







**Empowerment of Nglongsor Village PKK Members in Utilizing Banana Peel Waste into Crackers:
A Zero Waste Approach for Waste Management and Economic Improvement**

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Abstract

Background: Nglongsor Village has banana peel waste that has not been optimally utilized and causes environmental problems.

Objective: Empowering PKK Mothers through training on processing banana peel waste into zero-waste crackers to support family economy.

Methods: The activities were carried out through socialization, technical training, business assistance, packaging innovation, digital marketing, and evaluation, with 20 PKK members as participants.

Result: Quantitatively, the program increased participants' knowledge by approximately 70–80% based on pre-test and post-test results. A total of 18 out of 20 participants (90%) were able to independently produce banana peel crackers, contributing to an estimated 50% reduction in banana peel waste at the household level. In addition, one PKK business group was established with an average production capacity of 50 packages per production cycle.

Conclusion: The program successfully reduced organic waste and enhanced women's economic independence. These outcomes contribute to the achievement of the Sustainable Development Goals (SDGs), particularly SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production).

A. Introduction

Nglongsor Village, Tugu District, Trenggalek Regency is an agrarian area with abundant banana production potential. However, the high level of banana production has not been accompanied by optimal management of agricultural waste, particularly banana peel waste, which is mostly discarded or only used as animal feed. This condition has the potential to cause environmental problems and has not yet provided added economic value for the community. On the other hand, the PKK women's group in Nglongsor Village plays an active social role, but has not been fully empowered in productive economic activities that could improve family welfare.

Bananas are one of the tropical fruit commodities with high production levels in Indonesia and play an important role in supporting the local economy (Nadila, 2024). Data show that national banana production continues to increase, resulting in a large availability of raw materials as well as waste (Zainy, dkk., 2022). In Nglongsor Village, banana utilization is still focused on fruit consumption, while other parts such as banana peels have not been optimally utilized (Rohmani & Yugatama, 2019). Banana peel waste is generally discarded or used as animal feed with low economic value (Putri, dkk., 2022). If not properly managed, this type of agricultural waste has the potential to cause environmental pollution and reduce environmental quality (Khairi, dkk., 2025).

In fact, banana peels contain nutritional components and bioactive compounds that have the potential to be developed as alternative food ingredients. Banana peels contain carbohydrates, protein, dietary fiber, as well as phenolic and flavonoid compounds that are beneficial for health (Segura-Badilla, dkk., 2022). These contents make banana peels suitable for processing into value-added food products, one of which is crackers. Studies show that banana peel-based crackers have good consumer acceptance in terms of taste, texture, color, and aroma (Abdul Aziz, dkk., 2019). In addition, the consumption of banana peels also has potential health benefits due to their bioactive compounds (Zainy, dkk., 2022).

Efforts to process banana waste using a zero waste approach have been implemented in various community service programs and have proven effective in improving community skills and income (Asfar, dkk., 2023). The zero waste concept emphasizes optimal resource utilization to minimize waste generation and support a circular economy (Song & Zeng, 2015). This approach is also aligned with the Sustainable Development Goals (SDGs) (Awasthi, dkk., 2021). However, there are still limited community service activities that specifically integrate banana peel waste processing, empowerment of PKK women, packaging innovation, and digital marketing within a single sustainable program.

Based on these conditions, the PKK women's group in Nglongsor Village faces several key problems, including low skills in processing banana peel waste into marketable products, limited knowledge of product packaging and branding, and minimal understanding of digital marketing. In fact, women's empowerment through training and continuous assistance has been shown to enhance family and village economic independence (Rahmadewi, dkk., 2024). Therefore, the Community Service Program (PKM-PM) entitled "Empowerment of PKK Women in Nglongsor Village through the Utilization of Banana Peel Waste into Zero Waste-Based Crackers for Waste Management and Economic Improvement" was designed as an integrative solution to address environmental problems while simultaneously improving family economic independence through zero waste-based waste processing, product innovation, and digital marketing.

B. Methods

1. Activity Design and Location

This community service activity employed a participatory approach based on community empowerment through training and mentoring methods. The activity was conducted in Nglongsor Village, Tugu District, Trenggalek Regency, which was selected due to its high banana production potential while banana peel waste has not yet been optimally utilized.

2. Population and Sample

The population in this activity consisted of all members of the Family Welfare Empowerment (PKK) group in Nglongsor Village. The sampling technique used was purposive sampling with the following criteria: (1) PKK members who were actively involved in organizational activities, (2) had an interest in developing food-based micro-enterprises, and (3) were willing to participate in the entire series of activities. Based on these criteria, 20 participants were selected as the main partners of the program (Asrulla, et al., 2025).

3. Implementation Stages

The activity was carried out through four main stages:

a. Planning

This stage included a needs analysis through an initial survey, identification of partner problems, preparation of training modules, and coordination with village officials and PKK administrators to obtain administrative and logistical support (Javaid & Hassan, 2021).

a. Preparation

An initial socialization was conducted for prospective participants regarding the zero waste concept and the economic potential of banana peel waste processing. The team prepared training materials, production tools and materials (blenders, stoves, frying pans, press machines, banana peel raw materials, flour, and spices), as well as product packaging designs.

b. Implementation

The implementation consisted of several core activities:

- 1) Technical production training: Participants were trained directly using a learning-by-doing approach, starting from cleaning and processing banana peels, mixing the dough, molding, drying, and frying the crackers until they were ready for consumption. Flavor variations (spicy, cheese, and onion) were also introduced to enhance product attractiveness.
 - 2) Packaging and branding training: Participants were taught how to create attractive and hygienic packaging designs, develop product branding, and determine selling prices based on production cost calculations and profit margins.
 - 3) Digital marketing training: Participants were guided in creating social media accounts for product promotion, product photography techniques, persuasive description writing, and marketing strategies through e-commerce platforms.
- c. Mentoring and Evaluation
- Mentoring was conducted periodically to ensure business sustainability, including guidance on simple financial management and recording of capital and profits. Evaluation was carried out both formatively (during the activity) and summatively (at the end of the activity) to measure program achievements.

4. Instruments and Data Collection Techniques

Data were collected through the following methods:

- a. Participatory observation: Direct observation of the training process and participants' ability to practice the skills taught.
- b. Interviews: Semi-structured interviews were conducted to explore participants' perceptions of the program, challenges encountered, and plans for business sustainability.
- c. Documentation: Photo and video documentation to record all stages of the activity.
- d. Pre-test and post-test questionnaires: Used to measure improvements in participants' knowledge and skills before and after the training, covering aspects of waste processing, production techniques, packaging, and digital marketing.

5. Data Analysis Techniques

The collected data were analyzed using both descriptive qualitative and quantitative approaches. Qualitative data obtained from participatory observations and semi-structured interviews were analyzed thematically to identify patterns, key themes, and changes in participants' attitudes or behaviors related to waste management and business development. Meanwhile, quantitative data from the pre-test and post-test were analyzed using descriptive statistics, including percentages and mean scores, to measure improvements in participants' knowledge and skills. In addition, a paired sample t-test was applied to examine the significance of differences in participants' scores before and after the training, with a significance level of $\alpha = 0.05$.

6. Indicators of Success

Program success was measured using several indicators. At least 80% of participants were expected to be able to independently produce banana peel crackers with acceptable consumable quality. The program also targeted a minimum production of 50 packs of crackers per production cycle, along with a 50% reduction in banana peel waste in the village. Furthermore, participants' knowledge and skills were expected to increase by at least 70% based on pre-test and post-test results. Another indicator of success was the establishment of a PKK business group committed to continuing banana peel cracker production on a sustainable basis.

7. Ethical Considerations

All participants were provided with complete information regarding the objectives and procedures of the activity. Participation was voluntary with verbal consent. Participants' personal data were kept confidential and used solely for research purposes and program documentation.

C. Results and Discussion

1. Results

The Community Service Program (PKM-PM) implemented in Nglongsor Village, Tugu District, Trenggalek Regency produced significant outcomes in terms of organic waste management, skill capacity enhancement, and the strengthening of economic independence among PKK women. Program outcomes were obtained through pre-test and post-test measurements, participatory observation during program implementation, brief interviews with participants, and documentation of program outputs.



Figure 1. Coordination with the Chair of the TP PKK Nglongsor Village

The pre-test results indicated that most participants had limited understanding of the zero-waste concept, the potential utilization of banana peel waste, waste-based food processing techniques, hygienic packaging principles, and digital marketing strategies. The initial level of participants' understanding ranged from 10–25%, indicating that banana peel waste was still perceived as having no economic value. This condition highlights the urgency of implementing community service programs oriented toward improving environmental literacy and entrepreneurship based on local potential.



Figure 2. Socialization Stage

Following the implementation of a series of training and mentoring activities, post-test results demonstrated a significant improvement in participants' knowledge and skills. Approximately 80–95% of participants understood the zero-waste concept as a sustainable waste management approach and were able to explain the stages of processing banana peels into crackers. In addition, participants showed improved understanding of food hygiene standards, attractive and safe packaging techniques, and the use of digital media as a product marketing tool.



Figure 3. Training Stages for Making Dough and Initial Processing

In terms of practical skills, 18 out of 20 participants (90%) were able to independently produce banana peel crackers with acceptable consumption quality. The products exhibited a crispy texture, consumer-acceptable taste, and more attractive packaging compared to conditions prior to the program. The utilization of banana peels as the main raw material also resulted in an approximate 50% reduction in organic waste at the household level, thereby contributing directly to improved environmental cleanliness in the village.



Figure 4. Marketing and Branding Training Stages

Beyond individual skill enhancement, the program also generated institutional impacts through the establishment of a PKK business group focused on banana peel cracker production. This group has an average production capacity of 50 packages per production cycle and has begun implementing simple task divisions in production, packaging, and marketing processes. Participants also started utilizing social media platforms such as WhatsApp and Instagram, as well as local marketplaces, as initial channels for product promotion and sales.

Table 1. Program Outputs and Discussion

Aspect of Understanding	Pretest (Before the Program)	Posttest (After the Program)
Zero Waste Term	Most participants did not know the term, only about 20% had heard of it	Almost all participants understood the term, increased to about 90%
Benefits of Banana Peels	Considered as waste, only about 25% knew they could be reused	Understood as food and economic resources, about 95%
Banana Peel Processing	Did not know how to process them, about 15%	Able to explain and practice the process, about 90%
Product Packaging	Limited understanding of packaging functions, about 20%	Understood attractive and hygienic packaging, about 85%
Digital Marketing	Almost no knowledge, about 10%	Understood basic online marketing; about 80%
Economic Value of the Product	Did not see business opportunities, about 20%	Aware of business potential and additional income, about 90%

2. Discussion

The results of the PKM-PM program implementation indicate that a zero-waste-based community empowerment approach is capable of generating integrated positive impacts across environmental, social, and economic dimensions. The improvement in participants' knowledge and skills confirms that participatory training methods combined with hands-on practice are effective strategies for enhancing the capacity of rural communities.

According to experiential learning theory proposed by Kolb (2015), the learning process becomes optimal when participants are directly involved in concrete experiences followed by reflection and repeated application. The learning-by-doing approach applied in the banana peel cracker processing training enabled participants not only to understand the concepts theoretically but also to master technical skills that can be directly applied to household economic activities. This is reflected in the ability of the majority of participants to independently produce crackers after the training activities.

From an environmental perspective, the utilization of banana peel waste as a food ingredient is consistent with the zero-waste and circular economy concepts, which emphasize waste reduction and the optimization of resource use. Song and Zeng (2015) explain that zero-waste strategies aim to reduce environmental burdens by transforming waste into value-added products. The findings of this program demonstrate that the application of these concepts at the village community level is not only technically feasible but also socially and culturally acceptable to the community.

From a socio-economic standpoint, the establishment of a PKK business group and the introduction of digital marketing reflect the principles of women's empowerment, which emphasize increased access to skills, knowledge, and economic opportunities. Empowering women through food-based micro-enterprises has been proven to enhance self-confidence, household economic independence, and women's roles in village development. These results are consistent with previous studies indicating that women's involvement in productive economic activities contributes to improved family welfare and the strengthening of community social capital.

2.1 Implications

The PKM-PM program has practical and conceptual implications for the development of community empowerment models based on local potential, particularly in organic waste management and the strengthening of women's economic capacity. The integration of the zero-waste concept with food processing skill training and digital marketing demonstrates that environmental issues can be addressed simultaneously with the enhancement of household economic capacity. This approach is relevant for application in rural areas that have abundant agricultural waste resources that have not yet been optimally utilized, while also offering an alternative strategy for village development oriented toward environmental sustainability, economic independence, and active community participation.



Figure 5. Banana Peel Cracker Product

2.2 Research Contribution

This activity contributes to the development of community service practices and studies by offering an integrated empowerment model that combines zero-waste-based waste management, strengthening of women's capacity, local food product innovation, and the utilization of digital technology for marketing. The main contribution of this study lies in providing empirical evidence that participatory and experiential approaches can enhance the effectiveness of empowerment programs, and in demonstrating that environmental and economic aspects can be integrated simultaneously within a single community-based, applicable, and sustainable intervention.



Figure 6. Marketing and Branding Training Stages

2.3 Limitations

The implementation of this program has limitations related to the scope of evaluation, which remains focused on the initial outcomes of the program, particularly improvements in participants' knowledge, skills, and production capabilities. The evaluation of the program's impact on business sustainability and the development of marketing networks remains descriptive and does not yet fully capture the long-term dynamics of business development. In addition, variations in participants' responses and adaptive capacities in independently managing their businesses have not been examined in depth within the context of program sustainability.

2.4 Suggestions

Based on these limitations, future community service programs are recommended to expand the focus of evaluation to include aspects of strengthening group institutional capacity, production stability, and sustainable product marketing strategies. More structured mentoring approaches, as well as integration with village empowerment and MSME programs, are expected to strengthen group capacity in developing businesses based on local potential. Furthermore, the development of product innovations and more diverse promotional strategies can be pursued to enhance the attractiveness and market reach of zero-waste-based products.

D. Conclusion

The community service program implemented in Nglongsor Village, Tugu District, Trenggalek Regency successfully empowered the PKK women's group through the utilization of banana peel waste to produce zero-waste crackers, addressing the issue of underutilized organic waste while providing a productive economic solution for households. Through training and mentoring, the participants improved their skills in processing banana peel waste, developing attractive packaging, and utilizing digital technology for marketing. The results showed that the banana peel crackers were safe for consumption, received positive community responses, and demonstrated promising market potential. This activity not only enhanced women's economic independence but also supported household waste reduction and strengthened the role

of PKK as a driver of the village economy. Furthermore, the findings suggest that the zero-waste approach can serve as a sustainable strategy for waste management and local MSME development, with potential for replication in other villages, supported by further research and policy initiatives to ensure long-term sustainability.

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F. Author Contribution Statement

AS acted as a mentor lecturer, providing direction and supervision, and ensuring the program's implementation according to its objectives. CMJ served as the primary person in charge of the activity, monitoring it, and preparing the final report. YID was responsible for implementing training, providing technical assistance, and managing the program directly with partners. ADR played a role in preparing progress reports and supporting the socialization process of the activity. LAN was responsible for the preparation stage, initial coordination with partners, and logistical support for the activity. SDK assisted in the evaluation and measurement of the activity's success, and contributed to the development of the evaluation instrument. All authors contributed to the program design, field implementation, and drafting of this article.

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