

# Dissemination of fermented technology and diet formulation to provide economical feed in Sikka District

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## ABSTRACT

The initiation of this community service was driven by the challenges faced by livestock farmers in Sikka Regency, East Nusa Tenggara (NTT). One of the main issues in small-scale livestock farming is the availability of feed, both in terms of quality and quantity. Although Sikka Regency has abundant agricultural byproducts, such as banana stems, cassava leaves and stems, and papaya leaves, these resources remain underutilized due to farmers' limited knowledge and technical skills in processing them into livestock feed. The target group for this program are pig farmers. This community service program aims to support the production of livestock feed by maximizing the use of agricultural byproducts to ensure year-round availability. The implementation methods included extension activities, dissemination of fermentation technology, ration formulation, and guidance on feed production. The results demonstrate that farmers were able to produce livestock feed from banana stems using fermentation technology. The program enabled farmers to access a lower-cost alternative compared to commercial feed, priced at Rp 7,230 per kilogram based on the proposed ration formulation. This community service activity is expected to encourage farmers to further utilize locally available agricultural byproducts as feed resources.

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## 1. INTRODUCTION

Sikka District is located on Flores Island in East Nusa Tenggara (NTT). Administratively, the district covers an area of 1,731.91 km<sup>2</sup> and consists of 21 subdistricts and 147 villages (Badan Pusat Statistik, 2025). Its topography is characterized by lowland coastal areas and mountainous inland regions. The local economy is driven by agriculture, livestock, fisheries, plantations, and tourism. Masri (2025) reported that the creative economy sector in this district is largely dominated by arts and culture. In addition, traditional cuisine represents a unique attraction for tourists.

Pig farming in Sikka Regency plays an important role in the local economy, providing a key source of income for many residents. Compared to other types of livestock, pigs hold higher cultural and economic value within the local community. People commonly raise pigs for sale in local markets as well as for use in traditional ceremonies (Bisa et al., 2022). In this context, pigs are regarded as sacrificial animals used to honor ancestors and elders. Keray et al. (2024) noted that pig farming is also maintained as a cultural obligation passed down across generations. According to the Livestock Service Office, pigs

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rank first in terms of population, with a total of 33,850 animals (Dinas Peternakan, 2024). This number has remained stable over the past three years, indicating consistently high community engagement in pig farming.

The pig farming sector is still in the recovery phase following the outbreak of African Swine Fever (ASF), and several challenges continue to hinder this process. One common issue faced by livestock groups in Waigete Village, Sikka Regency, is the shortage of feed, both in terms of quantity and quality. The root of this problem lies in the farmers' lack of understanding regarding feed processing, which results in the nutritional needs of the pigs not being met. Inadequate nutrition for pigs will affect their productivity (Kertiyasa, 2025). Anifiatiningrum et al., (2024) assessed that the level of education affects farmers' ability to adopt technology. Dewi et al. (2022) added that farmers with higher education tend to have better access to information and technology relevant to improving productivity and business efficiency. Meanwhile, Lakawolo et al. (2022) found that there are still many farmers with elementary and junior high school education levels in Sikka District.

Farmers' limited capacity to process feed remains a human resource related constraint that needs to be addressed. Thus, the training in feed processing using locally available ingredients to produce healthy and nutritionally balanced feed offers a practical solution. Available feed materials can be processed through drying and converted into flour, or preserved in fresh form as silage. Ingredients that are easier to make into flour are corn, banana stems, tubers, and grains, which can all be stored for extended periods of time and are easily digested by pigs. Low-quality, flour-based feed ingredients, particularly those high in fiber or containing antinutritional factors, can be improved through fermentation. The use of probiotics, such as EM-4, enhances this process by increasing feed digestibility, reducing dependence on fresh feed, and improving palatability. Glatz (2017) reported that the use of sweet potatoes in silage form is more beneficial than commercial feed. Similarly, Tonga et al. (2023) found that fermented feed made from local ingredients leads to greater weight gain in Balinese pigs compared to commercial feed.

Waigete Village is located in a highland area where banana stems are abundant, and the community cultivates various agricultural crops, including water spinach, radishes, and papayas. Farmers typically use banana stems and other vegetable scraps either in raw or boiled form. However, feeding them raw reduces the digestibility of the feed. Furthermore, boiling can reduce the vitamin content in the feed. Agricultural byproducts, such as banana stems, vegetable scraps, and leaves, can be processed into silage. Silage is produced through a fermentation process that begins by chopping the mixture of agricultural byproducts into small pieces. Banana stem silage is produced to improve its nutritional value through fermentation. This process can reduce crude fiber content, increase protein levels, and enhance feed digestibility.

The use of fermented feed ingredients in pig diets can increase the protein content from 1 percent to 4.46 percent the TDN of the diet, while reducing crude fiber content and increasing the digestibility of organic matter, dry matter, and feed protein (Thiasari & Setiyawan, 2016). It is known that the use of fermented feed for pigs provides high growth and better feed efficiency, as indicated by a decrease in feed conversion ratio (FCR). Through the fermentation process, banana stems can be turned into silage, which can improve its quality so that it can replace the basal/complete feed. Banana stem silage can be used up to 30 percent in non-ruminant rations without affecting performance (Rizkiyah & Agustina, 2016).

The community service activity was designed in two stages with the aim of disseminating feed technology and diet formulation to pig farmers in Sikka District. In the first step, farmers will be trained in local feed processing using fermentation methods. Next step, farmers will prepare diets according to the nutritional needs of their pigs. This is in line with the work of (Senthilkumar & Raja, 2021) who found

that empowering the younger generation in pig farming can provide better income and improve the welfare of farmers.

## 2. METHODS

### Location and Partners

The approach used in this community service activity was Participatory Action Research (PAR), in which the community service team and partners collaboratively identified priority issues and developed practical solutions. This activity was conducted in Waigete Village, Waigete Subdistrict, Sikka District, involving 30 pig farmers as participants (Figure 1).



**Figure 1.** Sikka district location on map

### Materials and Tools

The materials used included rice bran, ground corn, fish meal, mineral mix, liquid EM-4, granulated sugar, salt, coconut oil, banana stem, vegetable scraps, and other agricultural byproducts. The supporting tools for the community service activities were a chopper machine, tarpaulin, 200-liter drums, buckets, and a bench scale.

**Table 1.** Chopper machine specifications

	<p><b>Specifications:</b>                  Multifunctional Grass Chopper                  Stainless Steel Body                  Power: 1.2 kW / 6-7 HP                  Speed: 3000 rpm                  Screens: 2 units (5 mm and 10 mm holes)                  Hammermill Blades: 12                  Production Capacity: 250 kg/h</p>
	<p><b>Size:</b>                  Unit Dimensions: 120 x 50 x 60 cm                  Weight (including engine): 57 kg</p>
	<p><b>Strength:</b>                  Improves production efficiency and reduces feed costs</p>
	<p><b>Purpose:</b>                  To reduce the size of organic materials, such as stems, vegetable byproducts, and corn cobs, so they can be more easily fermented into animal feed.</p>

## **Activity Plan**

The community service program was systematically designed based on the problems faced by the pig farming group, particularly the need to utilize and maximize agricultural waste as animal feed to ensure year-round availability. The program consisted of a series of activities, as presented in Table 2.

## **Pre-Activities Stage**

This community service activity was a collaboration between the Regional Development Planning, Research, and Innovation Agency (Bapperida) of Sikka Regency and the Animal Husbandry Study Program, Faculty of Marine Animal Husbandry and Fisheries. Following the signing of the cooperation agreement, the service team conducted a survey to further explore the potential of locally available feed resources in the district. The purpose of this survey is not only to evaluate potential of local feed but also to understand the perceptions, needs, and challenges faced by the community and business actors in the livestock sector. The survey results can be used to assess the effectiveness of processing technology implementation and provide an overview of its impact on livestock productivity. This evaluation is important for improving existing programs and ensuring sustainability in the future.

## **Dissemination**

The dissemination activities in this community service program included pig husbandry management, processing of agricultural byproducts through fermentation, and the formulation of pig feed rations. These activities were conducted to improve farmers' knowledge, understanding, and skills. This approach is based on the principle that pig production can be increased through better feed management and adequate nutrition. Feed management plays a crucial role in animal husbandry and should not be overlooked. Effective feed management contributes to increased livestock productivity, reduced production costs, improved animal health, stronger business sustainability, and enhanced farmer knowledge. By optimizing feed management practices, farmers can improve the overall performance of their farming activities, which in turn supports the economic and social well-being of the community.

## **Practical Assistance**

The community service activities were designed in two main practical stages: fermentation-based feed processing and feed ration formulation. The stages of fermented feed processing included: (1) Collecting agricultural byproducts; (2) Chopping the materials using a chopper machine; (3) Mixing EM-4 and rice bran with the chopped materials; and (4) Storing the mixture in plastic drums for fermentation. The feed ration formulation stage included: (1) Weighing feed ingredients based on the calculated energy requirements for each production phase; (2) Mixing the feed; and (3) Storing the final feed product.

## **Monitoring and Evaluation Stages**

The monitoring and evaluation stages are essential components of community service activities, as they are used to assess the effectiveness of the program. Several evaluation methods can be applied, including questionnaires, interviews, direct observation, and group discussions. The use of multiple methods helps provide a more comprehensive understanding of the program's outcomes. During the evaluation stage, participants were given a pre-test and post-test consisting of 10 statements (Table 3), each requiring a True/False response. The number of participants selecting each response was analyzed, and the results were presented in the form of a diagram.

**Table 2.** Stages of implementation of service activities

<b>1<sup>st</sup> Activity</b>	<b>Pre-Activities Stage</b>	<b>Time</b>
<b>Activity</b>	Meetings with the Sikka Regency Research, Planning, and Innovation Agency (Baperinda) regarding the selected locations and pig farming groups that will receive technology and innovations for livestock feed processing.	Day 1
<b>Goals</b>	Identifying suitable locations for target partners based on the availability of livestock groups in three subdistricts, specifically Waigete Village, which has a livestock group with 30 members	
<b>2<sup>nd</sup> Activity</b>	<b>Dissemination</b>	
<b>Activity</b>	A material presentation was given on agricultural byproducts such as banana stems, water spinach scraps, papaya leaves, and cassava leaves, which can be processed into fermented feed to increase nutritional content. Additionally, a presentation was given on the importance of formulating feed rations independently to reduce dependence on commercial feed.	Day 2
<b>Goals</b>	To increase farmers' knowledge of waste management methods using fermentation and the independent formulation of pig feed rations.	
<b>3<sup>rd</sup> Activity</b>	<b>Training on Fermented Feed Production</b>	
<b>Activity</b>	A trial run was conducted using a chopper to reduce the size of the mixed byproducts, followed by mixing the EM-4 and stirring the fermenter until thoroughly mixed, and then storing the mixture for 4 days.	Day 3
<b>Goals</b>	To produce pig feed using a fermentation method to enhance the feed's nutritional content.	
<b>4<sup>th</sup> Activity</b>	<b>Training on Diet Formulation</b>	
<b>Activity</b>	Identify feed ingredients such as rice bran, corn, banana stem silage, and fish meal. Next, determine the feed formulation based on the nutritional requirements of pigs as outlined by the National Research Council and ensure the cost is lower than that of commercial feed.	Day 3
<b>Goals</b>	To produce more affordable pig feed and enhance farmers' knowledge of feed formulation.	
<b>5<sup>th</sup> Activity</b>	<b>Monitoring and Evaluation Stages</b>	
<b>Activity</b>	Conducting post-production testing of fermented products and the formulation of livestock feed rations, and evaluating the success rate of the fermented products on the 4th day	Day 7
<b>Goals</b>	Understanding the improvement in stock farmers following the implementation of fermentation-based animal feed processing and the development of self-formulated rations	

**Table 3.** The list of statements for training evaluation

<b>No</b>	<b>Statements</b>
1	Fermented feed can improve the nutritional quality of livestock rations.
2	The right feed formula can influence microbial growth in the rumen.
3	Silage with high lignin content is better for all types of livestock.
4	Fermented feed can reduce greenhouse gas emissions from livestock
5	Vegetable scraps and banana stems can be used as pig feed.
6	Locally sourced feed is more expensive than commercial feed
7	Local feed materials require processing before they can be used as feed
8	Only large-scale farmers can use local raw materials efficiently.
9	Feed containing high fiber is not good for pigs
10	Feed combinations must take into account the specific needs of each phase of pig growth

### 3. RESULTS AND DISCUSSION

#### Results

##### Pre-activities stage

This community service activity was conducted as a collaboration between the Regional Development Planning, Research, and Innovation Agency (Bapperida) of Sikka Regency and the Animal Husbandry Study Program, Faculty of Animal Husbandry, Marine, and Fisheries. The collaboration was formalized through Decision Letter (Surat Keputusan) No. 22/PPK.Indeks/Bapperida.074/VII/2024, which serves as the operational guideline for implementing the program.

The program aims to enhance the knowledge and skills of pig farmers in processing feed and formulating livestock rations independently, thereby reducing their dependence on commercial feed. In addition, the activity promotes the adoption of research-based innovations to address the challenges faced by pig farmers.

The survey was conducted to assess field conditions related to animal feed and the challenges faced by pig farmers in Waigete District while also establishing communication with farmers and local officials to obtain reliable information. Through the survey and direct discussions, it was found that farmers were not yet able to fully utilize agricultural byproducts such as banana stems, vegetable scraps, and household waste as pig feed. Additionally, farmers reported that the rising cost of commercial pig feed is not proportional to the income generated from pig sales. The results of this survey and discussion became the basis for designing a work program in line with the needs of pig farmers, specifically the production of fermentation-based feed and the formulation of more economical feed formulation for pigs.

##### Dissemination

The dissemination was conducted through presentations to pig farmers (Figure 3), covering methods to improve feed quality by processing local ingredients into silage and combining them with other local materials to produce complete feed rations. Pig production can be improved by providing adequate nutrition through the use of banana stem-based silage. The use of banana stem silage through fermentation offers several benefits, including reduced production costs, increased income, and improved farmer welfare (Kertiyasa et al., 2025b). In addition, interactive discussions with pig farmers were carried out to stimulate engagement and identify potential challenges. During these discussions, farmers raised questions about the silage-making process, feeding techniques, and proper management practices to prevent disease in pigs.



**Figure 2.** Dissemination

### Assistance on production fermented feed

The practical implementation of fermented feed production used agricultural byproducts such as banana stems, vegetable scraps, and papaya leaves (Figure 3). For this activity, Bapperida provided a chopper machine to process these materials. Chopping reduces the size of the materials and increases their surface area, thereby facilitating the fermentation process (Dewi et al., 2024).



Figure 3. The process of cutting banana stems, vegetables, and papaya leaves

In addition, materials such as Effective Microorganisms (EM-4), rice bran, sugar, and salt are also needed. In this activity, farmers brought banana stems, papaya leaves, and vegetable scraps, which were then mixed and chopped as shown in Figure 5. The mixtures are measured using a bucket to determine the ratio with rice bran. The ratio of banana stems, vegetables, and rice bran was set at 5:1, meaning that five gallons of chopped agricultural byproducts were mixed evenly with one gallon of rice bran. Next, a solution of EM-4 probiotics, sugar, and water was prepared in a ratio of 10:10:1000 (in milliliters) and mixed thoroughly until well combined. The prepared solution is then evenly applied to the mixture of bran, chopped banana stems, and vegetables until fully distributed, after which 200 grams of salt is added to enhance the palatability of the silage (Enga et al., 2025). The well-mixed ingredients are then fermented inside an airtight plastic drum for approximately 4 days (Sander et al., 2024). The ingredients are added in batches and compacted to maximize the fermentation process, then tightly covered.



Figure 5. Practice of making fermented feed

### Assistance on diet formulation

The formulation of feed intakes aims to balance the ingredients used with the nutrition needs of pigs. Quality feed intake formulation requires farmers to understand the appropriate formulation techniques relevant to the specific conditions and able to calculate the nutrition needs of pigs at a relatively lower cost (Lazarus et al., 2025). A more economical feed formulation will reduce dependence on commercial feed.

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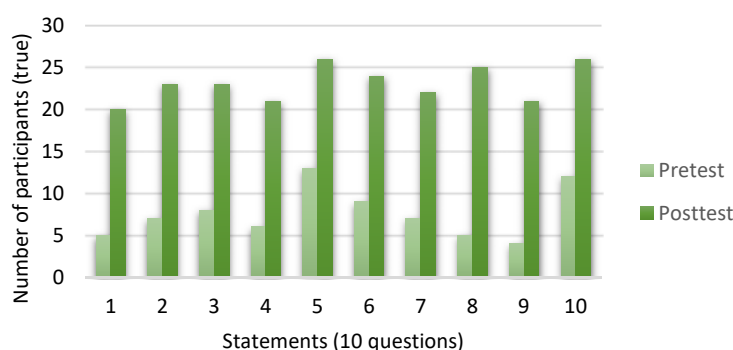
The assistance in diet formulation resulted in a suitable ration for the pig growth phase that meets nutritional standards and considers the availability of local feed ingredients in the surrounding area. The formulation process was carried out in a dry environment to prevent moisture exposure, which could affect feed shelf life. Table 2 presents the composition and nutritional content of the feed for pigs in the growth phase.

**Table 4.** Composition and nutritional content of the formulated feed

Feed Ingredients	Percentages (%)	Price (Kg/Rp.)	Nutrient Content					
			EM kcal/kg	PK (%)	LK (%)	SK (%)	Ca (%)	P (%)
Corn Flour	22	Rp1.760	774.40	2.07	0.84	0.55	0.0066	0.062
Banana stem silage	15	Rp375	330.00	0.98	0.71	6.38	0.002	0.033
Rice bran	30	Rp1.200	960	4.05	1.64	3.90	0.01	0.04
Concentrate KGP 709	31	Rp3.410	837	11.16	1.11	2.17	1.24	0.50
Minerals	0.5	Rp125	0	0	0	0	0.22	0.05
Oil coconut	1.5	Rp360	135	0	1.5	0	0	0
<b>Total</b>	<b>100</b>	<b>Rp7.230</b>	<b>3,036.40</b>	<b>18.26</b>	<b>4.8</b>	<b>1.44</b>	<b>1.44</b>	<b>0.68</b>

### Monitoring and Evaluation Stages

The results of the monitoring and evaluation of the community service activities are presented in Figure 6. In general, the statements addressed topics related to feed fermentation technology, ration formulation, and pig farming practices. The use of fermentation technology improves the nutritional value of feed and enhances its digestibility (Kertiyasa et al., 2025a). Proper ration formulation also increases feed efficiency, thereby reducing production costs, through the use of nutritionally balanced ingredients and the optimization of affordable local resources.



**Figure 6.** Results of descriptive analysis of pre-test and post-test

Descriptive analysis showed an increase in the average percentage of correct responses from 43 percent before the training to 86 percent after the presentation. Overall, the responses were positive, as indicated by the higher number of participants who answered all questions correctly. These results suggest that participants have gained the knowledge and technical skills needed to implement

appropriate feed processing technologies in pig farming. In addition, the activity contributed to raising awareness of the importance of optimizing the use of local resources.

## **Discussion**

Community service activities in Sikka Regency, East Nusa Tenggara, were prompted by the challenges faced by local pig farmers regarding feed availability. While the pig farming sector holds significant economic and cultural value for the people of Sikka, its productivity is often challenged by feed limitations, both in terms of quality and quantity. Although this region has an abundance of agricultural byproducts, such as banana stems and vegetable scraps, these potential byproducts are remains underutilized due to farmers' lack of technical knowledge in feed processing. Therefore, this program aims to bridge this gap through an innovative approach that maximizes local resources to ensure a year-round supply of feed for farmers.

The community service program was designed around two main practical activities: fermented feed production and ration formulation. Fermentation was introduced as a solution to enhance the nutritional value of local feed ingredients, which typically have high crude fiber content and/or antinutrients, which can be useful to extend the shelf life of the feed to 1–6 months. [Gaina et al. \(2023\)](#) reported that the fermentation process using EM-4 was able to reduce crude fiber content while simultaneously increasing protein content and feed digestibility in pigs. [Jati & Zaki \(2023\)](#) also stated that adding EM-4 liquid to vegetable scraps silage can soften the texture.

In this study, the fermentation materials used were banana stems and vegetable scraps. However, there are also many other materials that are frequently used, such as rice straw, rice bran, and local fruit byproducts. Fermentation technology using banana stems as a raw material has been shown to increase the organic and mineral content of banana stem silage, while the addition of varying levels of additives, such as 30 percent hibiscus flowers, can further enhance its nutritional value ([Suarna et al., 2020](#)).

During the training on production process, partners were trained to operate the chopper machine. The chopper machine will chop the banana stems and vegetables so that surface area of the materials is increased, which helps with fermentation process. The chopped material then mixed with rice bran, EM-4 solution, sugar, and salt, then stored in airtight plastic drums.

The next practical activity involved ration formulation using linear programming (LP). This method was selected to help partners obtain the lowest-cost ration while meeting the required nutritional standards. Nutritional requirements are formulated based on the pig's growth phases, including the starter, grower, boar, sow, pregnant sow, and lactating sow phases ([Tala & Irfan, 2020](#)). In this activity, the ration formulation was developed only for the grower phase in accordance with the partner's request based on the nutritional requirements of the National Research Council (NRC). Based on the ration formulation, the ration price is Rp7.230 per kilogram, lower than that of commercial feed, which is Rp11.000 per kilogram. By processing fermented waste and preparing rations independently, farmers can save Rp3.770 per kilogram of feed. This reduction in feed costs will significantly impact the profits earned by farmers. Additionally, fermented feed will serve as a solution to ensure the availability of nutritious feed through the year.

The success of this program was evaluated through routine monitoring and the use of pre-test and post-test methods to measure improvements in participants' knowledge. The results indicate that farmers in Waigete Village are now able to produce fermented feed independently and understand the importance of proper ration formulation for their livestock. This initiative has generated positive impacts, including reduced production costs and increased farmer self-reliance in responding to feed

price fluctuations in the market. Moving forward, it is expected that partners will be encouraged to further explore and utilize a wider range of locally available agricultural byproducts.

#### 4. CONCLUSION AND RECOMMENDATIONS

The community service initiative has provided applicable solutions for partners in addressing the challenges of limited access to high-quality feed and the high cost of commercial feed. Through this program, fermentation technology was integrated to process banana stems and vegetable scraps into nutritious silage. The results show an increase from 43 to 86 percent in farmers' technical knowledge and skills. Through this initiative, partners can also independently formulate feed at a significantly lower cost at Rp7.230 per kilogram. Several steps were taken, ranging from the use of a chopper to the formulating ratios according to the pigs' nutritional needs, which proved effective in encouraging farmers to maximize the potential of local agricultural byproducts. The success of this program is expected to serve as a model for the sustainable utilization of other agricultural byproducts to achieve feed self-sufficiency in Waigete Village, Sikka Regency.

An effective strategy for strengthening farmers' skills is to establish collaborative groups that facilitate the sharing of resources and knowledge. This initiative can be supported by organizing regular discussion forums and meetings where farmers can exchange information and experiences. Collaboration among farmers can help reduce reliance on commercial feed and improve feed efficiency. By actively involving the community and utilizing local resources, community service programs can improve the welfare of farming communities in NTT. To support the sustainability of the community service program, the following recommendations are made: (1) The Sikka Regency Government, particularly Bapperida, should monitor the progression after the community service program to ensure its sustainability; (2) Village governments should coordinate with the livestock farmer groups regarding the rotational use of chopper machines or considering centralized operations; (3) Livestock farmer groups should coordinate their members to regularly and systematically produce fermented byproducts and prepare feed rations; (4) Livestock group members should actively participate in available activities to enhance their knowledge and skills and to share information on feed processing through fermentation and independent ration formulation.

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