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COMMUNITY EMPOWERMENT THROUGH INCREASING THE VALUE OF EMPTY PALM OIL BUNCHES INTO BIOCHAR FOR IMPROVING THE SOIL QUALITY OF PALM OIL PLANTATIONS IN ADOLINA ESTATE

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Abstract

This community service activity is carried out with the aim of helping partners increase the added value and achieve zero waste from the empty fruit bunch waste produced by the Adolina PTPN IV palm oil mill. The increase in added value of empty fruit bunch waste from palm oil is achieved by processing it into biochar, as it has been proven to be one of the soil amendment technologies for sustainable and regenerative agricultural practices. This community service activity was carried out by initially producing biochar by a team of service providers consisting of lecturers and ITSI students, using raw materials obtained from the Adolina PTPN IV factory. After the biochar product was completed, the research results were disseminated as a practical product by directly applying it in the Adolina palm oil plantation area. This community service activity was carried out using methods of socialization, education, and evaluation for partners about biochar and its application in the Adolina plantation. The partners feel very happy and grateful for this activity as they gained new information and added practical skills about alternative uses of biochar as an organic fertilizer that can enhance soil fertility and improve the quality of the plants (oil palm fruits) produced. Partners also provided input to continue working together in enhancing the capacity of human resources and institutions through research and community service collaborations, so that it can be more optimal and extensive in deepening the application of appropriate technology in plantation lands, potentially leading to commercialization products that can benefit both parties..

Keywords : Biochar, Waste, Palm Oil, Fertility, Soil

INTRODUCTION

Empty palm oil bunch waste can be used as ground cover, compost raw material, and livestock feed raw material. To avoid harmful pests and diseases, this waste must be specially treated before being used as ground cover. However, composting TKKS waste requires large land, heavy equipment, and a lot of labor (resulting in high carbon emissions). However, the compost produced through this process contains relatively low nutrient content. (Kresnawaty et al., 2017).

Empty palm oil bunches have the potential to be a renewable energy source that can be utilized after undergoing an initial process, such as pressing. The pressing process transforms empty fruit bunches (EFB) into more easily combustible fibers that can be used as boiler fuel in power plants (Erivianto, 2022). In addition to this use, palm oil mill waste can be converted into biochar. The process of biochar formation involves pyrolysis, which is the heating of organic materials or biomass without or with minimal oxygen at temperatures between 250-700 °C (Ridhuan et al., 2019). Pyrolysis is the process of decomposing materials with heat in the absence

of oxygen, starting with combustion and gasification, followed by partial or total oxidation of the main products. Biochar is produced from an incomplete combustion process, leaving behind nutrients that can enhance soil fertility. The use of biochar as an effort to restore soil quality has become a common solution in addressing soil problems. The application of biochar can address the problem of acidic soil by increasing the pH value, enhancing the cation exchange capacity (CEC) of the soil, and providing nutrients such as N, P, and K. In addition, biochar also plays a role in maintaining soil moisture, increasing drought resistance, and remediating soil contaminated with heavy metals such as Pb, Cu, Cd, and Ni (Putri et al., 2017). The use of biochar in plant growth media has also been proven to enhance plant growth with increased stem diameter and plant height. Putri et al., (2017) reported that the application of biochar resulted in increased soil pH, organic C content, total N, P availability, flowering period, plant height, dry weight of the plant's upper part, as well as N and P absorption. Meanwhile, according to Triandika (2022), biochar also contains metal elements such as Cu, Mg, K, and Ca, which provide benefits as soil quality enhancers..

Partner is PTPN IV, which owns the Adolina plantation and is a highly professional national plantation company. ITSI, represented by lecturers and students, collaborates with partners to engage in community service activities in the form of disseminating research results, which is part of the 2024 Kedaireka Matching Fund grant program. The partner also has a palm oil mill that produces a lot of residue (waste) in the form of empty fruit bunches that are not maximally utilized. Based on that, the service team from ITSI has produced a useful product from the empty fruit bunches of palm oil waste into biochar, which has been tested and proven to have good nutrient content and potential to serve as a soil conditioner for plantations to improve the quality of the produced fruit.

The team then disseminated the research results to direct partners at the Adolina plantation to present the research findings, introduce the biochar product, and directly apply it to oil palm plants together with the partners. This community service activity also aims to help PTPN IV increase the value of TKKS waste through the utilization of TKKS waste into biochar, which is known to have many benefits, especially in improving soil fertility and plant productivity.

METHOD

This community service activity is carried out by a team of service providers consisting of ITSI lecturers together with ITSI students as an output of the Kedaireka Matching Fund grant from the Ministry of Education and Culture, Research, and Technology. This community service activity was carried out at Kebun Adolina PTPN IV in November 2024. This activity is divided into several stages, they are :

1. Planning

   The planning stage is the initial phase that consists of surveying and processing empty palm oil bunches into biochar. The research team collaborates with the plantation and Adolina factory to obtain materials and process them until laboratory tests on the biochar content. The mitigation results carried out by the field service team revealed that the empty fruit bunches of oil palm, which are produced in large quantities at the factory, have not been fully processed to their maximum potential (zero waste). The service team, together with partners who are the proposers of the Kedaireka matching fund, agreed to maximize the value enhancement of palm empty fruit bunches so that they can be utilized as biochar to help improve the soil in palm oil plantations. Additionally, it is also known that the use of fertilizers in the Adolina plantation is still dominated by inorganic fertilizers, which have the potential to harm the environment and therefore will not optimally support the SDGs for palm oil plantations, which is the focus of Indonesia's sustainable national development.

2. Implementation

The implementation stage consists of three main activities, namely the identification of prior knowledge, lectures and discussions; demonstration (application) of the finished biochar to the Adolina oil palm plantation. The service team first made biochar from empty palm oil bunches by burning them using a combustion device called a pyrolysis kiln. The results of the biochar lab tests have shown that it contains many nutrients that can help improve soil properties, mitigate climate change by absorbing carbon in the long term, and reduce greenhouse gas emissions. This finished biochar was then brought to Adolina and its form and benefits were socialized to the field workers in the plantation (such as foremen and field assistants). The socialization was conducted over the course of one day, during which the application of biochar on the fronds of oil palm plants was also carried out. The seminar and discussion covered two main topics: the role of biochar in improving soil properties and the techniques for making and applying biochar in the garden.

3. Evaluation

This stage marks the end of the activity, where the service team evaluates the level of success and effectiveness of the activity by conducting interviews with garden assistants, garden managers, foremen, and daily workers in the garden about biochar and its application in the garden. This is the final part of the activity as a form of reflection to gather perceptions, responses, and feedback from all partners regarding the material and implementation, aimed at improving the quality of future service activities.

RESULTS AND DISCUSSION

This service was carried out in collaboration with PTPN IV partners at the Adolina Plantation on November 15, 2024. This activity is also part of the dissemination phase of research results on appropriate technology that produces biochar from empty palm oil bunches as a form of support for the government's program on sustainable national development, namely sustainable "zero waste" palm oil plantation management.

The issue of chemical fertilizer use remains a dominant topic that is considered to have a significant potential to harm the environment and contradict the SDGs of palm oil plantations. Palm oil plantation entrepreneurs, especially partners, understand that the use of chemical fertilizers is not good, but due to considerations of time, cost, and process, the use of chemical fertilizers continues. Partners also understand and have heard about biochar, but the process of making and utilizing it has not been implemented because it is considered time-consuming and costly, so it has not yet been used as a substitute for organic fertilizer to help improve and amend the soil in the Adolina palm oil plantation.

At the beginning of this service activity, it was understood from several questions from the partners present during the discussion that the service team realized they did not yet know what biochar is, its benefits for agriculture, and the difference between biochar and charcoal. Biochar is a type of charcoal used for soil improvement. The main difference between biochar and charcoal is that biochar is a type of charcoal made through modern pyrolysis methods, whereas charcoal can be produced using either traditional or modern methods. Charcoal's main function or typical use is as fuel, while biochar's function is primarily to maintain soil health, increase soil productivity, and enhance soil fertility. Biochar, charcoal, and activated carbon are three forms of carbon that have a lot of overlap, with very similar compositions and production methods.

Socialization and education through outreach attended by partners, the service team provided explanations about biochar and the materials that can be used to make biochar, one of which is palm oil plant waste, thereby increasing the partners' knowledge. The service team

motivated partners at Adolina Plantation to engage in supporting "zero waste" activities as part of the focus on SDGs for oil palm plantations, by utilizing palm oil waste in the form of biochar that can be made independently to meet the carbon needs of plantation land. The use of biochar for each planting will improve both the physical and chemical fertility of the soil, resulting in better crop yields and maintaining soil fertility. The biochar produced by the service team was then tested, and it was found that the biochar has a high nutrient content. Biochar has been proven to be a porous wood charcoal substance, and since its raw material comes from living organisms, biochar is also referred to as biocoal (Gani, 2009). Biochar is produced through incomplete combustion or limited oxygen supply (pyrolysis). The potential raw materials for biochar are abundant, consisting of agricultural waste that is difficult to decompose or has a high C/N ratio. Biochar can persist in the soil for a long time (> 400 years) because it is difficult to decompose (Soil Research Institute, 2009). In the soil, biochar provides a habitat for soil microbes, but it is not consumed and generally, the applied biochar can remain in the soil for hundreds or even thousands of years. In the long term, biochar does not disrupt the carbon-nitrogen balance, but it can retain and make water and nutrients more available to plants. When used as a soil amendment along with organic and inorganic fertilizers, biochar can enhance productivity, as well as nutrient retention and availability for plants (Gani, 2009).

This community service activity went smoothly. The partners are very pleased, as evidenced by the active participation of the participants in this activity, which shows a high level of interest in the benefits of biochar directly related to efforts to improve agricultural productivity and the sustainability of agroforestry ecosystems. Additionally, this training provides new insights into the techniques for producing and applying biochar, which not only improves soil fertility but also has the potential to reduce production costs by decreasing the use of chemical fertilizers (Woolf, et al. 2010). Thus, this community service activity not only enhances the participants' knowledge but also provides practical solutions that can be immediately implemented in their land management, which will ultimately impact the increase in garden productivity, resulting in high-quality fresh fruit. Partners who previously had little understanding of the benefits of biochar in improving soil physical properties, after the training, became more aware of its impact on enhancing soil structure, allowing plant roots to grow better and reducing the risk of soil erosion (Duryat et al., 2024).

Here are some activities carried out by the service team together with partners, ranging from the production of biochar to field application, as seen in the following pictures:

Figure 1. The Process of Making Biochar from Palm Oil Empty Fruit

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Figure 2. Biochar Products and Handover of Biochar Products to Partners

Figure 3. Socialization and Application of Biochar in Oil Palm Plantations

The service team continues to foster cooperation, build communication, and actively motivate partners to always utilize palm oil waste in the form of biochar in their businesses, so that partners can maximally support sustainable palm oil development by using biochar as an organic fertilizer, which will improve both the physical and chemical fertility of the soil, resulting in better and higher quality crop yields.

CONCLUSION

Soil fertility is a determining factor for plant productivity, therefore efforts to improve its properties are very much needed.One of the methods that can be employed is the addition or return of organic matter through the utilization of empty palm fruit bunches as biochar. At the same time, it serves as an alternative solution for utilizing the abundant waste from palm oil mills, thereby adding value. Biochar is one of the soil amendment materials that plays many roles in improving soil fertility, including its physical, chemical, and biological properties, and serves as a primary source of organic carbon conservation in the soil.

Through this community service activity, the partners learned that there is another material that can be utilized to improve the soil fertility of their oil palm plantation, namely biochar. Partners also acknowledged gaining new knowledge about biochar and the utilization of oil palm plant residues as raw materials for biochar. This community service activity will also be sustainable so that partners, together with the service team from ITSI, can manage palm oil waste to produce biochar sustainably to meet their own needs or potentially for commercialization..

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