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Producing and Using Organic NPK Fertilizer From Agricultural and Household Waste by a Farmer Group in Sleman, Yogyakarta

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Abstract The agricultural industry, including the cultivation of paddy and vegetables, plays a crucial role in the economy of Padukuhan Dukuh and serves as its residents' primary source of income. Nevertheless, farmers have expressed that the challenge of acquiring subsidized fertilizers from the government substantially hinders the agricultural process. Compound fertilizer, often known as NPK fertilizer, is a specific chemical fertilizer frequently used by farmers to enhance soil fertility rapidly. This community service program aims to spread awareness about using alternative fertilizers (such as compost and liquid organic NPK) to minimize the adverse effects of fertilization on the environment. Additionally, the program seeks to promote the conversion of agricultural and household waste into organic fertilizers. The service activity took place from September 10 to October 14, 2023. Padukuhan Dukuh is the location where the production of alternative organic fertilizers using agricultural and home waste takes place. This service aims to offer support to the members of the "Ngudi Makmur" Farmer Group, located in Padukuhan Dukuh, Sinduharjo, Ngaglik, Sleman, DIY. There were 20 members of the farmer group present at the service. The community service stages are categorized into various implementation methodologies, specifically knowledge sharing, a workshop, monitoring, and evaluation. The results have been collected, and a favorable response from the community has been received. This offers a unique organic NPK fertilizer that is readily available and more efficient. The program has been assessed from various perspectives, including its sustainability. Several aspects must be taken into account to evaluate the program's sustainability. These factors encompass the necessity to enhance the caliber of human resources, augment crop output, maintain the reliability of fertilizer production via compost houses, and consider the economic and socio-cultural values.

1. INTRODUCTION

Sub-urban communities are geographically and demographically located in the periphery of urban centers where the dynamics of anthropogenic activities vary. Padukuhan Dukuh, Sinduharjo Sub-district, Kapanewon Ngaglik, Sleman Regency is one of the sub-urban areas that geographically still includes the Yogyakarta Urban Agglomeration Area. This area is one of the locations that still contributes agricultural products to the supply chain in the Sleman Regency area.

The agricultural sector (paddy and vegetables) is one of the main drivers of the economy and the main source of livelihood for the people of Padukuhan Dukuh. However, farmers have reported that the difficulty in obtaining subsidized fertilizers from the government is one of the obstacles in the agricultural process. In addition, rice fields have experienced a decline in soil quality, causing less than

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optimal yields. This is due to the difficulty in obtaining fertilizers and the side effects of the continuous use of chemical fertilizers. In the short term, chemical fertilizers can speed up the planting period because the soil can directly absorb the nutrient content, but in the long term, this has a negative impact (Wu et al., 2023).

Generally speaking, plants cannot absorb all the nutrients from chemical fertilizers. This results in chemical fertilizer residues that have the ability to bind soil particles together when they come into contact with water, making the soil less loose and more likely to harden. Because of the disease, organisms that break down soil lose their habitat and see a population decline. The soil will grow dependent on chemical fertilizers as a result of this. For organic fertilizer to have the most significant impact on lowering the need for chemical fertilizers, improving soil quality, and increasing crop productivity, the ideal rate of replacement must be established (Duan et al., 2023).

In addition, fertilizers are also a problem for the government because there is currently a scarcity of fertilizers, especially chemical fertilizers. This has caused fertilizer prices to increase dramatically, while fertilizer needs are increasing due to farmers' dependence on chemical fertilizers. This dependence has a serious long-term effect because it will have an increasingly damaging effect on the soil, so the need for fertilizers will also increase (Lalremsang et al., 2023). In the end, farmers' income will decrease due to the decline in soil productivity, the increasing need for fertilizers, and the high price of fertilizers. Based on this explanation, it is necessary to use organic fertilizers as an alternative to reduce dependence on chemical fertilizers and to improve damaged soil conditions.

The application of organic fertilizers, livestock manure composts, and the return of crop residues, whether buried or used as mulch, is necessary for crop cultivation that relies solely on inorganic fertilizers. The accumulation of organic matter in the soil is a crucial key to soil fertility, water retention, and productivity (Awale et al., 2017; Scotti et al., 2015). Organic matter in the soil serves to improve soil properties, both physical (soil structure, aggregate stability, water holding capacity, soil color, soil flexibility), chemical (cation exchange capacity, nutrient supply, pH, buffering capacity, absorption, and complexity) and biological (energy source and microbial substrate) (Adiaha, 2017; Awale et al., 2017).

Using household waste to make organic fertilizer reduces landfill waste and methane emissions, recycles valuable resources, and adds essential nutrients to the soil. It enhances soil structure and microbial activity, promotes sustainability using renewable materials, and reduces dependence on synthetic fertilizers. This cost-effective method saves money on commercial fertilizers and supports local production, minimizing the carbon footprint. Additionally, it provides slow-release nutrients, improving plant health and resistance to pests and diseases. Overall, it is a practical and eco-friendly approach to waste management and soil enrichment (Hajam et al., 2023).

Compound fertilizer, commonly referred to as NPK fertilizer, is one type of chemical fertilizer that farmers often use to improve soil fertility instantly. Compound fertilizer (NPK) is one of the inorganic fertilizers that can be used very efficiently in increasing the availability of macronutrients (N, P, and K), replacing single fertilizers such as Urea, SP-36, and KCl, which are sometimes difficult to obtain in the market and very expensive (Simanjuntak et al., 2015). Studies have shown that soil microorganisms are closely related to the content of nutrients such as soil organic carbon. The presence of organic matter can provide microorganisms with the nutrients required for life activities, thereby promoting the development of microbial communities (Zhao et al., 2023).

NPK fertilizer is a very efficient fertilizer for farmers to use, but until now, the NPK fertilizer that is often used is an inorganic or chemical fertilizer, which has terrible side effects like other chemical fertilizers. This is a consideration for making innovations related to the manufacture of organic NPK fertilizers, which are safer to use, do not have side effects, and even tend to improve soil quality to increase production yields. Controlled-release fertilizers, in particular, have gained popularity as a promising approach to sustainably providing crop nutrients while reducing excessive fertilizer usage and minimizing environmental impacts (Sair et al., 2023).

Organic fertilizers offer significant advantages over artificial fertilizers, particularly regarding environmental impact and sustainability (Avery, 2021). Unlike artificial fertilizers, organic fertilizers reduce the risk of water and soil pollution as they do not contain harmful chemicals. They enhance soil structure, increasing its ability to retain water and nutrients, thereby reducing erosion and runoff. Being made from renewable resources like composted plant material and animal manure, organic fertilizers contribute to a more sustainable agricultural system and help reduce waste by utilizing organic waste from agriculture and households (Pajura, 2024).

The other advantages are soil fertility and health. Organic fertilizers release nutrients slowly, providing a steady supply to plants over time. This contrasts with the rapid nutrient release from artificial fertilizers, which can lead to nutrient leaching. Additionally, organic fertilizers promote healthy microbial activity in the soil, enhancing nutrient availability and supporting plant growth. Economically, organic fertilizers can be more cost-effective in the long run despite the initial labor intensity, as they reduce the need for expensive chemical inputs. They can be produced locally, reducing dependency on external sources and supporting local economies (Wang et al., 2020).

By converting home and agricultural waste into liquid and solid organic NPK fertilizers, this community service is part of an attempt to assist the community in addressing the issue of dependence on synthetic fertilizers. As a result, it is also able to raise community interest in utilizing organic fertilizers sustainably through this community service. This community service program aims to educate and teach farmer groups and locals about environmentally friendly

fertilizer alternatives to organic fertilizers, such as compost fertilizer and liquid organic non-polymer potassium. The second is to motivate locals and farmer organizations to process home and agricultural trash to turn it into organic fertilizer.

2. METHOD

This service activity was carried out from September 10 to October 14, 2023. Alternative organic fertilizers are made using agricultural and household waste in Padukuhan Dukuh. The targets of this service are members of the Ngudi Makmur Farmer group, Padukuhan Dukuh, Sinduharjo, Ngaglik, Sleman, DIY. 20 members of the farmer group attended the service participants.

The service stages are divided into several implementation methods: knowledge sharing, training, and periodic assistance.

1. Knowledge Sharing
   This activity was carried out on September 10, 2023, and involved sharing related information and discussions with farmer groups in Padukuhan Dukuh. Included in this session was the initial sounding of problems faced by farmers. Furthermore, this activity also emphasized the importance of using organic fertilizer as an alternative fertilizer and as an effort to improve the soil quality of rice fields.

2. Fertilizer Making Training
   Training on making organic NPK fertilizer using basic ingredients of agricultural and household waste was carried out by means of direct demonstrations to farmer groups in Padukuhan Dukuh in accordance with the procedure for making liquid organic NPK and solid NPK fertilizers. This training process was carried out on October 14, 2023.

3. Evaluation and Mentoring
   After the training is carried out, monitoring and mentoring were also carried out for farmer groups when making organic fertilizer on a large scale. This is intended so that there is direct implementation for farmers in order to realize independence after the activity ends.

The roadmap for service activities is shown in Figure 1.

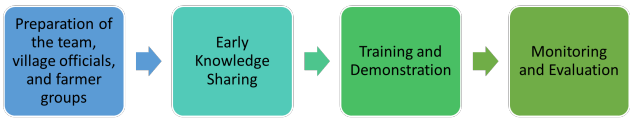

Figure 1 . Stages of implementation of service activities

3. RESULT AND DISCUSSION

Organic fertilizer application is an efficient method for improving soil water and nutrient availability and grain yield in semi-arid and arid areas (Duan et al., 2023). The use of organic fertilizers is done to reduce the use of chemical fertilizers and increase understanding of the suitability of using organic fertilizers and their use in vegetable pesticides to deal with pests and weeds. In addition, the use of these fertilizers can also reduce production costs. The benefit of this organic fertilizer for farmers is that in addition to farmers being able to fertilize appropriately, organic fertilizers can also be used to increase and improve the structure and biological conditions that fertilize the soil with the presence of macro and micronutrients so as to create a safe environment for humans (Abdullah et al., 2023).

3.1 The workshop stage of making solid and liquid organic NPK fertilizers

Figure 2 (a) showed the activity begins with knowledge sharing related to training in making solid organic NPK fertilizer (compost). Then, Figure 2 (b), showed the service team carried out the training process, starting with the distribution of tools and materials for making solid organic NPK fertilizer. This organic NPK fertilizer-making activity involves materials considered waste that are readily available in Padukuhan Dukuh. This is one of the materials that are considered waste but can be used by the community, especially farmers, as organic NPK fertilizer to reduce dependence on chemical fertilizers.

Figure 2 . (a) Early knowledge sharing; (b) The service team

The advantage of the solid organic NPK fertilizer product made in this service is that it can make organic NPK fertilizer with a relatively faster ready-to-use time. For example, this service's solid organic NPK fertilizer is ready to use within 1 hour. However, the service team suggests using this compost after 24 hours to ensure that the fermentation process runs perfectly. Solid organic fertilizer

is made to make ready-to-use organic fertilizer in a short time. The manufacturing steps are as follows. Materials: 1) Fresh Cow manure (enough); 2) roasted husk/husk charcoal (2 large plastic bags); 3) agricultural lime (1 kg); 4) broken salt (0.5 kg); 5) dry soil (2 crates); 6) thawed starter/catalyst of the Remen brand (1 dipper); 7) molasses/molasses (0.5 liter). Tool requirements: hoe/shovel, hand shirt, and bucket. The process of making solid organic NPK fertilizer is shown in Figure 3 (a).

Figure 3 . Process of making: (a) Solid organic NPK fertilizer; (b) Liquid organic NPK fertilizer

Using household waste to create compost organic fertilizer involves several steps. First, organic waste, such as kitchen scraps and garden waste, must be segregated from non-organic waste. Store the organic waste in a compost bin or pile, avoiding meat, dairy, and oily foods. Shred larger pieces of waste to increase the surface area for microorganisms. Balance green materials (high in nitrogen) with brown materials (high in carbon) in a ratio of about 3:1. Layer the materials alternately in the compost bin, starting with browns. Aerate the pile regularly to introduce oxygen and keep it moist like a damp sponge. Microorganisms will break down the waste, generating heat. Monitor the temperature and moisture level, turning the pile when it cools. After one week, the compost will be dark, crumbly, and earthy smelling.

In addition to solid organic NPK fertilizer, this service also conducted training on the process of making liquid organic NPK fertilizer. The process of making liquid NPK fertilizer is shown in Figure 3 (b). The basic ingredients for making liquid organic NPK fertilizer use raw materials that are relatively easy for the community to obtain. The materials used are Nitrogen source (Pete), Phosphate source (Bamboo Leaf), and Potassium source (Banana Heart). Molasses ½ liter, salt ½ kg, lime 1 kg, shrimp paste five pieces mashed, Remen liquid 2 liters, and fresh cow dung 5 kg. The fermentation process is relatively shorter at only seven days. Thus, it can be considered effective and efficient in the implementation process.

The manufacturing steps are:

1. Nitrogen, phosphate, and potassium source materials are finely chopped.
2. The materials are put into a barrel and mixed with molasses, salt, lime, ground paste, liquid Remen, and fresh cow dung.
3. After all the ingredients are added, they are stirred, and water is added until they are full.
4. Other components may be added if they can be made into organic fertilizer.
5. The barrel is allowed to stand for seven days, and then the liquid organic NPK fertilizer is ready for use.

The service team realized that farmers' dependence on chemical fertilizers is still very high and requires sustainable efforts to maximize the use of Organic NPK for farmers. The use of inorganic fertilizers (chemical fertilizers) in the long term causes soil organic matter levels to decrease, soil structure is damaged, and environmental pollution. If this continues, soil quality and environmental health will be reduced. On the other hand, the scarcity of synthetic chemical fertilizers is also often a problem (Fauzan et al., 2021). However, dependence on synthetic chemical fertilizers will have a long-term negative impact on agricultural land. So, this must be controlled from now on (Liu et al., 2022).

Basically, the materials used in this service are straightforward for service participants to obtain. In fact, these materials tend only to become unused waste. For example, residents are not accustomed to using cow dung as an ingredient in making fertilizer at the service location. In addition, the limited knowledge of residents also makes this alternative to NPK fertilizer based on household and agricultural waste still a new thing. There are many benefits found in cow dung organic fertilizer, namely improving soil's physical, chemical and biological properties, maintaining and increasing plant productivity (Wiraguna et al., 2022).

This service program provides comprehensive new knowledge for the target community. Sustainability and regular monitoring of this program are two aspects that must be considered. The training and knowledge-sharing session that has been carried out comprehensively can be the initial capital for farmers who need to rely on waste-based organic NPK fertilizer. This can be well developed to gain economic value and other farmer benefits (Marwantika, 2020).

3.2 Monitoring and evaluation stage

The results of the series of services that have been carried out get a positive response from the community.

This provides a new experience for service participants who have a different view of the use of organic NPK fertilizer. Therefore, several things are evaluated in this program, namely, the sustainability aspect of the program. The things that must be considered next regarding the program's sustainability include improving the quality of human resources, increasing crop productivity, consistency of fertilizer production through compost houses, and economic and socio-cultural values.

The evaluation results from the community aspect showed that the community responded positively to the activities carried out. This is evidenced by the mass production process of the Organic Fertilizer by the Farmer group for all its members. This is clear evidence of the usefulness of this service program. The community is enthusiastic about receiving new knowledge from the service team because they feel that the aspects taught and assisted are easy to apply and directly impact their agricultural activities. Thus, this service process opens new gaps related to farmers' alternatives to reduce dependence on chemical fertilizers in existing plant commodities. Hopefully, this program can provide impactful and sustainable benefits for the community and farmers, particularly in realizing sustainable and safe agriculture for the environment and human health.

4. CONCLUSION

The community service program proceeded as planned. In the short term, farmers have successfully produced organic fertilizer. In the long term, we anticipate improved soil fertility and increased corn production. Additionally, there has been a valuable transfer of knowledge among farmers, promoting food independence and enhancing the community's economic value.

Recommendations for the sustainability of this program in the future are that the community can be more independent in efforts to improve the quality of human resources, measure the effectiveness of organic NPK fertilizers with chemical fertilizers, and use sustainable production programs with a more organized system through farmer group mechanisms. Therefore, this can be an opportunity for future service programs.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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