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Training on Making Eco-Enzyme as a Natural Insecticide and Liquid Organic Fertilizer for Farmer Groups to Create Environmentally Friendly Agriculture

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Abstract: Habaring Urung is a sub-district where most farmers work and is one of the local vegetable and fruit-producing areas in Palangka Raya City. So far, farmers tend to use synthetic insecticides and chemical fertilisers obtained from agricultural shops to cultivate plants. Apart from expensive operational costs, synthetic insecticides and chemical fertilisers are known to damage the environment if used over a long period. Therefore, this program aimed to equip the knowledge and skills of farmer groups in the Habaring Hurung Sub-district to make environmentally friendly insecticides and liquid organic fertilisers. This activity was carried out using the Participatory Action Research (PAR) method. Implementation of activities consisted of several stages, i.e., preparation, problem identification, focus group discussions to determine programs that suit the problem, program implementation through training, and evaluation by administering questionnaires. This program was implemented in September 2023 at the Habaring Hurung Sub-district Office Hall with 39 activity participants. The enthusiasm and active participation of participants during the implementation of the program showed a positive response. The questionnaire results as part of the program evaluation also showed that almost all participants agreed (72.22%) and strongly agreed (27.78%) that participants' knowledge and skills increased after participating in this activity program. In addition, this program is also considered very useful and is planned to be continued independently by the activity participants. It shows that the program has increased the knowledge and skills of farmer groups in the Habaring Hurung Sub-district in making insecticides and liquid organic fertilisers that are environmentally friendly and of high value to support sustainable agricultural policies.

Keywords: eco-enzyme; insecticide; farmers; liquid organic fertilizer

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INTRODUCTION

Habaring Urung is a village with an area of approximately 73.58 km² located in Bukit Batu District, Palangka Raya City, Central Kalimantan. This village has a reported population of around 857 people, with 65% of the population working as farmers. The agricultural land in Habaring Urung covers about 32.12 km² and is quite fertile, making it one of the local suppliers of rice, vegetables, and fruits in Palangka Raya City.

So far, the farmers in Habaring Urung tend to use synthetic insecticides and chemical fertilisers for crop cultivation. The synthetic insecticides commonly used by farmers include Prevathon 50 SC, Curacron 500 EC, and Decis 25 EC. Meanwhile, the chemical fertilisers used are NPK Pak Tani 16-16-16 and NPK Mutiara 16-16-16. Besides being relatively expensive, the excessive use of these synthetic insecticides and chemical fertilisers can damage crops and the environment and pose health risks to humans. The farmers in Habaring Urung have abundant resources to produce eco-friendly natural insecticides and liquid organic fertilisers. However, the current problem is the farmers' need for knowledge and skills to utilise these resources for beneficial agricultural products. In addition to being directly used by farmers, it is also hoped that natural insecticides and liquid organic fertilisers can be mass-produced for commercialisation to increase the residents' income.

One resource for making natural insecticides and liquid organic fertilisers is organic waste from household waste. So far, local residents dispose of organic waste by burying, burning, or piling it up by the roadside or around residential areas. If ignored, this can pollute the environment and pose health hazards. Therefore, utilising organic waste to produce beneficial natural insecticides and liquid organic fertilisers is essential.

Several studies have reported that organic waste can be processed into eco-enzymes, which can be applied as a natural insecticide and liquid organic fertiliser (Meilani et al., 2023; Parwata et al., 2021; Tea et al., 2022). Eco-enzyme is generally a fermentation solution of organic waste (especially fruit peels), sugar, and water. During fermentation, glucose from fruit peel waste and sugar is broken down into pyruvic acid. Pyruvic acid is then decomposed by pyruvate decarboxylase into ethanol and carbon dioxide under anaerobic conditions. The resulting ethanol is broken down into acetaldehyde and water and then converted into acetic acid (Larasati et al., 2020; Ulfia Septiani et al., 2021). The acetic acid produced from the fermentation process and the active compounds from flavonoids, quinones, saponins, and alkaloids produced from fruit peel waste make eco-enzymes useful as a natural insecticide to kill insects on plants. The eco-enzyme solution also contains macro and micro nutrients derived from the fruit peel waste itself, making it useful as a liquid organic fertiliser to improve soil fertility (Neupane & Khadka, 2019; Pakki et al., 2021; Parwata et al., 2021; Sari et al., 2021; Tea et al., 2022).

Based on these considerations, this program aims to enhance the knowledge and skills of farmer groups in Habaring Hurung Village to produce eco-friendly and valuable natural insecticides and liquid organic fertilisers.

METHOD

This community service activity employs the Participatory Action

Research (PAR) method. This method was chosen due to its advantages in providing opportunities for activity partners to play an active role, learn, and develop together to achieve the desired social change (Azhari *et al*., 2020; Katoppoa & Sudradjat, 2015; Suud *et al*., 2023)

Implementation Stages
The implementation of this activity consists of several stages: preparation, problem identification, focus group discussion to determine programs suitable for the identified issues, program implementation through training, and program evaluation using questionnaires. The partners in this community service program are the farmer groups from Kelurahan Habaring Hurung, Kecamatan Bukit Batu, Palangka Raya City.

Preparation Stage
The preparation stage involves coordinating with the head of Kelurahan Habaring Hurung. This coordination is intended to communicate the activity's objectives and goals and obtain permission for its implementation.

Problem Identification Stage
Problem identification was conducted through discussions with the village head and representatives from local organisations in Habaring Hurung on May 5, 2023. The discussions concluded that the main issues were farmer groups' use of environmentally unfriendly agricultural materials and improper handling of organic waste from unsold and low-quality produce. These issues needed immediate attention.

Focus Group Discussion (FGD)
An FGD was held on May 15, 2023, to determine a suitable program for addressing these problems. The community service team, the village head, and farmer group representatives concluded that training on making eco-enzyme solutions from fruit peel waste as natural insecticides and liquid organic fertilisers would be the most appropriate program.

Formulation Design Stage
Before the program implementation, the team and farmer group representatives designed the formulation for making eco-enzyme solutions. It was determined that eco-enzyme solutions could be made by fermenting palm sugar, fruit peel waste, and water in a ratio of 1:3:10 for three months. After three months of fermentation, the eco-enzyme solution is extracted and packaged according to its use: (a) As an insecticide, 1 mL of eco-enzyme solution is diluted in 1000 mL of clean water and packaged in 250 mL plastic bottles; (b) As a liquid organic fertiliser, 1 mL (low dose) or 100 mL (high dose) of eco-enzyme solution is diluted in 1000 mL of clean water and packaged in 500 mL plastic spray bottles.

Program Implementation
The training program was conducted on September 4, 2023, at the Habaring Hurung village hall. The training was attended by 39 participants, including the village head, village officials, and Habaring Hurung farmer group members. Participants were selected based on the following criteria: (i) men and women aged 25-65 years, (ii) working as farmers, and (iii) having no prior knowledge of organic waste management into agricultural products.

Training Methods
The training methods were socialisation and demonstration. The socialisation covered topics on organic waste and its dangers, techniques for making eco-enzymes such as natural insecticides and liquid organic fertilisers, product packaging, and usage instructions. The training continued with a demonstration

of making and using eco-enzymes as insecticides and liquid organic fertilisers.

Program Evaluation

After the training, the team evaluated the participants. The participants were asked to fill out a questionnaire with statements to measure the success of the community service activity. The participants chose from the following responses: Strongly Agree (SA), Agree (A), Somewhat Agree (SwA), Disagree (D), and Strongly Disagree (SD). The statements included: 1) the relevance of the training theme to participants' needs; 2) ease of understanding the material; 3) increase in participants' knowledge after the socialisation and demonstration; 4) implementation of the activity; 5) usefulness of the activity; 6) sustainability of the activity for participants. Questionnaire data analysis involves data entry, validity testing, and descriptive analysis. Participants' attendance and activity during the session were also monitored through an attendance list and Q&A sessions.

RESULTS AND DISCUSSION

The method used in this community service activity is PAR. This method focuses on active community participation in designing and implementing strategic action plans chosen to solve the problems faced. Based on discussions with the village head, representatives from the Family Welfare and Empowerment Organisation (PKK), and the farmer groups in Habaring Hurung, it was identified that the use of environmentally unfriendly agricultural materials by the farmer groups and improper handling of organic waste from unsold and low-quality fruit harvests were issues that needed immediate attention. Therefore, an FGD was conducted to determine a suitable program to address these problems. This activity was attended by the community service team, the village head, and representatives from two farmer groups in the Habaring Hurung area. The discussion concluded that training on making eco-enzyme solutions from fruit peel waste as natural insecticides and liquid organic fertilisers was the most appropriate program to address the issues.

The community service team, along with two representatives from the farmer groups, then designed the formulation for making the eco-enzyme solution. The design showed that the eco-enzyme solution could be made by fermenting palm sugar, fruit peel waste, and water in a ratio of 1:3:10. The fermentation process of palm sugar, fruit peels, and water into an eco-enzyme solution generally takes three months. In the first month, glucose is broken down into ethanol under anaerobic conditions. In the second month, the ethanol produced is converted into acetic acid, and by the third month, the eco-enzyme is produced (Hidayat et al., 2023; Larasati et al., 2020; Septiani et al., 2021). The eco-enzyme solution produced in the third month is then packaged as natural insecticides and liquid organic fertilisers (Figure 1).

(a)

(b)

(c)

Figure 1 Products: (a) eco-enzyme, (b) natural insecticide, and (c) liquid organic fertiliser

The solution is brown with a fresh, acidic aroma. These results align with research conducted by Idrus et al. (2023) using fruit peels and palm sugar.

During the training program implementation, socialisation was conducted using lecture and discussion or Q&A methods (Rambe, 2021). The lecture method was used for material presentation, while discussions allowed participants to ask questions and share their opinions (Figure 2). The enthusiasm and active participation of the participants during the training showed a positive response to the program's implementation. This was evident from the participants' active participation in the discussion or Q&A sessions.

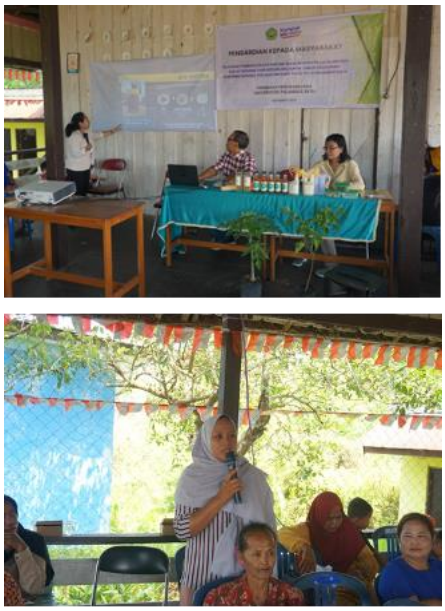

Figure 2 Socialisation activities

The training continued with a demonstration of making eco-enzymes for natural insecticides and liquid organic fertiliser (Figure 3). The eco-enzyme products created by the community service team and farmer group representatives were also distributed to the participants. Putra et al. (2023) reported that this activity is essential for participants to directly experience the benefits of agricultural products and gain further information on their usage.

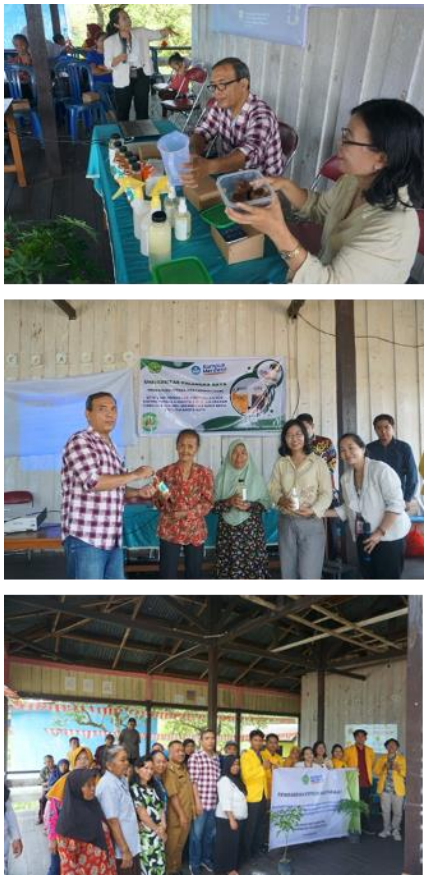

Figure 3 Demonstration activity, product distribution, and group photo with the head of the habaring hurung village

The program's success was then evaluated by providing the participants a questionnaire prepared by the community service team. The results are shown in Table 1. The results indicate that almost all participants agreed (72.22%) and strongly agreed (27.78%) that their knowledge and skills improved after participating in this program. Additionally, Table 1 shows that the average participant agreed and strongly agreed that the program theme was suitable for their needs, the material presented was easy to understand, and the program was well executed. The community service

program was also considered very beneficial and is planned to be continued independently by the participants.

The community service team also examined the eco-enzyme solution produced after the training. After three months of fermentation, the eco-enzyme solution was dark brown with a pH of 4 and a fresh, acidic aroma. The farmer group in Habaring Hurung Village packaged and used the resulting eco-enzyme solution as a natural insecticide and liquid organic fertiliser. This result shows that the participants successfully created natural insecticide and liquid organic fertiliser from the eco-enzyme solution. This also proves that the community service program successfully enhanced the knowledge and skills of the farmer groups in creating environmentally friendly and high-value insecticides and liquid organic fertilisers to support sustainable agricultural practices.

Table 1 Evaluation questionnaire results filled by 39 participants

No	Statement	Response				
		SA	A	SwA	D	SD
1	The theme of the community service program is suitable for the participant's needs.	47.22%	52.78%	0%	0%	0%
2	The material presented is easy for the participants to understand.	61.11%	33.33%	0%	5.56%	0%
3	The knowledge and skills of the participants increased after attending the community service program.	27.78%	72.22%	0%	0%	0%
4	The community service program was well executed.	22.22%	77.78%	0%	0%	0%
5	The community service program was beneficial.	44.44%	55.56%	0%	0%	0%
6	The community service program can be continued independently by the participants.	22.78%	72.22%	0%	0%	0%

CONCLUSION

The participants who attended the training showed enthusiasm and active participation throughout the activities. The eco-enzyme solution made during the training had a pH of 4 and was dark brown with a fresh, acidic aroma. This indicates that the participants could make eco-enzyme solutions that could be used as natural insecticides and liquid organic fertilisers. As part of the evaluation, the questionnaire results also showed that almost all participants agreed and strongly agreed that the program theme was suitable for their needs, the material presented was easy to understand, the program was well executed, and the program increased their knowledge and skills. The community service program was very beneficial and is planned to be continued independently by the participants. The follow-up actions from this community service activity include (1) regularly monitoring the farmer group's crop cultivation results after using the natural insecticide and liquid organic fertiliser produced and (2) conducting training on branding the agricultural products made independently by the farmer groups in Habaring Hurung Village.

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