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Dissemination of Organic Waste Crushing Machine Technology to Accelerate the Competitiveness of Zero Waste-Based Farming Businesses

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Abstract Straw, a byproduct of rice harvesting, is a waste material from farming activities that can be repurposed as animal feed and organic fertilizer. Rice straw, when supplemented with probiotics, can enhance feed nutrition, and its high potassium content contributes to the fertility of agricultural soil. The purpose of this community service activity was to increase the knowledge of the Sri Warga farmer group about the benefits of rice straw and the application of organic waste shredding machine technology. The physical shredding of rice straw improves its quality as animal feed and accelerates the composting process for organic fertilizer. The results of the community service activity demonstrated the farmer group members' enthusiasm for adopting organic waste shredding machine technology and utilizing rice straw. There was a notable increase in their understanding of the dual benefits of rice straw—as a nutritious animal feed and as a resource for enhancing soil quality through organic fertilizers. This activity significantly improved the knowledge and awareness of Sri Warga farmer group members about the potential uses of rice straw. A post-activity questionnaire revealed that 95% of the farmer group members understood the benefits and nutritional content of rice straw for use as organic fertilizer or animal feed, compared to only 70% before the activity. This highlights the success of the community service initiative in empowering the Sri Warga farmer group with valuable knowledge and practical solutions for utilizing rice straw effectively.

1. INTRODUCTION

As an agricultural country, Indonesia boasts extensive productive agricultural land, which serves as the primary livelihood for much of its population. Agriculture is one of the largest sectors supporting the nation's economy. Almost every region in Indonesia has agricultural land, including Kutai Kartanegara Regency (Kukar) in East Kalimantan. Sungai Pimping Loa Duri Ulu Seberang (LDS) Village, located in Kukar, is notable for having the largest agricultural land in the region. The majority of the village's population are farmers and livestock herders, raising animals such as cows and goats. The village is home to six farmer groups, each comprising approximately 25 members, providing a platform to support and organize the farmers' activities. Among these groups is the Sri Warga farmer group, which includes 25 active members who manage agricultural land and engage in farming activities to sustain their livelihoods.

The Sri Warga farmer group is the target partner for economically productive community development in this community service activity. Located in a strategic area,

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Sungai Pimping Loa Duri Ulu Seberang (LDS) Village is designated as a preparatory village to support the development of the Archipelago's capital city. However, the village faces significant challenges, primarily poor transportation accessibility. Reaching the village requires traversing a 20-kilometer mining road characterized by rocky and dusty conditions, which negatively impact the productivity and welfare of the community. One of the primary issues faced by the community, particularly the farmers, is limited access to fertilizer. Fertilizer is a critical input for enhancing agricultural productivity and improving crop quality. The lack of availability of high-quality and affordable fertilizer poses a barrier to agricultural progress, leading to reduced crop yields. Additionally, the farmers in Sungai Pimping Village face challenges related to the adoption of modern agricultural technology. This includes technology for processing crops and managing harvest waste, such as rice straw and husks. Addressing these issues is essential to improve agricultural efficiency, increase productivity, and enhance the welfare of the farmer community.

The Sri Warga farmer group produces rice, brown rice, and sticky rice as their primary agricultural products. Alongside the rice consumed or sold by the community, the harvest generates byproducts such as rice straw and husks. If properly processed, this harvest waste can be transformed into secondary products with significant economic value. However, the Sri Warga farmer group has yet to fully utilize these byproducts to their potential. Government or educational institutions can play a key role in providing farmers with the necessary knowledge and skills to make use of rice harvest waste. In this community service activity (PKM), farmers were educated on the utilization of rice harvest waste, particularly rice straw. Additionally, the introduction and application of organic waste shredding machine technology were provided, enabling farmer groups to process rice straw effectively. This initiative aims to empower the Sri Warga farmer group to maximize the value of harvest waste and contribute to their economic growth.

Rice straw is one of the waste products of rice harvest that can be used as a source of animal feed (Yanuartono et al., 2017). Straws are mainly used as animal feed during the dry season when farmers have difficulty obtaining high-quality green fodder. The harvest cycle, the amount of rice production, and the packaging time are some of the factors that can affect the nutritional value of straw. Rice straw contains little protein, fat, and starch, as well as high crude fibre (Alhanif et al., 2023). The high content of silica lignin causes the crude fibre in rice straw. Therefore, straw as animal feed needs to be given biological treatment by adding probiotics. In addition to biological treatment, mechanical and chemical treatments can be given to increase the nutritional value of rice straw as animal feed.

Mechanical or physical treatment of rice straw to be used as animal feed can be done by cutting and shredding rice straw. This physical treatment does not affect the chemical properties of straw (Yanuartono et al., 2017). Chopped rice straw (with a size of 2-5 cm) can be mixed with additional materials such as bran, concentrate, tofu dregs, and others so that the influence of microorganisms can be faster and more evenly distributed (Wahyuni & Yani, 2019).

In addition to being used as animal feed, straw can be used as organic fertilizer or compost (Sitepu et al., 2017). According to Cahyono (2024), compost is an environmentally friendly fertilizer that increases soil fertility and is a source of nutrients that can increase land productivity in the long term. The nutrients in rice straws are very beneficial for plants. However, these nutrients will be lost if burned (Nurmalasari et al., 2021). Shredding straw will speed up the composting process and turn it into organic fertilizer (Aden et al., 2023; Nurrohkayati et al., 2023).

Currently, farmers in LDS village only burn and naturally decompose rice straw for fertilizer use. This is due to farmers' need for more understanding regarding the benefits of rice harvest waste, especially rice straw. In addition, it is also due to the lack of application of waste processing machine technology that farmers can use. Based on this, strong collaboration is needed between various stakeholders so that the quality of agricultural and livestock productivity in LDS village can be optimized. One of the collaborations is conducted by Community Service activities entitled Dissemination of Organic Waste Shredding Machine Technology as an Effort to Accelerate the Competitiveness of Zero Waste-based Farming Businesses. This service activity aims to increase the knowledge and skills of the Sri Warga farmer group regarding the benefits and processing of rice harvest waste (straw). The application of organic waste shredding machine technology that farmer groups can use to shred straw into animal feed and organic fertilizer with better quality (Nurrohkayati et al., 2023). Furthermore, the diversification of rice straw products can be used by farmer groups and sold to wider consumers (Salim et al., 2021). Therefore, with this community service activity, it can create better conditions for the Sri Warga farmer group to increase the production of agricultural products from the use of organic fertilizers and increase their income, welfare, and food security in the long term.

2. METHOD

Community service activities were carried out in Loa Duri Ulu Village (LDS), Sungai Pimping RT/RW 017/005, Loa Janan District, Kutai Kartanegara Regency, East Kalimantan, Indonesia. The target partners of the community service were the Sri Warga farmer group, which is an economically productive community group. The scope of the problems solved were production aspects and management aspects.

The main objective of this partnership program was to be a bridge in accelerating the economy of the Sungai Pimping Village community. With the help of the organic waste shredding machine technology provided, the Sri Warga farmer group will be able to increase their income by reducing the cost of purchasing fertilizer. The benefits

of this community service activity are as follows. First, shredded rice straw can be used as raw material for organic fertilizer on the farmer group's agricultural land. Thus, farmers can reduce the cost of purchasing fertilizer. Second, farmer groups can sell shredded rice straw to the surrounding community, particularly to other farmers, for use as animal feed for goats and cows. This provides an opportunity for farmers to generate additional income from the sale of animal feed made from shredded grass or rice harvest waste. Third, the use of semi-automatic tools is expected to make agricultural work easier, reduce workload, and increase efficiency. With the adoption of this modern technology, village communities can become more economically independent and improve their overall welfare.

Figure 1 . Knowledge sharing of rice straw processing

The community service activities consisted of five stages of implementation as follows. First, the knowledge sharing of the production aspect was done by communicating the diversity of processed rice straw products (Figure 1). Discussion of the benefits and contents of rice straw to be used as animal feed and organic fertilizer. Information sessions were conducted at the LDS Village Office, accompanied by village officials and the head of the farmer group. Second, the Sri Warga farmer group received training on using organic waste shredding machine technology, maintaining the machine, and using e-commerce as a marketing and sales medium for processed agricultural waste products. Third, the technology provided to the farmer group comprised an organic waste shredding machine to shred rice straws and sacks to package the shredded rice, which will then be used as animal feed or organic fertilizer. The farmer group was also given an e-commerce account to sell processed rice straw products. Fourth, mentoring and evaluation. Mentoring is carried out by assisting farmer groups in processing rice straw into animal feed and organic fertilizer by chopping it first. Furthermore, the results of the chopped rice straw are composted using EM4. In addition to being used on agricultural land, rice straw organic fertilizer can also be used on vegetable plants processed by the LDS village women's farmer group. Fifth, program sustainability.

The sustainability of the community service program is as follows:

a Healthy and prosperous life: The Sri Warga farmer group can use processed organic fertilizer, and animal feed for the Sri Warga farmer group and can also be sold to the broader community (inter-regional and national). Thus, the Sri Warga farmer group previously only had income from agricultural products. With this PKM activity, the Sri Warga farmer group can increase its income from processed organic waste, namely organic fertilizer and animal feed. Thus, there will be a healthy life where there is no more garbage piling up in the residential environment of residents and can improve the welfare of farmer groups by increasing income from the sale of organic fertilizer and animal feed. Sri Warga farmer groups can utilize e-commerce to market products to the wider community (inter-regional and national). Utilizing this e-commerce can increase fertilizer and animal feed sales.

b Industry, Innovation, and Infrastructure: Local organic fertilizer and animal feed production industry, which farmer groups can utilize.

3. RESULT AND DISCUSSION

3.1 Analysis of empowerment values before the implementation of the community service

The use of agricultural machinery technology for processing crops or crop waste is still limited in application in Loa Duri Ulu Village (LDS), which has the largest agricultural land in Kukar, East Kalimantan. The village is home to six farmer groups, each with 25 members, and each farmer manages approximately 1.5 hectares of agricultural land. Currently, before the implementation of the PKM program, farmers have been using harvesting machines such as rice threshers. However, some of these machines are damaged, and farmers are unable to repair them due to the distance to the nearest repair workshop. This creates challenges for farmers during the rice harvesting process. In addition, farmers have not adopted technology for processing crop waste, such as straw, into more valuable products. This lack of adoption is primarily due to a lack of understanding of how to utilize crop waste effectively to create more beneficial and economically viable products.

In addition, there are challenges related to business management, particularly in understanding and using semi-automatic tools for processing agricultural products and waste. Some farmers lack the necessary skills or knowledge to operate these tools effectively, which can hinder their ability to increase agricultural productivity. Improper use of the tools not only limits their potential benefits but can also lead to damage, further compounding the farmers' difficulties.

Another issue is related to the maintenance and repair of semi-automatic tools. When these tools are damaged or fail, farmers in the village face significant challenges in accessing fast and affordable repair services. This can lead to extended production downtime and financial losses for the farmers. To address this problem, it is crucial to provide adequate training and assistance to farmers in the proper use and maintenance of semi-automatic tools. By doing so, the

potential of these tools to enhance agricultural productivity in LDS Village can be fully realized, ultimately contributing to improved economic conditions for the community.

3.2 Analysis of empowerment values after the implementation of the community service

Assisting the Sri Warga farmer group in LDS Village with organic waste shredding machine technology represents a critical step in addressing many challenges faced by farmers. The organic waste shredding machine enables the efficient processing of organic waste, such as rice straw from harvest residues or other crop waste, into valuable products like organic fertilizer and animal feed. This technology significantly reduces the time and energy required for shredding processes, allowing farmers to allocate their resources to other productive activities. Additionally, the use of the shredding machine decreases reliance on human labor, which is often in short supply during peak periods, such as harvest seasons or other high-demand agricultural activities. By addressing labor shortages, the machine ensures that essential processes continue uninterrupted. In the long term, the use of an organic waste shredding machine improves the quality of processed products. The uniform and finely shredded material is easier for livestock to digest, enhancing livestock productivity and overall health. To ensure the successful adoption and sustained use of this technology, a holistic approach is essential. This includes providing training and technical support to farmers, enabling them to operate and maintain the machinery effectively. Such comprehensive support maximizes the potential benefits of the shredding machine, contributing to improved agricultural productivity and sustainable farming practices in LDS Village.

Figure 2 . Organic waste shredder machine usage training

Training on the use of organic waste shredding machines was provided to the Sri Warga farmer group (Figure 2). Previously, farmers allowed rice straw, a byproduct of the rice harvest, to rot without utilizing its potential. Through training, farmers learned that rice straw can serve as raw material for organic fertilizer, animal feed, and other applications. Fertilizer made from rice straw can be used as an organic agricultural input, helping farmers transition to more sustainable practices. To efficiently process rice straw into fertilizer and improve its quality, it needs to be cut into pieces measuring 5–10 cm. The organic waste shredder machine enables this process, making it faster and more effective. Additionally, many Sri Warga farmers who raise livestock, such as cows or goats, were previously using manual tools like sickles to cut grass for animal feed. With the organic waste shredder machine, farmers can now process grass more quickly and efficiently, ensuring livestock receive better-quality feed. This improvement not only enhances livestock nutrition but also reduces the physical burden on farmers, allowing them to focus on other productive activities.

Business management training was provided to the farmers to help them achieve maximum results with minimal effort. One key aspect of this training focused on the maintenance of the organic waste shredder machine. Proper machine maintenance ensures a longer service life and optimal performance, enabling farmers to continue processing agricultural waste efficiently and sustainably.

Marketing management training was conducted to teach farmers how to effectively market and sell diversified rice straw products using e-commerce platforms. By utilizing e-commerce, farmers can expand their reach beyond the local community, allowing their products to be marketed to a broader audience. This approach provides an opportunity for global consumers to learn about and purchase these processed rice straw products, increasing the farmers' income and economic opportunities.

The adoption of more advanced agricultural technology can significantly reduce the physical workload for farmers, enhance their quality of life, and drive local economic growth. Shredded waste, such as rice straw, can be repurposed as raw material for organic fertilizer and animal feed, providing farmers with valuable resources for improving agricultural productivity and livestock nutrition. Beyond personal use, processed organic waste can be transformed into marketable products like fertilizer and animal feed, opening opportunities for sales at regional and national levels. To maximize these opportunities, training in marketing and sales management using modern technology is essential for the Sri Warga farmer group. Such training equips farmers with the skills to effectively promote and sell their products, leveraging e-commerce platforms and other digital tools. By marketing their processed waste products, the farmer group can expand their market reach and significantly boost their income, contributing to greater economic stability and growth for the community.

3.3 Application of technology and innovation to society

Organic waste shredding machine technology is applied by providing shredding machines to Sri Warga farmer group partners. Two shredding machines were given to Sri Warga farmer group. The benefits of this community service activity are as follows:

1. Utilization of organic waste shredding machine technology
   Application of organic waste shredding machine and technology as an acceleration of the competitiveness of zero waste-based farming businesses. The organic waste shredding machine is used to shred rice straw

into animal feed and higher-quality organic fertilizer. With this organic waste shredding machine, farmers can utilize rice straw properly as organic fertilizer on agricultural land. This fertilizer can improve the quality of agricultural land so that good-quality rice harvests are obtained.

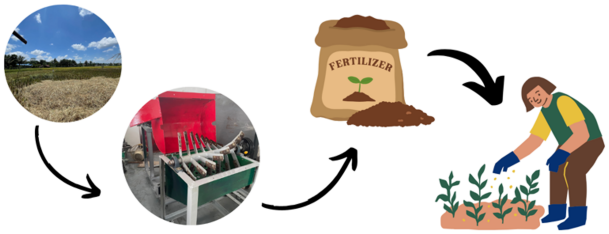

Figure 3 . Rice straw as organic fertilizer

Figure 4 . E-commerce utilization

2. Rice straw as organic fertilizer (Figure 3)
   One of the organic materials that can be used to make fertilizer is agricultural waste (rice straw, corn cauliflower drums, sugar cane bagasse, coconut fibre) (Alhanif et al., 2023). Small waste sizes can accelerate the decomposition process to become fertilizer in the process of making fertilizer. The organic waste shredding machine shreds rice straw into small organic waste. Organic fertilizer can improve the soil's physical, chemical, and biological properties. Rice straw is an agricultural waste with a high potassium (K) content. K plays a role in starch formation, activating enzymes, opening stomata (regulating respiration and evaporation), increasing resistance to drought and disease, and root development (Nurmalasari et al., 2021).

3. Rice straw as animal feed
   Using straw as animal feed is mainly carried out during the dry season when farmers find it difficult to obtain high-quality green fodder (Gummert et al., 2013). Rice straw has low crude protein content and high crude fibre, including cellulose, hemicellulose, lignin, and silica (Gummert et al., 2013). Shredding also aims to increase nutritional value, intake and speed of passing through the digestive tract. The advantage of using this feed is that livestock (cow) manure is odorless.

4. Utilization of e-commerce (Figure 4)
   Market segmentation: Small and large-scale livestock farmers, organic farmers looking for natural fertilizers, and sustainable agricultural industry players.
   Benefits: Wider Market Access, reaching consumers throughout Indonesia, easier and safer transactions, faster and easier purchasing process, flexible payment facilities, targeted Marketing: Using advertising and promotion features from e-commerce platforms to attract buyers.
   Potential to Increase Income: On e-commerce such as Lazada, Tokopedia, and Shopee, dry rice straw is sold for 10 - 30 thousand / bundle. If it is assumed that one bundle = 1 kg and each farmer's harvest get a minimum of 100 kg of straw, then each farmer's harvest can get an additional income of IDR 1 million - IDR 3 million. Currently, rice straw waste is only given free of charge to straw collectors.

4. CONCLUSION

In conclusion, the community service activities were carried out successfully in improving the knowledge of the Sri Warga Farmer Group. Based on the results of the questionnaire assessing the level of understanding of the benefits of rice straw during the community service activity socialization, completed by 20 members of the farmer group in LDS Village, Kutai Kartanegara, the following conclusions were drawn. Before given material on the benefits of rice straw, 70% of the farmer group members knew about the benefits of rice straw as a fertilizer that can improve soil elements and as a raw material for animal feed (30% or six people did not know). Before the community service activity was carried out, rice straw was used by the community as compost by letting it rot naturally or burning it (the charcoal was used as fertilizer) and as a planting medium for vegetables. However, some people also did not use the rice straw (just left it like that). After implementing this community service activity, 95% of the farmer group members learned that rice straw has many benefits, namely as an organic fertilizer that can improve soil elements and as a raw material for animal feed. Chopping rice straw into a finer size will make it easier to process. With a smaller size of rice straw (chopped results), the straw decomposition process will be faster. Thus, the composting process of fertilizer will be better. As animal feed, rice straws of an acceptable size will be easier for livestock to chew and digest. However, straw must be given other mixtures for animal feed to increase feed nutrition. Furthermore, farmer groups can use straw fertilizers on their own rice fields and vegetable gardens.

This community activity also focused on enhancing the economic prosperity of farmers enhancing the economic prosperity of farmers before the community service activity was implemented, some rice straw waste was used as fertilizer, while some was taken by collectors for use as animal feed. However, the collectors did not purchase the rice straw, meaning farmers did not gain additional income

from it. Currently, rice straw is widely sold on e-commerce platforms, as shown in the accompanying image, with prices ranging from IDR10,000 to IDR30,000 per bundle. Beyond its use as raw material for fertilizer and animal feed, rice straw can also be repurposed for handicrafts. With the implementation of this community service activity, it is expected that farmers will generate additional income by selling diversified products such as straw-based fertilizer and animal feed. Assuming one bundle equals 1 kg, and a single farmer's harvest produces 100 tons of straw, farmers could potentially earn IDR1,000,000. Collectors will no longer take the straw for free, and by utilizing this resource effectively, the Sri Warga farmer group will contribute to the establishment of a green economy.

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CONFLICT OF INTERESTS

The authors declare there is no conflict of interest.

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