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Improving Soil Fertility Through Agricultural Waste Treatment in Subak Telun Ayah, Gianyar, Bali

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ABSTRACT

The community service carried out aims to increase the knowledge and understanding of farmers in the processing of agricultural waste, especially composting rice straw. Community service is also held to increase farmers' knowledge regarding the role of rice straw compost in improving soil fertility. The method used is socialization or counseling as a form of knowledge transfer to farmers. The socialization involved 20 members of the Subak Telun Ayah group, Gianyar Bali. The results show that due to limited knowledge of the benefits of rice straw for soil fertility, farmers tend to burn the agricultural waste produced. Farmers also do not believe in the benefits of compost so they prefer the use of inorganic fertilizers.

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INTRODUCTION

The burning of plant residues in the open field has become a concern, as it has a significant effect on climate change mitigation efforts. combustion has led to a decline in air quality and various health problems (Raza *et al*., 2022). There are still people who are unaware of the negative effects of open burning on the environment and health effects (Bajracharya *et al*., 2021). The practice of burning agricultural crop residues is a challenge in agricultural production systems, due to increased air pollution (Raza *et al*., 2022). Rice straw as one of the agricultural wastes tends to be burned by farmers. It is recorded that 30.34% of farmers in Klungkung Regency, Bali have a habit of burning the rice straw produced. Farmers' reason to eradicate pests and speed up waste management to pursue tillage for the next planting period (Muliarta, 2018).

The impact of combustion is the loss of soil nutrients, where the soil can lose all N elements, P elements are lost by about 25%, K elements are lost by about 20% and S elements are lost from 5 to 60%. The amount of nutrients lost during combustion is influenced by the methods used to burn rice straw waste (Dobermann & Fairhurst, 2002). Burning is carried out by farmers because of the lack of knowledge about how to process straw into compost. Field extension officers also do not provide knowledge on how to compost hay to farmers and only provide ways to compost manure (Muliarta, 2019). One of the burnings of rice straws is closely related to the type of crop that will be planted in the next planting period. Farmers believe that burning ash can increase the production of corn and peanuts (Muliarta, 2018).

Burning agricultural waste is the knowledge that farmers have gained for generations in managing waste. Even this practice causes farmers to lose the potential to compost raw materials to improve soil quality (Muliarta & Purba, 2020). The weight of rice straw waste is an indicator of the ability of rice plants to absorb nutrient content in the soil (Masganti, 2011). An increase in the amount of nutrient uptake by plants will help plant growth to be better and plant weight also increase (Mahmud *et al*., 2016). Fertilization treatment has a noticeable effect on the production of straw waste, in addition to the influence of plant varieties, weather, and planting methods (Rosmiza *et al*., 2014). Efforts to return rice straw waste to the ground are a solution to avoiding loss of organic matter content due to intensive cultivation (Gaind & Nain, 2011).

The nitrogen and potassium content in rice straw is a nutrient that is needed by plants. The return of rice straw to the ground is an important effort in maintaining the availability of soil K elements to meet the K elements needed by plants (Pavithira *et al*., 2017). Other important content in rice straw is C-organic around 44.71%, N-total around 1.08%, P reaches 0.17% and element K reaches 2.7% (Indriyati *et al*., 2008). The return of agricultural waste to the soil as organic matter, in addition to maintaining the availability of nutrients, also plays a role in maintaining soil microbial populations (Muliarta, 2020). The addition of organic matter in the form of agricultural waste containing C and N elements will have an impact on increasing the microbial population in the soil. An increase in the addition of organic matter to the soil will also be followed by an increase in microbial populations (Nirukshan *et al*., 2016). The use of agricultural waste as

organic matter to improve the soil is an effort to efficiently use inorganic fertilizers. This step will also reduce the volume and impact on the environment from agricultural waste pollution (Muliarta & Suanda, 2020).

The burning of agricultural waste, especially rice straw, has been very easy to find. The incineration of agricultural waste also occurs in Subak lands in Bali, such as in the Subak Area in the Tegalalang Village area, Gianyar Bali. Tegalalang Village is one of the villages that developed into a tourist area. The area is a mountainous area with an altitude of about 900 m above sea level with a longitudinal position towards the West. The territory of the village has a flat soil structure and is affected by two seasons (rainy and dry). The average rainfall in Tegalalang is around 146 mm/month and the average air temperature ranges from 15 ^{0}C-32 ^{0}C. Subak Telun Ayah is one of the Subak which administratively and geographically is part of the Tegalalang Village area. This Subak has a land area of 32 ha with a rice cultivation orientation. Straw waste produced in Subak Telun Ayah is generally burned. Subak member farmers want to process agricultural waste, so it requires socialization and training in hay processing. Farmers on the other hand have a desire to reduce the use of inorganic fertilizers and towards environmentally friendly agriculture. Farmers have a desire to process the hay produced, in addition to the difficulty of obtaining inorganic fertilizers, and also because of the desire to reduce pollution due to the incineration of agricultural waste. Another target is farmers who want to make the Subak Telun Ayah area an ecotourism area. The Subak Telun Ayah area has been one of the favorite locations for tourists to do trekking activities.

IMPLEMENTATION AND METHODS

1. Form of Activity

Community service is carried out in the form of socialization or counseling to partners, namely Subak Telun Ayah, Tegalalang Village, Gianyar, Bali. The form of socialization or counseling is chosen to transfer knowledge to farmers about the importance of utilizing agricultural waste for efforts to maintain soil quality and fertility. The goal is to increase understanding among farmers to reduce the cost of purchasing inorganic fertilizers and the importance of processing agricultural waste to realize sustainable agriculture. The choice of the word socialization or counseling is the same as lighting, where socialization also has a meaning as a transfer of knowledge. Socialization conceptually has the meaning of the science of human behavior in a social system (Amanah, 2017). Socialization if carried out by agricultural extension workers has a strategic meaning to help farmers in improving their farming business. Extension workers have a role in fostering farmers to manage their farming businesses to be effectively and efficiently, the final target is to increase farmers' income (Khairunnisa *et al*., 2021).

Socialization activities to improve soil fertility through agricultural waste treatment are carried out in several stages, namely:

a. Preparation of activities

The initial stage of preparation is carried out by determining the partners of the activity, by making visits to several Subak groups. The Subak Telun Ayah group was then chosen because it faced problems in agricultural waste management and the desire to use the waste to realize environmentally friendly agriculture. Another consideration is that the selection of Subak Telun Ayah is in line with the vision of Warmadewa University which has an ecotourism perspective, considering that the Subak Telun Ayah area has become one of the favorite locations for tourists to do trekking activities. The next stage is to ask for permission and willingness to carry out socialization activities by involving Subak members as participants. The Subak group was also asked to help provide a place for socialization and prepare participants. The results of coordination with Pekaseh (Chairman of Subak) agreed that the socialization activity would be held on April 25, 2022. The team of lecturers and students who will carry out the activity begins to prepare equipment, socialization materials, accommodation, and equipment donations.

b. Socialization

Socialization or counseling starts at 09.00 WITA to 12.15 WITA at Wantilan Pura Duur Bingin, Tegalalang Village, Gianyar, Bali. The implementation of the activity began with the introduction of the service team from the Faculty of Agriculture, Warmadewa University, and the introduction of the Subak management, as well as the problems of agricultural waste management faced. The presentation of the material was delivered by Dr. Desak Ketut Tristiana Sukmadewi, S.Si., M.Si for about 30 minutes. The presentation of the material was continued with discussion and familiarity with the Subak group. The material presented was related to the potential for agricultural waste production, utilization, agricultural waste content, agricultural waste treatment, and its relationship with soil fertility.

c. Closure

The socialization activity for improving soil fertility was closed with the handover of agricultural equipment in the form of hoes and sickles. The next event was a group photo as documentation of activities and a meal together. After the socialization activity, the service team prepares a report as a form of documentation for the implementation of the activity.

2. Goals

Socialization of improving soil fertility through agricultural waste treatment in Subak Telun Ayah, Gianyar Bali is specifically aimed at members of the Subak Telun Ayah group. The number of farmers involved in socialization activities is 20 people.

3. Outputs and outcame

The outputs of this community service activity include:

1. Subak members are given knowledge about the content of the agricultural waste and various alternative ways of utilization
2. Subak members are given knowledge about the benefits of agricultural waste for soil fertility and soil microbial diversity.
3. Subak members understand the material and are allowed to explore the material through discussion activities

Outcame obtained by farmers from socialization activities are:

1. There is an increase in farmers' knowledge regarding the role of agricultural waste to maintain soil quality and fertility.
2. Farmers have in-depth knowledge related to methods of utilization and treatment of agricultural waste so that it does not cause environmental pollution.
3. Socialization activities are also expected to have an impact on farmers' behavior in implementing fertilization balance, and slowly be able to reduce the use of inorganic fertilizers.
4. Farmers are expected to be able to implement environmentally friendly and sustainable agriculture.

RESULTS AND DISCUSSION

1. Farmers face limited knowledge in processing agricultural waste so it tends to be burned

Farmers in Subak Telun Ayah tend to burn rice straw waste because of their limited knowledge, awareness, and skills in managing rice straw waste. For the group of farmers in Subak Telun Ayah, the most practical way of managing rice straw waste is to burn the waste (Figure 1). However, the impact that will be caused on the surrounding environment has not been further understood. People prefer to burn straws and use chemical fertilizers to apply to plants. Bhuvaneshwari et al. (2019) stated that the incineration of agricultural waste has become an environmental problem and also a problem in terms of health, including as a contributor to global warming. Agricultural waste if processed will provide economic benefits, namely reducing production costs, increasing rice and corn incomes, and will improve the welfare of farmers (Yazid *et al*., 2020).

One of the efforts that can be done is to process this rice straw waste into compost. Another obstacle faced by farmers is that it requires costs, energy, and a long time in the composting process. Rice straw generally contains cellulose, hemicellulose, and lignin, as well as small amounts of protein that make the C/N value high, with the C/N value of fresh rice straw being 80-130. The high C/N ratio value causes the rice straw decomposition process to take a long time. If you wait for the decomposition process naturally, it will take a long time until it

reaches 12 months (Ikhsan *et al*., 2021). The presence of lignin causes rice straw to take a long time to be decomposed. Straw contains about 15-24% lignin and a consortium of lignin-decomposing microbes is needed to accelerate decomposition (Dash *et al*., 2022).

The solution that can be provided is to compost directly in the rice fields to reduce costs and labor in the transportation process. Efforts to speed up the composting process can be made with the addition of a decomposer. Decomposers that are easy to obtain can use the manure of raised livestock or use fertile soil. The results of the study on local cow dung in Palu contained three types of decomposing microbes, namely *Lactobacillus sp*, *Actinomycetes sp*, and *Aspergillus sp*. Decomposing microbes are living things that have an important role in decomposing materials derived from organic compounds that enter the environment as plant nutrients so that they can be reused by green plants (Idham *et al*., 2016).

Figure 1. Farmers tend to burn agricultural waste produced

2. Farmers do not yet know the content of rice straw and its benefits for soil fertility

Burning hay provides several disadvantages and causes nutrient loss which has an impact on decreasing soil fertility. Burning hay affects soil fertility, as it increases the potential for loss of nutrients present in the soil. These nutrients include nitrogen (N), phosphorus (P), potassium (K), and sulfur (S) successively reduced by 80%, 25%, 21%, and between 40% to 60%, as well as losing some other organic matter in the ground (Rhofita, 2016). Farmers have not realized that straw compost has a lot of nutrients that can increase soil fertility. The use of rice straw compost can reduce the use of inorganic fertilizers by 125 kilograms. The addition of rice straw compost can increase crop yields by 33 percent. This is thought to be because rice straw compost can minimize the release of nitrogen in the soil and improve soil structure (Salbiah *et al.*, 2013). The addition of rice straw compost by 5 tons per hectare is also able to increase vegetative growth (stem height and the number of saplings) by 22 percent, thereby increasing the amount of rice production (Putri, 2015).

Further education and assistance are needed for the community to be able to handle the problem of straw waste appropriately which can be beneficial for soil fertility. The assistance provided (Figure 2 and Figure 3) is expected to improve the ability of farmers to use agricultural waste as raw materials in making compost so that the community can reduce the level of environmental pollution caused by burning straws. According to Mousaei (2021), education and counseling services increase farmers' confidence in managing the environment and the waste produced.

Figure 2. Socialization Activities

3. Farmers are still pessimistic about the benefits of organic matter in improving soil fertility

Farmer groups in Subak Telun Ayah have not realized that the use of organic matter is one of the important factors to maintain soil fertility, both physical, chemical, and biological fertility of the soil. Farmers still use rice straw compost as an organic fertilizer, because they are worried that the effect will make plant growth not as good as when applied inorganic fertilizer. In this case, education related to the combined use of organic and inorganic fertilizers is important. Organic fertilizers are not like inorganic fertilizers that can provide a fast release of nutrients. Therefore, it is necessary to brief farmers that the use of organic and inorganic fertilizers can be combined, to improve fertilization efficiency and reduce the cost of using inorganic fertilizers (Figures 2 and 3). The combination of organic fertilizer (50%) and inorganic fertilizer (50%) can increase rice growth and yield compared to being fed with 100% inorganic fertilizer. In short, the combination of organic and inorganic fertilizers can reduce the use of inorganic fertilizers (Sunarpi *et al*., 2021). The simultaneous application of organic and inorganic fertilizers is also to improve soil and environmental health in the long term (Akther *et al*., 2019).

Organic fertilizers are able to maintain soil fertility in the long term to support sustainable agriculture. This organic fertilizer is able to improve the physical properties of the soil such as soil structure so that the capacity to hold groundwater becomes better, and the absorption of nutrients is optimal. Organic matter also improves soil aeration, so that roots and other soil biota get enough oxygen. In addition to physical properties, organic matter is also able to improve the chemical and biological properties of the soil. The improved chemical properties of the soil are the increased nutrient content, even though it is not as high as the content of inorganic fertilizers. Organic matter, biologically will increase and maintain the survival of soil biotas such as fauna and soil microbes. Soil microbes can help improve the availability and absorption of nutrients in the soil. According to Devianti et al. (2021), agricultural waste can be converted into useful materials such as compost or organic fertilizers. In simple terms, the waste is mixed with additional composting materials to enrich the nutrient and fertilizer composition. Waste that has become organic fertilizer will prevent and save the soil from the harmful effects of chemical fertilizers. Waste that is organic matter will provide improvements in the physical, chemical, and productivity properties of the soil (Karmakar et al., 2013). Organic matter on the other hand also contributes to an increase in soil microbial populations (Arslan *et al*., 2008).

Figure 3. Discussion on deepening socialization material

4. Farmers are still encouraged to use inorganic fertilizers and do not know the long-term impact

Farmers in Subak Telun Ayah generally still use inorganic fertilizers with high doses and intensive administration exceeding the recommended dose. This is done because farmers think that the more and more intensive the fertilizer is applied, it will be directly proportional to the results that will be obtained. Farmers are not yet aware of the long-term impacts of overapplying inorganic fertilizers. Excessive use of inorganic fertilizers will lead to a decrease in land productivity. If this is left unattended, it will cause criticality in agricultural land, causing a decrease in agricultural production. Applying fertilizers exceeding the recommended dose is often done by farmers, causing residues of chemical substances in the long term to cause criticality in the field (Soekamto & Fahrizal, 2019). Based on this, it is necessary to carry out proper and balanced fertilization

to ensure the optimum availability of nutrients so that the expected increase in crop yields is obtained. Efficient use of fertilizers is basically to apply fertilizer in a form and amount that suits the needs of the plant, in the right way and at the right time according to the needs and growth rate of the plant. Plants can use fertilizer optimally only on active rooting, but it is very difficult to absorb nutrients from dry or dense soil layers (Soekamto & Fahrizal, 2019).

CONCLUSIONS

Farmers face limited knowledge in the processing of agricultural waste so it tends to be burned. The solution that can be given is to do composting directly in the rice fields. Efforts to speed up the composting process can be done by adding easily available decomposers such as animal manure and fertile soil.Farmers have not realized that agricultural waste, especially rice straw waste, has a lot of nutrients that can increase soil fertility. Farmers are educated that rice straw compost improves soil organic matter to improve the physical, chemical, and biological properties of the soil.

RECOMMENDATIONS

Continuous socialization and assistance are needed to increase farmers' knowledge and understanding of the benefits of rice straw for soil fertility. The service carried out is also only limited to initial socialization, so in the future, it is necessary to follow the demonstration of plots to improve the skills of farmers in composting and how to use rice straw compost.

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