the production of 287kg per ha. The shrimp survival rate (SR) was 41% with an average number of 80 shrimps per kg, and it was sold at IDR43,000 per kg. Figure 6 shows the partial harvest brought in by partners using simple tools in form of a modified net. Partial harvesting is an activity that was done in order to reduce a small portion of the shrimp biomass in one pond. Partial harvesting has various objectives, namely maintaining a balance between biomass and shrimp space, reducing waste production to make it easier to process and accelerate the growth of the shrimp.

Figure 5. Milkfish production

After reared for 66 days, the shrimp reached an average size of 12.5 g per shrimp, and it could be classified into the fast-growing category. Suwoyo claimed that white leg shrimps harvested from extensive aquaculture and rearing duration of ≥70 days could reach an average size of 10 g per shrimp. However, in this practice, shrimp harvest had SR level of <50%, which was categorized as a low level. It was assumed that it was caused by various factors, including poorly managed embankment preparations that might have been manifested in the existence of pests in the embankment when stocking.

Figure 6. White leg shrimp production

The application of this technology had stimulated the cultivation and increased the production of white leg shrimps and milkfish, especially for the Sitto Mas Partner Group. In general, the of implementation of the PKM activities had been realized with 100% success rate in terms of increasing the knowledge, skills, and the income of the target local community. Ideally, the rearing duration for milkfish needed to be extended, but due to unfavorable weather of the transition from dry to rainy season, the fish health was compromised, and it affected its survival. In addition, the SR was not optimal because a few days after the spread of seedlings a floods occurred, and the embankments were overflowed.

3.4 The Evaluation of Community Engagement and Sustainability Activities

In terms of the activity process, the results of the evaluation showed that after training, the knowledge of participants about organic fertilizer including the techniques available to be used for the application of small-scale organic fertilizer production had increased. The assessment in terms of the activity process that was based on the aspect of yield, the two groups had succeeded in conducting embankment aquaculture with satisfactory results. The growth of Shrimp and milkfish were rated as healthy, indicating that the harvest would bring benefits to the farming community.

4. CONCLUSION

The implementation of this activity was able to increase the knowledge, perceptions, and skills of the participants in producing fermented the organic fertilizer. Embankment management no longer depended on inorganic fertilizers. Livestock waste became more useful, and organic fertilizers could be produced at any time by the target local community. The use of the organic fertilizer was able to provide and alternative and overcame the limitation of fertilizer availability for the embankments. The subgrade of the embankment became fertile in such a way that it promoted the growth of natural food or clutches. There has been an increase in community's income because marginal farms had re-produced with satisfactory growth and survival rates of the white leg shrimp and milkfish. It is suggested that the pond farmers can take advantage of waste materials and innovate to improve productivity and community empowerment.

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