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Empowerment of the Tirtobakti II Farmer Group to improve production capacity of frass organic fertilizer

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ABSTRACT

Limited subsidized fertilizer has caused the Tirtobakti II Farmers Group to provide organic fertilizer independently. Even though the process of making organic fertilizer using fermentation is well known, the process of making organic kasgot fertilizer is the choice of KT Tirtobakti II because it is more practical and efficient. KT Tirtobakti II's kasgot production process is constrained by limited maggot production resources and limited maggot production facilities. Empowerment activities at KT Tirtobakti II aim to develop the capabilities of KT Tirtobakti II members in increasing kasgot production capacity through providing maggot feed and providing production facilities. Activities are carried out through a series of activities in the form of education, practice, mentoring and evaluation. The positive impact of empowerment activities can be seen in the increasing ability of KT Tirtobakti II members to calculate the need for maggot feed ingredients according to kasgot production targets, the existence of partnership cooperation between KT Tirtobakti II and fruit and vegetable traders in traditional markets to meet maggot feed needs, and increasing production capacity by using maggot house facilities.

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1. INTRODUCTION

Agriculture plays a crucial role in supporting the national economy, particularly in achieving food security, enhancing competitiveness, absorbing labor, and alleviating poverty. Sukamakmur Village in the Ajung District is one of the areas with high agricultural productivity in Jember Regency. The agricultural production in this region primarily consists of rice and corn, along with production of beans, soybeans, sweet potatoes, and cassava. Agricultural production data for the Ajung District is presented in Table 1.

Agricultural production requires fertilizers for plant growth and harvest quality (Damascena et al., 2023). According to the Ministry of Agriculture Regulation No. 10 of 2022 on the Procedures for Determining the Allocation and Highest Retail Price of Subsidized Fertilizers for the Agricultural Sector, subsidized fertilizers are designated for certain commodities, including rice, corn, soybeans, chili peppers, shallots, garlic, sugarcane, coffee, and cocoa. Subsidized fertilizers are fertilizers whose procurement and distribution are subsidized by the government to meet the needs of farmers under a

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government program in the agricultural sector. The highest retail prices (HET) for subsidized fertilizers have increased since 2022, with Urea increasing by Rp450 per kg, ZA by Rp300 per kg, and SP-36 by Rp400 per kg (Zainuddin et al., 2022). This price increase has been complained about by farmers who consider subsidized fertilizers to be expensive. This situation causes farmers to reduce their usage and not apply fertilizers on time, ultimately leading to a decline in agricultural production, as seen in Waimital Village, where the average rice production since the fertilizer shortage is 1,527 per planting season. In comparison, rice production before the fertilizer shortage was 1,567 kg per planting season (Ajina et al., 2023).

Table 1. Data on agricultural production in Ajung District

Commodity	Harvest Area (Ha)	Productivity (Kw/Ha)	Production (tonne)
Corn	1,633	53.78	8,783
Peanuts	14	12.40	17.36
Soybeans	14.66	16.00	23.46
Rice	7,681	63.07	48.45
Sweet potato	12	270.00	324.00
Cassava	24	185.00	444.00

Source: BPS Kabupaten Jember (2020)

To address the fertilizer issue, the Tirtobakti II Farmers Group in Sukamakmur Village, Jember Regency, has started developing compost production using livestock and agricultural waste. The compost development is conducted with the assistance of local PPL (Agricultural Extension Workers). Compost production can be done using the method of stacking materials (livestock and agricultural waste) with the help of EM4 activators or a combination of EM4 and MOL activators (Hastuti et al., 2021; Ratriyanto et al., 2019). Simpler compost production methods continue to be developed as the complexity of organic waste processing practices significantly impacts farmers' motivation in its creation (Anantariya et al., 2023). In 2022, the Ajung Agricultural Extension Center (BPP), as BPP Kostratani in Jember Regency, trained the Tirtobakti II Farmers Group to produce organic fertilizers using maggot decomposers.

Maggot is the larval stage of the Black Soldier Fly (BSF). Maggot farming is widespread in various regions because they do not act as disease agents, have high protein content, a relatively long lifespan, and the production process does not require high technology (Apriyanto et al., 2023). Maggot is used to decompose organic waste and as animal feed. Fresh maggot is used as feed for fish, poultry, and reptiles, while dried maggot is used as feed for fish and cats (Apriyanto et al., 2023; Nurhayati et al., 2022; Rusdianto et al., 2023). Maggot farming in several areas aims to reduce organic waste (Kodrianingsih et al., 2023). Moreover, the byproducts of maggot farming, such as maggot compost (frass) and liquid fertilizer, have benefits as organic fertilizers with good results (Tri et al., 2023).

Frass production from maggots farmed by the Tirtobakti II Farmers Group (hereinafter referred to as the target) has been applied by group members on demonstration plots for three planting seasons. Farmers' willingness to apply frass fertilizer on demonstration plots is based on information about the results of previous frass fertilizer use. Research shows a significant effect of frass application on the height and fresh weight of mustard greens (Fauzi et al., 2022). Subsequently, the Tirtobakti II Farmers Group aims to develop production facilities to increase frass and POC frass production.

In addition to the need for production facilities, increasing frass production requires a larger amount of maggot feed. So far, the feed used for maggot feed is agricultural waste such as edamame waste, okra waste, or vegetable farming residues. The challenge of using agricultural waste as maggot feed is its seasonal availability (not available daily), necessitating a solution to provide maggot feed

materials available daily in sufficient quantities. The community empowerment goal for the Tirtobakti II Farmers Group is to enhance members' ability to provide raw materials and increase frass and POC frass production by adding production facilities.

2. METHODS

The method of implementing community empowerment activities targeting the Tirtobakti II Farmer Group is outlined in the activity design and method of activities. The activity design is developed jointly with the target group because in this activity, the target is not only the object but also acts as the subject.

Activity Plan

Table 2. Activity implementation plan

1st Activities	**Socialization of Activity Plans to Targets**	
Activities	Socialization of planned activities to be carried out with members of KT Tirtobakti II 26 May 2023	26 May 2023
Goals	Socialize activity plans that will be implemented to resolve target problems	
2nd Activities	**Production Planning Education**	
Activities	Education on calculating maggot feed requirements according to targets Installation of a table for calculating maggot feed requirements Presentation of strategies for meeting maggot feed needs	3 June 2023
Goals	Increasing the ability of KT Tirtobakti II members in planning maggot feed needs	
3rd Activities	**Partnership Assistance**	
Activities	Partnership practices in providing maggot feed	17 June 2023
Goals	Increasing the ability of KT Tirtobakti II members in providing maggot feed	
4th Activities	**Assistance in Providing Maggot Feed**	
Activities	Assistance in preparing maggot feed	15 July 2023
Goals	Accompanying the process of sorting and preparing maggot feed	
5th Activities	**Provision of Frass Production Facilities**	
Activities	Construction of frass production facilities Assistance in the maintenance of frass production facilities	5 August 2023
Goals	Providing maggot house facilities to increase frass production capacity Accompanying the maintenance of production facilities	
6th Activities	**Evaluation**	
Activities	Monitoring and evaluation Colloquium	4 November 2023
Goals	Ensure that the results achieved are in accordance with the targets that have been set	

Tools and Materials

The tool needed to carry out this community empowerment activity is a frass sifter. The materials needed are agricultural waste, rejected fruit and vegetables, plastic bags, shovels, and poster paper.

Activity Methods

Socialization

Socialization aims to convey plans for activities that will be carried out together in solving target problems.

Education

Education is conducted to enhance the knowledge, skills, and capacity of KT Tirtobakti II in production planning. Education is necessary to estimate the requirements for maggot feedstock and the needs for production facilities according to the required frass production. The first stage in implementing education is the preparation of materials. The second stage involves delivering education to members of KT Tirtobakti II, and the third stage is evaluation. Education is carried out through material presentation and discussions. The topics covered in this activity include: (1) The formula for processing organic waste with BSF larvae; (2) Calculation of maggot feedstock requirements; and (3) Alternative sources of maggot feedstock.

Education is a crucial point in empowerment implementation to ensure that partners in empowerment have the capability to sustain the program. Education methods are not only conducted in a classical classroom setting but also through practical demonstrations.

Assistance

The mentoring method is an approach or strategy to involve, guide, and support communities in developing their own capacity, skills, and resources. The main objective of this community service activity is to provide the community with the tools and knowledge needed to take an active role in improving quality of life sustainably.

The mentoring activities for maggot cultivation aim to increase the efficiency of frass production in KT Tirtobakti II. Therefore, mentoring activities include forming partnerships in providing maggot feedstock, preparing maggot feedstock, constructing maggot production facilities, and mentoring the maintenance of maggot cultivation infrastructure. Mentoring is conducted with active participation from participants, namely members of KT Tirtobakti II.

Evaluation Design

In implementing this community empowerment activity, there are three indicators used to measure the success of the intervention. The first indicator is the improvement in understanding among members of KT Tirtobakti II in calculating the need for maggot feedstock. The second indicator is the increase in the capacity of maggot and frass production. The third indicator is the availability of maggot production facilities.

Evaluation is conducted jointly by the implementing team, members of KT Tirtobakti II as the target audience in this activity, and the Research and Community Service Institute (LP2M) of the University of Jember.

3. RESULTS AND DISCUSSION

Community empowerment is a participatory process, which means giving trust and opportunities to the community to examine the main issues in community development and jointly design efforts to address them. In implementing community empowerment, it should follow certain principles, namely, the program/activities aim to solve the problems faced, utilize local resources, consider local cultural values, and environmental impacts, avoid creating dependency, conducted together on an equal footing, and must be self-sustainable by the community without external intervention.

During the education phase, KT Tirtobakti II receives information about the types of waste and the best waste formulations to obtain high-quality frass. High-quality frass meets the quality standards of compost according to SNI 19-7030-2004 on Compost Specifications from Domestic Organic Waste. Although maggots can reduce various types of organic waste such as agricultural residues, vegetables, fruits, meat, fish, and animal waste, a specific formulation is required to obtain high productivity of frass. In this activity, the best formulation for producing frass refers to research results (Farid et al., 2022), which are 80 percent vegetable and 20 percent fruit composition and 100 percent vegetable composition.

Figure 1. Education on maggot feed planning

The maggot feed requirements according to the formulation are fruits and vegetables. The local resources available in Sukamakmur Village include agricultural waste such as edamame stalks, okra stalks, and ungraded tomato harvests. With the increasing need for frass production, additional resources are required to meet the daily maggot feed needs. Therefore, the second educational material provided to KT Tirtabakti II covers the calculation of maggot feed requirements and the provision of maggot feed resources. The average frass production percentage for a 21-day processing period is 80 percent of 1 kg of feed material. Therefore, to produce 1 ton of frass, 1,250 kg of fruit and vegetable waste is needed. The relationship between the need for fruit and vegetable feed and frass production is presented in Table 3.

Table 3. Calculation of maggot feed requirements for frass production

Frass production (kg)	Composition A (80% Vegetables And 20% Fruit) (kg)	Composition B (100 percent Vegetables) (kg)
1,000	1,000 (Vegetables) 250 (Fruits)	1,250
1,500	1,500 (Vegetables) 375 (Fruits)	1,875
2,500	2,500 (Vegetables) 625 (Fruits)	3,125

The Table 3 is used to explain to farmers about the need for maggot feed materials according to the frass production targets. Members of KT Tirtobakti II have gained an increased understanding of the method for calculating maggot feed requirements, leading to questions about how to sustainably meet these needs. The next phase of education involves illustrating a partnership model between KT Tirtobakti II and fruit and vegetable traders in the traditional market around Sukamakmur Village. The proposed partnership scheme is in Table 4.

Table 4. Calculation of maggot feed costs

Scheme	Description	Cost per Bag	Details
A	KT Tirtobakti II buys fruit and vegetables that are not suitable for sale from market traders	Rp.6,333.33	The price per bag of fruit/vegetables (20-25 kg) is IDR 5,000.00 with transportation costs IDR. 20,000.00 (carrying capacity 15 sacks)
B	KT Tirtobakti II exchanged 5 bags of fruit/vegetables (20-25 kg) for 1 bag of frass (20 kg)	Rp.5,333.33	Transport costs Rp. 20,000.00 (carrying capacity 15 bags) The selling price of 1 bag of frass is IDR 20,000.00

For decision-making regarding the use of scheme A or B, a survey was conducted on fruit and vegetable traders at the Ajung and Jenggawah markets. The survey was conducted by the implementation team together with the chairman of KT Tirtobakti II to determine which scheme was more feasible to implement. In scheme A, the price per sack of fruits or vegetables with a capacity of 20-25 kg is Rp. 5,000.00, and the fuel cost for transportation using a three-wheeled vehicle is Rp. 20,000.00. The carrying capacity of the three-wheeled vehicle is 15 sacks. Therefore, the cost per sack expended for scheme A in one purchase is Rp. 6,333.33. In scheme B, KT Tirtobakti II does not purchase surplus fruits and vegetables but instead trades 5 sacks of surplus fruits and vegetables for 1 sack of frass. The selling price of frass produced by KT Tirtobakti II to the general public is Rp. 20,000.00 per sack. If the carrying capacity in one purchase is 15 sacks of surplus fruits and vegetables, then the amount of frass delivered is 3 sacks (5 sacks of surplus fruits/vegetables: 1 sack of frass) at a price of Rp. 60,000.00. Therefore, the cost per sack expended for scheme B in one purchase is Rp. 5,333.33.

The survey results indicate that scheme A is more feasible to implement because it is difficult to find fruit and vegetable traders who can collect 5 sacks of surplus fruits or vegetables within 3 days. Therefore, scheme A was chosen by KT Tirtobakti II to meet the needs of maggot feed materials. In the practical stage, members of KT Tirtobakti II purchase surplus fruits and vegetables from traders at the Ajung and Jenggawah markets every 3 days. In seven purchasing practices (one maggot life cycle), a total of 1840 kg of surplus fruits and vegetables were obtained, averaging 263 kg per purchase. After 21 days of maggot cultivation, approximately 1.5 tons of frass were obtained. Scheme B is continued sustainably by KT Tirtobakti II, resulting in the fulfillment of maggot feed material needs.

In addition to meeting the maggot feed material requirements, to further increase the production of frass, KT Tirtobakti II also needs larger maggot rearing facilities. Currently, frass production is carried out by utilizing empty space in the house of one of the members. The design of the frass production house begins with measuring the available land, drawing up the design, construction, and transferring the production facilities to the production house. The following illustration shows the location of the frass production house construction and the process of constructing the frass production house.

Figure 2. Location and process of making a maggot house

The maggot house is constructed using a galvalum frame, vinyl as the roof, and mesh netting as the walls. The use of mesh netting as walls serves to prevent maggot predators such as chickens from entering the maggot house. Additionally, the use of mesh netting helps maintain ideal air circulation inside the maggot house. The optimal temperature for maggot cultivation is between 24-36ºC. If the ambient temperature exceeds 36ºC, the larvae will exit their food source to seek cooler areas by hiding in the crevices of containers. If the ambient temperature is below 24ºC, their metabolic processes will slow down, resulting in slowed larval growth. Maggots also dislike light, so the maggot house uses vinyl roofing material that does not allow direct sunlight to pass through.

With the availability of the maggot house, frass production can be increased up to four times compared to previous production levels. The frass production process begins with hatching BSF eggs on hatching media consisting of soft, high-protein feed that is easily penetrated by hatching baby maggots, such as rice bran, tofu pulp, or broiler chicken feed. Due to the hot daytime temperatures in Sukamakmur village, the hatching cages are moistened when the feed starts to dry out. After hatching, the baby maggots will reside in the hatching cages for 5-7 days. If the growing media becomes too wet, the baby maggots will move upwards. Afterward, the baby maggots are transferred to a biopond, which serves as their habitat for feeding and growth. Bioponds for maggot rearing can be constructed using plastic or wooden tanks with tiered designs for space efficiency.

Surplus fruits and vegetables obtained from market traders are sorted. Maggots can consume fruits more easily than greens (vegetables or agricultural waste). The fruits obtained from the market are chopped, but not too finely. Maggots do not favor overly crushed organic materials because it hinders their movement and breathing. Surplus vegetables and agricultural waste must be fermented in sacks for decomposition. After fermenting for 3 days, the surplus vegetables and agricultural waste are ready to be fed to the maggots. The following is the flowchart illustrating the process of harvesting frass, POC, and maggots.

The implementation team provides mentoring to KT Tirtobakti II to ensure that the frass production process meets the needs of the farmer group. Currently, KT Tirtobakti II independently continues to develop partnerships with various parties, one of which is fruit shop owners. This is done to increase frass production capacity.

The evaluation phase of the activity, conducted jointly by the implementation team and KT Tirtobakti II, aims to assess the stages of the activity and whether the education materials and practices are well-received by KT Tirtobakti II members. Additionally, evaluation stages are conducted by the Community Service and Research Institution through monitoring and evaluation mechanisms including room monitoring, field monitoring, and colloquia. Evaluation results are summarized in Table 5.

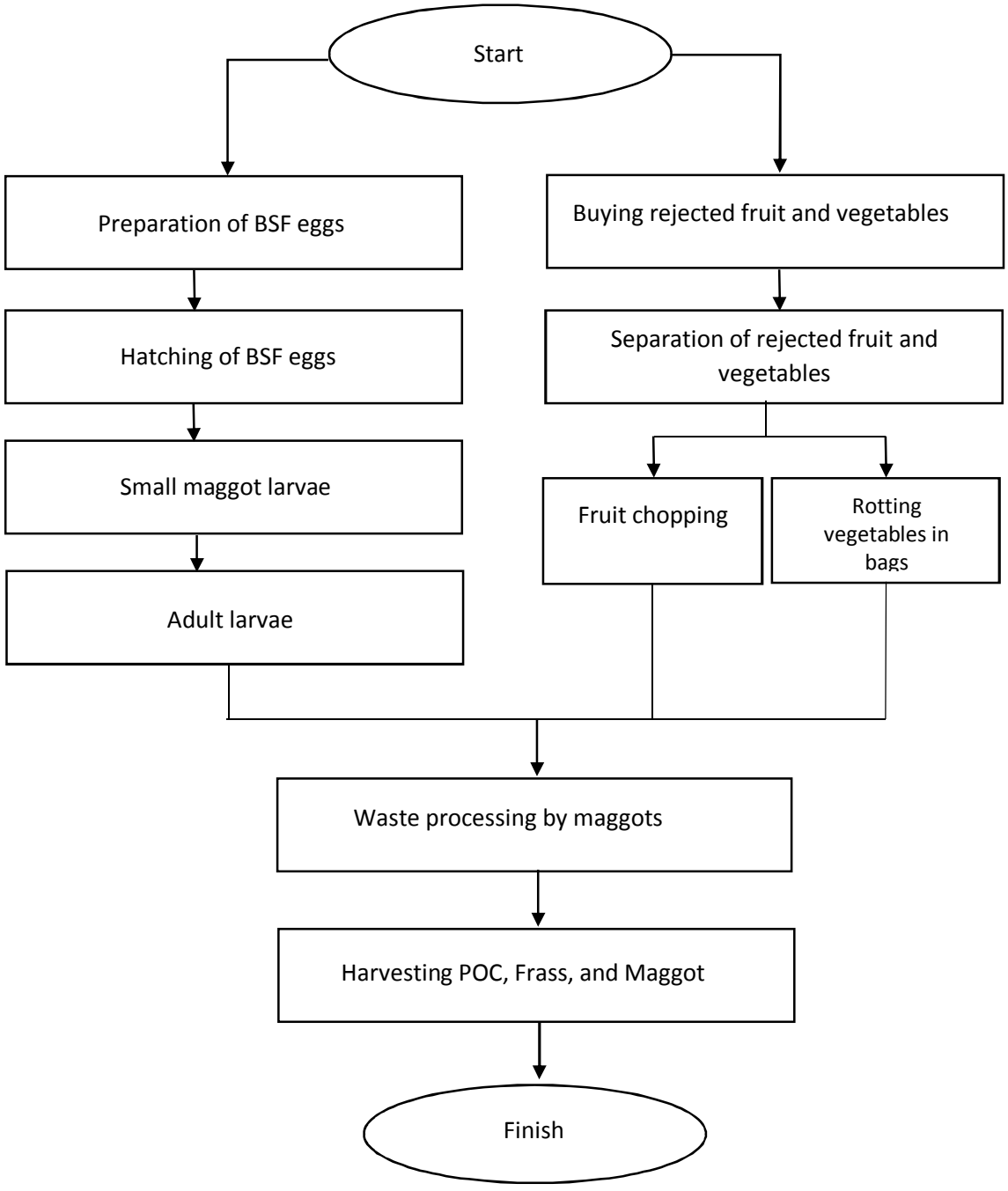

Figure 3. POC, frass, and maggot harvest flow diagram

Evaluation is conducted jointly by the implementation team and members of KT Tirtobakti II. It involves observing and recording every activity, input, and output generated. The module created to guide KT Tirtobakti II members has been utilized to calculate the raw material requirements. After determining the amount of raw material needed for maggot feed, KT Tirtobakti II members then plan the procurement of raw materials and strive to fulfill them through cooperation with several market vendors.

The capacity of maggot and frass production increases as the number of facilities and infrastructure is roughly doubled.

Table 5. Activity evaluation

Indicators	Conditions Before	Conditions After
KT Tirtobakti II members' understanding of the material for calculating the need for raw materials for maggot feed	KT Tirtobakti II members provide feed raw materials based solely on intuition by observing the availability of feed in the cultivation pens	KT Tirtobakti II members were able to calculate the need for organic waste as raw material for maggot feed and plan its procurement.
Maggot and frass production capacity	KT Tirtobakti II processes 10-20 kg of waste per day	KT Tirtobakti II processes organic waste of 20-40 kg of waste/day
Facilities and infrastructure for maggot production	KT Tirtobakti II has 6 maggot cultivation tanks/cages	KT Tirtobakti II has 12 maggot cultivation tanks/cages

Discussion

The empowerment activities in organic waste management using maggots have been widely conducted. However, some of these activities are still in the introductory stage and have not yet reached the economically valuable and sustainable production stage. Community empowerment activities conducted by Kodrianingsih et al. (2023), Kusumawati et al. (2020), and Tri et al. (2023) focus on introducing organic waste processing and identifying business opportunities for the community. The empowerment activities in KT Tirtobakti II differ because, based on initial interviews, it was found that KT Tirtobakti II has actively produced frass and maggots, but not optimally. The target of empowerment in this activity is partners who have actively felt the benefits of the product and the economic benefits of maggot and frass production. Therefore, the interventions differ from those in communities unfamiliar with waste processing using maggots. The socialization stage conducted by Kodrianingsih et al. (2023), Kusumawati et al. (2020), and Tri et al. (2023) targets groups such as youth organizations and the general public. The socialization material presented is different from the empowerment activities in KT Tirtobakti II. The socialization material no longer introduces the benefits of maggots and frass but focuses on solving problems faced by KT Tirtobakti II in increasing frass production capacity.

Frass production becomes the focus of KT Tirtobakti II's production because it is needed to meet the group members' demand for fertilizer. Frass or leftover media from live maggots can be used as liquid organic fertilizer and compost to reduce farming costs (Atma et al., 2022). The use of organic fertilizers in semi-organic rice farming requires lower total farming costs compared to non-organic farming costs. The semi-organic rice farming cost is Rp. 6,712,000.00 per ha, while the total non-organic farming cost is Rp. 7,623,000.00 per ha (Darwis, 2014).

The implementation of educational activities for calculating maggot feed needs, such as fruit and vegetable waste, is part of the effort to plan production capacity. This education is carried out to improve KT Tirtobakti II members' understanding in determining the required level of capacity to meet the desired production targets. So far, the process of procuring maggot feed has been done using instincts and experience, where maggot feed will be prepared when the quantity starts to decrease. Education on calculating maggot feed needs is done using a table to avoid confusion among KT Tirtobakti II members. The table of calculated production targets and maggot feed requirements is placed on the maggot house wall for easy reading by KT Tirtobakti II members. The impact felt by KT Tirtobakti II members is

the ease of measuring maggot feed needs if they want to achieve a certain amount of frass production.

The fulfillment of maggot feed needs through a partnership system has never been done by KT Tirtobakti II. So far, maggot feed needs have been met using agricultural waste from members' land. The use of agricultural waste has seasonal limitations, where if it is outside the harvest season, maggot feed supply becomes hindered. The initiation of a partnership system with fruit and vegetable vendors in traditional markets around Sukamakmur village sheds light on meeting maggot feed needs. Fruit and vegetable vendors also benefit from this partnership because, so far, discarded fruits and vegetables have ended up in the trash. With this partnership system, discarded fruits and vegetables still have economic value. The partnership system built is not a formal partnership system, as it adapts to the local wisdom of the local community.

Sukamakmur village is a rural area that still strongly maintains a culture of togetherness. The key to the success of community empowerment in rural areas is the role of social capital elements in addressing issues together. In social capital, there are elements such as trust, norms, and networks that play a significant role in rural communities (Alfiansyah, 2023). This partnership model can be replicated in other villages that still have strong social capital.

Figure 4. Target partnership exploration

In the implementation of this community service program, several inhibiting factors occurred during the activities: (1) because the training conducted is direct training, there needs to be an explanation in the form of practical demonstrations to participants at each meeting. This is based on the participants' knowledge, who are new to the techniques of utilizing plastic waste and its processing methods; (2) some participants feel disgusted during practical sessions. This is because, at the beginning of the meeting, the implementing team did not provide an overview of the characteristics of the materials to be used. Thus, participants still imagine the materials used as dirty and filthy waste; (3) there is an obstacle in the teaching method of this training, which emphasizes practical methods, sometimes requiring assistance in the form of guidance to inform them about the stages to be done; (4) the limited time frame necessitates clear time allocation in the implementation of this community service program, and the lack of facilities to create a design, such as a drawing table. Therefore, participants still need to use the floor to create design drawings. This is still within reason because the facilities used are owned by the local RT and RW areas and are not intended as facilities for design workspaces.

4. CONCLUSION AND RECOMMENDATIONS

The empowerment program for members of KT Tirtobakti II aims to enhance the skills and knowledge of the participants to increase frass production. The targets in this activity are for the

participants to be able to measure the need for maggot feed and fulfill the need for maggot feed through partnerships. The activities are carried out through education, mentoring, and evaluation. The education and mentoring provided to the participants have imparted knowledge of calculating maggot feed requirements, enabling them to estimate maggot feed needs according to frass production targets. Partnerships have been established with fruit and vegetable vendors at traditional markets around the Sukamakmur village. A maggot house production facility has been built on KT members' land to increase frass production capacity. As a result of these activities, frass production has been sustainably carried out by the participants.

There is a need for socialization and promotion of this program so that participants are not limited to high school graduates in one area. Given the variety of plastic waste types, additional implementation time is needed to provide sufficient knowledge about material processing, design, products, and product creation. Continuous mentoring and monitoring should be conducted for partners to ensure the program can be continued periodically. It is advisable to follow up the program through cooperation with other partners or parties outside the institution to understand broader responses to the implementation of a community service program that has been conducted. Partners can provide information that can be beneficial regarding needs that are aligned with the capabilities and knowledge to carry out similar community service programs.

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