ABDIMAS: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang
Vol.7(4) November 2022, 663-675
p-ISSN: 2721-138X e-ISSN: 2548-7159
http://jurnal.unmer.ac.id/index.php/jpkm

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MALANG

Implementation of LEISA Concept through composting rice straw waste in Subak Telun Ayah, Tegallalang

Implementasi Konsep LEISA melalui pengomposan limbah jerami padi di Subak Telun Ayah, Tegallalang

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ARTICLE INFO:
Received: 2022-05-28
Revised: 2022-07-14
Accepted: 2022-08-20

Keywords:
Composting, LEISA Concept, Rice straw, Subak, Waste.

ABSTRACT

In general, many farmers tend to still regard rice straw as waste material that is burned. Burning rice straw is a bad habit because it removes organic matter that contains nutrients needed by plants. As a result, farmers require higher fertilizer costs in the next planting period which is contrary to the concept of Low External Input Sustainable Agriculture (LEISA). Community Service in Subak Telun Ayah aims to increase farmers' knowledge related to the use of compost in rice cultivation and as an effort to reduce inorganic fertilization. The methods used are surveys, interviews, discussions, counseling, and plot demonstrations. Farmers claim to burn rice straw because it is based on the knowledge passed down from generation to generation and it is believed that straw waste is quickly returned to the soil. Farmers do not do composting because they do not know how to compost rice straw. Based on farmers' problems, assistance is carried out by providing training and making demonstration plots. After the mentoring program, farmers are willing to do composting, moreover it takes 30-35 days and is repeated every 7 days. Farmers' interest in composting is also triggered by the difficulty of obtaining inorganic fertilizers and the rising price of inorganic fertilizers.

How to cite: Muliarta, I. N., Sukmadewi, D. K. T., Selangga, D. G. W., Kariasa, I. G., Prawerti, D. A. D., Parwata, I. K. A., & Landra, I. W. (2022). Implementation of LEISA Concept through composting rice straw waste in Subak Telun Ayah, Tegallalang. *Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang, 7*(4), 663-675.
https://doi.org/10.26905/abdimas.v7i4.7825

1. INTRODUCTION

Tegallalang village belongs to a mountainous area located at an altitude of fewer than 900 m above sea level that extends to the West with a flat ground structure. The climate in Tegallalang Village is no different from other regions in Indonesia in general depending on 2 seasons, namely the rainy season and the dry season. The rainy season occurs from October to March and was previously a dry season

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with an average rainfall of between 146 mm/month with an average air temperature ranging from 15 ^{0}C-32 ^{0}C. Residents of Tegallalang Village are homogeneous residents who come from various hamlets in Tegallalang Village.

Administratively and geographically, there are several subak located in the Tegallalang Village area, one of which is Subak Telun Ayah, Tegallalang Village. Subak Telun Ayah geographically crosses 3 hamlets, namely Central Hamlet, Penusuan Hamlet, and Klabang Moding Hamlet, Tegallalang Village. The area of Subak Telun Ayah is 32 ha and is oriented towards rice cultivation with residual products in the form of rice straw. Rice straw waste has not been optimally utilized by farmers so far, so it tends to be wasted.

Farmers generally still view straw as waste or waste material so it tends to be burned. The results of a survey in Klungkung Regency showed that about 30.34% burned the rice straw produced on the grounds of speeding up tillage and eradicating pests. Another reason, because based on the knowledge gained for generations that rice straw ash can be beneficial for soil fertility (Muliarta, 2018). The habit of burning rice straw causes the soil to lose all N elements, lose P elements by about 25%, K element losses reach 20%, and S elements loss from 5 to 60%. The number of nutrients lost depends on the method used to burn rice straw (Dobermann & Fairhurst, 2002).

The processing and utilization of rice straw can be a way to face the problem of disposing of rice straw waste and reduce environmental pollution due to burning on open land (Kadam et al., 2000). Rice straw management can provide economic value for farmers and local communities and can stimulate broader rural economic growth by providing added value through industrial development and added value to the agricultural environment (Rosmiza et al., 2014b).

Rice straw has the potential to be a local raw material that can be processed into organic fertilizer. Its potential at the time of harvest is very abundant and has not been optimally utilized (Zhao et al., 2014). Globally it is estimated that the number reaches 650-975 million tons per year. Generally, in each production of 1 kg of grain, 1-1.5 kg of rice straw is produced (Binod et al., 2010). On average, one hectare of rice fields can produce rice straw as much as 15.15-22.35 tons/ha, or 5.87-7.82 tons of dry straw. If rice straw can be processed optimally, from every 1 ton of straw, 1/2 ton to 2/3 ton of compost can be produced (Gustiani et al., 2014).

Strawweight is an indicator of rice's ability to absorb nutrients (Masganti, 2011). Increased nutrient uptake in plants stimulates better plant growth and increases plant biomass or Straw (Mahmud et al., 2016). Fertilization factors are one of the factors that affect hay production in addition to the location, type of variety grown, weather, and planting method (Rosmiza et al., 2014a). The incorporation of rice straw directly on site can be a solution to the loss of soil organic matter content due to intensive planting systems (Gaind & Nain, 2011).

Rice straw contains several nutrients that are useful for plants such as nitrogen and potassium. The incorporation of rice straw into the soil is one of the important efforts in maintaining the stability of the soil K element and the need for plant K elements (Pavithira et al., 2017). Rice straw on the other hand also contains C-organic reaching 44.71%, N-total reaching 1.08%, P around 0.17%, and K elements reaching 2.7%.

In recent decades many composting methods have developed, such as vermicompost (utilizing worms as an organic matter spearhead), Berkeley (composting for cellulose-rich organic matter and nitrogen-rich organic matter), Bangalore (composting with fecal bases and municipal waste), and heap (composting with varied composting materials) (Setyorini et al., 2006). The development of composting methods is an attempt to manipulate so that factors that can accelerate the rate of the composting process can be achieved. In essence, the selection of technology and its modification will be more

dependent on the type of material to be composted, the availability of labor, and the availability of equipment and supporting materials (Supriadi, 2014).

Composting by aerobics requires a supply of air from the outside, by which the process of aeration can take place actively or passively. Passive aeration means the way of air jetting without tools or air entering the heap due to the difference in pressure coming from inside and outside the compost raw material. The temperature of compost heaps at aerobic composting is strongly influenced by environmental temperature (Man et al., 2010). In aerobic composting, approximately two-thirds of the carbon element evaporates into CO2 and the rest reacts with nitrogen in living cells (Setyorini et al., 2006). Commercially and individually, people do more aerobic composting because of the speed factor of the process and does not cause unpleasant odors compared to anaerobic (Komalasari, 2011).

Aerobic decomposition proceeds faster than anaerobic decomposition since aerobic decomposition is more efficient with a short decomposition time (Cooperband, 2000; Christy et al., 2013). Complex organic matter in the form of lignocellulose compounds is a material that is not easily degraded by anaerobic bacteria, this condition causes the anaerobic decomposition process to run slowly (Verma, 2014). The stage of hydrolysis of the complex organic matter becomes a limiter in the anaerobic decomposition process (Subramani & Ponkumar, 2012). The slow pace of the anaerobic decomposition process is also caused by the slow growth of methanogenic bacteria (Aslanzadeh, 2014).

The use of rice straw as compost is closely related to farmers' knowledge of how to compost agricultural waste. For example, farmers in Klungkung Regency do not know how to compost rice straw, because only 2.25% of farmers have attended rice straw composting training (Muliarta, 2021). The use of rice straw in compost to reduce the use of inorganic fertilizers is a form of application of the concept of low external input sustainable agriculture (LEISA) (Tangkesalu et al., 2021). A study showed that the use of rice straw compost (6 tons/ha) can reduce the use of inorganic fertilizers by 20%-80% of the recommended application rate without reducing crop yields (Man et al., 2010). Other studies have proven that the addition of rice straw compost combined with inorganic fertilizers results in production equal to 100% inorganic fertilizer. This result is proof that rice straw compost can provide efficiency in the use of inorganic fertilizers by around 20%-80% (Muliarta & Suanda, 2020).

To increase knowledge and ability in the use and processing of rice straw into compost, partners hope to get assistance from the PKM Team from Warmadewa University. The compost is expected to be used for rice cultivation so that it can implement the concept of low external input sustainable agriculture (LEISA). The processing of straw into compost and the use of compost for rice cultivation are directed to be the initial efforts in implementing the concept of zero waste in rice cultivation.

This community service activity involving members of the Subak Telun Ayah group, Tegalalang-Gianyar, has the aim of increasing farmers' knowledge in the use and management of rice straw so that farmers no longer burn the rice straw produced. Partners in the future are expected to be able to compost rice straws and be able to transmit their abilities to other farmers. Farmers are slowly expected to be able to implement the LEISA concept, to be able to realize organic and sustainable agriculture.

2. METHODS

Community service activities were carried out in Subak Telun Ayah, Tegalalang, Gianyar Bali. The goal is to improve the skills of partners in processing rice straw into compost. Farmers' knowledge also increases the use of compost in rice cultivation and as an effort to reduce inorganic fertilization. In order to realize this, the provision of rice straw composting techniques is carried out quickly, practically, and cheaply. The management of rice straw into compost is one way to reduce the volume of straw and

reduce the use of inorganic fertilizers that can have an impact on environmental pollution. The use of compost will also reduce the cost of purchasing inorganic fertilizers in rice cultivation activities.

Methods of Activity

The implementation of this community service uses observation methods, interviews, discussions, counseling/theoretical and practical training/conducting plot demonstrations, as well as facilitating the application of the concept of zero waste. The interventions provided are in the form of processing straw waste into compost and the use of compost to reduce the use of inorganic fertilizers. The target of the activity was 15 farmers who were members of Subak Telun Ayah.

Observation

Observations were made to find out the habits of farmers in handling the rice straw waste produced. This method is also used to uncover the reasons for farmers in handling hay during this time. Observation is carried out by directly looking at the habits of farmers in managing the rice straw produced. The results of observations become a guide to determine the form of intervention or activities to be carried out. Taking photos and videos using cell phones is carried out as material for documentation and evaluation in the future. Ekka (2021) stated that the observation method is one of the ways used by researchers to collect data. This way allows researchers to use their bodies, senses, and reflexivity as instruments to obtain information and know the social phenomena that occur.

Observation requires the researcher to spend a lot of time in the field with the possibility of adopting various roles in order to gain a more comprehensive understanding of the phenomena occurring (Baker, 2006). Efforts to examine social phenomena can be in diverse contexts, ranging from new ideas about culture, work practices, stakeholder relationships or motivations, as well as more specific investigations about technologies, processes, or events (Ekka, 2021). This method has been used in various disciplines as a tool for collecting data on people, processes, and cultures in qualitative research (Kawulich, 2005).

Observational research methods are important for understanding the actions, roles, and behaviors of people (Walshe et al., 2012). The observational data can be integrated as an addition or confirmatory study. This method is sometimes an additional means of corroborating research findings (Jamshed, 2014). The results can contribute to the theoretical and conceptual development as well as the explanation of social processes in palliative care. In particular, contributions to understanding the structure (Walshe et al., 2012).

Interview

Interviews are used to obtain in-depth information from farmers, including confirming the actions taken by farmers in dealing with rice straw waste. The interview focused more on farmers' problems in managing the rice straw produced, including farmers' expectations regarding efforts to use it to improve soil fertility. Interview data are used to strengthen the results of observations, so as to determine the appropriate form of activity in an effort to transfer knowledge to farmers.

According to Stuckey (2013), interviews are the primary way of collecting data in qualitative research to direct participants in responding to specific research questions. DiCicco-Bloom & Crabtree (2006) mentioned that interviews are one of the familiar approach strategies in collecting qualitative data. It is generally used from diverse disciplinary perspectives resulting in a wide variety. Bullock (2016) reveals the time it takes to collect, prepare, and analyze data is not easy or fast. However, it can be very rewarding and generate powerful insights into complex situations.

Extension

Counseling is carried out to provide farmers with theories on how to compost rice straw that is fast, cheap, practical, and quality. Through counseling, farmers can understand the importance of straw waste for the fertility of agricultural land, so that waste is managed optimally and does not cause environmental pollution. Counseling is provided by lecturers and students in the form of lectures and discussions. The material provided is more emphasized the technology of composting rice straw, the benefits of rice straw compost for soil fertility, and also given material related to the use of biopesticides.

Amanah (2017) revealed that the use of the term counseling is generally equated with lighting, even though it can be seen as a transfer of knowledge. The scientific basis of counseling is the science of human behavior as part of a social system. Extension activities carried out by agricultural extension workers have a strategic role in efforts to help farmers to improve their farming business. Extension workers play a role in fostering farmers in managing their farming business to be effective and efficient, with the hope of increasing farmers' incomes (Khairunnisa et al., 2021).

Plot Demonstration

Demonstrations of plots are carried out to deepen the understanding of farmers after obtaining counseling or theoretical training. This activity is an effort to implement the theory by asking farmers to be directly involved in carrying out the composting process. The implementation of demonstration of the plot is carried out directly in the rice fields, by first determining the location through the formation of mounds. The materials used include rice straw, dry cow dung, hoes, small buckets, large knives, bamboo, and tarpaulins.

The implementation of the demonstration plot is one of the efforts to accelerate the adoption of the technique of composting rice straw by farmers. This is in line with the statement of Sseguya et al. (2021) who stated that the plot is an effective model to increase the adoption of better technologies. According to Khan et al. (2009), the plot not only managed to create awareness among farmers about modern technologies but also motivated to apply their agricultural practices. Moreover, farmers participate in this activity to gain practical knowledge about better agricultural practices.

Monitoring and Evaluation

Monitoring and evaluation are carried out to ensure that the process of activities runs as planned, starting from preparation, planning, and implementation. Monitoring is carried out during the composting process to see the ability of farmers to implement the composting techniques provided through plot demonstration activities, as a simple way of assessing the maturity of the compost. The evaluation was conducted through direct interviews regarding farmers' perceptions of the composting technology provided, commitment to implementation, and willingness to use the resulting compost. The results of monitoring and evaluation are valuable information that can be used as a guide in making improvements. The target is for farmers to understand composting preparations to find out the benefits of using rice straw compost. Monitoring and evaluation can be a benchmark for the achievement of community service activities.

3. RESULTS AND DISCUSSION

Community service activities began with observation and coordination with Pekaseh (Chairman) Subak Telun Ayah, Tegalalang-Gianyar which was carried out on April 25, 2022. The results of observations

are known that there is a habit of farmers burning rice straw produced after harvest. The rest of the straw burning is very easy to find on every rice field plot in the Subak Telun Ayah area (Figure 1).

Figure 1. The rest of the burning of rice straw by farmers

Farmers choose to burn rice straw because it is to catch up with the next growing season, especially since rice straw waste interferes with the process of tillage. This is in line with Rosmiza et al., (2014a) who stated that burning straw by farmers aims to accelerate land processing and avoid the spread of pests and diseases. Straw burning has proven to be a source of carbon emissions and causes air quality to be poor (Chang et al., 2013). Burning rice straw in addition to causing pollution, also has an impact on public health (Tipayarom & Oanh, 2007).

The results of interviews with Pekaseh (Subak group leader) and Subak members revealed that none of the farmers composted rice straw. The reason is that farmers have never received rice straw composting training and do not know the method of composting rice straw. This condition is the same as what happened in Klungkung Regency, where there were no Subak member farmers who composted rice straw. The complex and labor-intensive procedure for making rice straw compost is one of the causes of farmers' difficulties in making rice straw compost (Supaporn et al., 2013).

Farmers who are members of Subak Telun Ayah are also still hesitant in using rice straw compost because there are concerns if the harvest will not be as expected. Farmers' concerns are quite reasonable because straw compost needs time to undergo a mineralization process so that the available nutrient content cannot be directly absorbed by plants. According to Goyal et al. (2009) an increase in the fertility of the soil will only be seen in about 3 years. Diacono & Montemurro (2011) stated that it takes about 15 years with the repeated addition of organic matter to be able to improve the fertility status of the soil.

The second stage of coordination was carried out on May 13, 2022, to determine the time and place of the counseling and plot. The plot demonstration was agreed upon on the same day after counseling or theoretical debriefing, but the plotting activities were agreed upon in the rice field area of the Subak Telun Ayah area. Enter from Pekaseh Subak I Made Bratha, the extension activities are enough 30 minutes and the time for the plot demonstration is more so that farmers understand each stage in detail. The implementation of activities is also expected to be less formal so that familiarity is built between the accompanying team and farmers.

The third stage is the implementation of counseling which will be held on May 16, 2022, at Wantilan Pura Duur Bingin. There are 3 basic materials presented, namely; Rice straw composting techniques, compost benefits for soil fertility, and pest control materials with natural pesticides. During the discussion process, farmers hope for a composting method that is fast and simple, as well as at a low cost. Farmers also hope that after the plotting activities, there will still be composting assistance, so that farmers understand and can compost well. The counseling activity was attended by representatives

from each of the Subak Telun Ayah districts (sections) and accompanied by the symbolic handover of composting equipment assistance (Figure 2).

Figure 2. The atmosphere of counseling accompanied by the handover of composting equipment assistance

The next activity was composting rice straw with a plot demonstration system which was carried out in rice fields in the Subak Telun Ayah Area. The composting site uses bamboo which forms a box with a size of 1.5 meters in length, 1 meter in width, and 1 meter in height. Composting stations are made on mounds to avoid soaking water when it rains. The composting chart is presented in Figure 3.

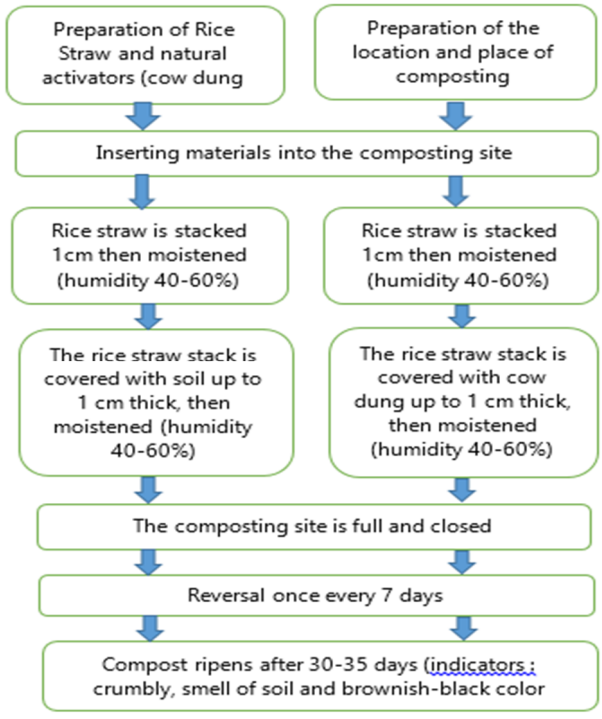

Figure 3. Composting flow chart

The compost material uses rice straw left over from farmers' crops at the rice field site and uses natural activators or decomposers in the form of soil and cow dung. Photos of rice straw composting activities are presented in Figure 4.

Figure 4. Composting rice straw in Subak Telun Ayah, Tegalalang-Gianyar

The use of natural decomposers in the form of soil and cow dung is carried out to avoid the purchase of commercial decomposers on the market, so that composting is cheaper. This step is one of the efforts to utilize local resources available in nature. The use of local activators or decomposers certainly has advantages, whereas local decomposers have better adaptability. This is in line with the statement of Junita et al. (2017) which revealed that local decomposers have high adaptability and have the potential to have better abilities in their home areas than using decomposers from other regions. The addition of commercial decomposers is not necessary for the composting of rice straw, since naturally microbes found on the surface of the material, can degrade plant material (Rishell, 2013). Microbes live in dense communities made up of different strains and species (Mitri & Foster, 2013). The addition of microbial associations or a single microorganism can have a positive, negative, or neutral response with other microorganisms present in the same material (Mitri & Foster, 2013; Tsigarida et al., 2003).

The straw material used in the composting process is not chopped, because of course, it will be difficult to chop the rice straw produced in the middle of the rice field and require additional labor. Based on the results of previous studies, it was found that chopped rice straw with a size of 1-5 cm with non-chopped ones produces no different compost maturity. Enumeration only speeds up the decomposition process at an early stage (Muliarta et al., 2019). Theoretically, it is true that the smaller the particle size, the better its biological degradation. The particle size of compost materials that are too small also limits the inlet space for oxygen, causing a slow decomposition process (Atalia et al., 2015; Cooperband, 2000). The oxygen requirement in the compost heap should not be lower than 5% and composting becomes optimal at the level of oxygen availability reaches 10% (Román et al., 2015).

During the composting process do not use additional sugar solution or molasses, the reason is to minimize the cost of composting. The addition of sugar only speeds up the decomposition process at an early stage but does not provide compost maturity or a noticeable different C/N ratio (Muliarta & Suanda, 2021). The addition of sugar, which is a source of carbon, is thought to trigger a rapid increase in organic acids, which causes the pH to drop to acid. Acidic pH conditions affect the rate of microbial respiration and decrease the rate of degradation (Ameen et al., 2016; Wang et al., 2015).

The frequency of reversals carried out during the composting process is a reversal once every 7 days. A more routine reversal will certainly be exhausting for farmers and allow require additional labor. Based on the results of the study, the frequency of compost reversal in 6 or 7 days once in aerobic composting of rice straw will produce mature compost within 30-35 days. A more routine frequency of reversals will interfere with the decomposition process and not provide faster compost maturity (Muliarta et al., 2019; Muliarta & Suanda, 2021).

The composting process begins with wetting the rice straw and cow dung and the soil used. Composting is carried out in 3 treatments, namely without the addition of natural decomposers, the addition of cow dung decomposers, and composting with the addition of soil. Pre-moistened rice straw

is put in a prepared place, with an average humidity of 40%-60%. When the haystack has reached 1 cm, it is covered with cow dung or prepared soil. Haystacks with natural decomposers continue to be made in layers until the composting site is full. Unlike the one without the addition of a natural decomposer, the hay is constantly stacked and compacted until the prepared place is full. In the next stage, the top is brushed with a tarpaulin, to preserve the moisture of composting. The compost is then turned over and checked for moisture once every 7 days. If the compost is slightly dry, it is necessary to add watering water to maintain humidity. Entering the 30th or 35th day, the compost is ready to be harvested and used on the land to be processed. The characteristics of mature compost are; crumbs when held, the smell of earth, and brownish-black in color.

Monitoring and evaluation are carried out from the beginning of the activity to the end, to find out the response and changes from partners to the counseling and assistance carried out. Through monitoring and evaluation, changes in farmers' perceptions and knowledge of rice straw waste and the possibility of processing it into compost were obtained (Table 1). The monitoring and evaluation carried out have not been able to see changes in behavior, because changes in behavior can only be seen in the next rice harvest season.

Table 1. Responses of Subak group members

Perceptions of Subak Member Farmers	Before Counseling and Demonstration Plots	After Counseling and Demonstration of The Plot
Rice straw management	Farmers prefer to be burned because it interferes with land processing	There is a desire to compost
Motivation for composting rice straw	There is no motivation for not knowing the method of composting rice straw	Motivated to do composting because you know the ways and benefits of composting
Perception of composting rice straw	It is difficult, takes a long time, requires additional costs and requires a lot of labor, and does not have a composting place.	Composting can be done simply, quickly, and practice and does not require additional labor and large land
Benefits of processing rice straw into compost	Does not provide additional benefits	Helps maintain soil fertility and can reduce the use of inorganic fertilizers whose prices are increasing

The service activities that have been carried out by the community service program implementation team in Subak Telun Ayah, Tegalalang, Gianyar Regency, Bali Province as a whole provide a change of view and provide knowledge for farmers in managing the rice straw produced. Farmers have a desire to compost rice straw during the next rice harvest period. There is a desire to use rice straw compost to reduce the use of inorganic fertilizers whose prices are starting to rise and are difficult to obtain. Farmers realize that the burning of rice straw so far, in addition to disposing of compost raw materials, also contributes to air pollution which increases exhaust emissions. The burning of straw in the Subak area also gives a negative image to Subak as a world cultural heritage and also a negative image for Bali tourism. Moreover, Subak Telun Ayah, Tegallalang is located in the Ubud Tourism area and the Subak Telun Ayah area is a trekking route for tourists.

4. CONCLUSION AND RECOMMENDATIONS

Farmers belonging to Subak Telun Ayah tend to burn rice straw on the grounds of speeding up the processing of the land. Rice straw has not been composted so far because farmers claim to not know how to compost and the benefits of rice straw compost. As a result, farmers optimize the use of inorganic fertilizers to get maximum results. This condition shows that farmers have not implemented the LEISA concept and have not led to sustainable agriculture. Farmers after obtaining counseling and training through the plot demonstration method have a desire to process rice straw into compost in the next rice harvest. Farmers hope for continuous assistance until they understand and can compost properly. The desire of farmers to carry out composting is also triggered by the rising prices of inorganic fertilizers. Farmers in other parts began to know the benefits of straw compost for soil fertility and health. Awareness of the importance of composting straw began to grow because the Subak Telun Ayah area is often a trekking place for tourists visiting the Ubud Tourist Area.

Socialization of the importance of rice straw management needs to be expanded to other Subak in Bali. The practice of processing straw into compost is not only an effort to maintain soil fertility but also a solution for handling agricultural waste. This step of processing rice straw waste into compost, if expanded throughout Bali, will be an effort to realize organic agriculture in Bali. Rice straw composting activities are also an effort to support the Bali Provincial government's policy regarding source-based waste/waste management. The Agriculture Office through the Field Extension Officer should conduct training on composting rice straws for its farmers. The movement of composting rice straw can later be followed by efforts to gradually reduce the use of inorganic fertilizers.

ACKNOWLEDGMENTS

We would like to express our gratitude to Pekaseh (Chairman) Subak Telun Ayah, I Made Bratha who has helped and provided an opportunity to carry out community service programs in Subak Telun Ayah. We convey the same remarks to subak members who have been willing to come down and be active during the counseling and plotting process. We also express our gratitude to the Founder (manager) of Duur Bingin Temple who has provided the opportunity to use Wantilan Hall (meeting room) for organizing counseling.

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