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Technology for the production of self-sufficient fish feed using locally sourced raw materials

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ABSTRACT

The high cost of commercial fish feed is a major challenge in aquaculture. To address this issue, technology dissemination for independent fish feed production using locally available raw materials was implemented with the Harapan Bersama Fish Farmers' Group in Beringin Village, South Kalimantan, Indonesia, from July to December 2023. This community service initiative aims to improve the capacity and skills of members of the Harapan Bersama Fish Farmers' Group to produce fish feed independently using local raw materials. The program involved 10 group members and included lectures, focus group discussions (FGDs), demonstrations, simulations, hands-on production practice, and regular monitoring and evaluation by the service team. Program success was assessed based on monthly feed production, production cost efficiency, and improvements in participants' knowledge and skills. The group achieved an average monthly feed production of 946 kg, with a reported cost efficiency of 78 percent compared with commercial feed. Participants' knowledge and skill levels increased by 194.44 percent and 183.22 percent, respectively. These results indicate that technology dissemination can strengthen fish farmers' capacity for independent feed production using local raw materials and may help improve production cost efficiency.

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1. INTRODUCTION

The Harapan Bersama Fish Farmers' Group (*Pokdakan*), located in Beringin Village, Barito Kuala Regency, South Kalimantan, consists of catfish and tilapia farmers supported by the Hasnur Centre Foundation (YHC), with funding provided through the Corporate Social Responsibility (CSR) programs of companies within the Hasnur Group. In recent years, the group's profit margins have declined from 40–50 percent five years ago to 20–30 percent. This decline is associated with high operating costs, particularly the rising cost of commercial feed, which has not been matched by corresponding increases in fish prices. In intensive fish farming, feed accounts for 60–70 percent of total production costs. Consequently, the group's continued reliance on increasingly expensive commercial feed presents a significant challenge to its profitability.

To address this problem, producing fish feed independently using locally available raw materials offers a potential solution. Barito Kuala Regency, South Kalimantan, has considerable resources that could

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support local fish feed production. These include small fish, with an annual production of approximately 900 metric tons in coastal villages; palm oil mill residue, with an annual production of approximately 1,660 metric tons in plantation areas; and fine rice bran, a by-product of rice milling, with an annual volume of approximately 25,800 metric tons. The availability of these abundant and relatively inexpensive materials creates opportunities to develop fish feed production technology based on local resources.

Despite this potential, members of the Harapan Bersama Fish Farmers' Group lack the knowledge and skills needed to produce their own feed using local raw materials. Technical guidance is therefore needed to help them select suitable ingredients and formulate feed that meets the nutritional requirements of farmed fish. Producing feed independently could provide farmers with a more affordable alternative to commercial feed, helping to reduce production costs and improve profit margins. In addition, the oil palm plantations operated by PT Hasnur produce palm kernel cake (PKC), which could be utilized as an ingredient in locally produced fish feed. According to Ansyari et al. (2023), producing fish feed independently at fish farming units can reduce production costs by up to 30 percent. This approach is particularly relevant to intensive tilapia farming, where feed accounts for 60–70 percent of total production costs. In-house feed production also enables farmers to adjust feed formulations to control the nutritional value of the resulting feed.

Previous studies have shown that appropriately formulated self-produced feed can improve feed utilization efficiency, improve the feed conversion ratio (FCR), and reduce production costs in fish farming (Susilawati et al., 2024). Producing feed independently also enables farmers to control raw material quality, adjust nutritional formulations to meet the needs of their fish, and reduce their dependence on commercial feed products (Ragasa et al., 2022). Developing the community's capacity to produce its own feed is therefore an important strategy for improving the self-sufficiency, efficiency, and sustainability of aquaculture operations (Sunarno et al., 2024). When properly formulated, local ingredients such as palm kernel meal, rice bran, maize flour, by-catch fish, and agro-industrial by-products have the potential to serve as economical, sustainable, and environmentally friendly fish feed ingredients (Amin et al., 2020). Using these materials can reduce production costs and support the principles of a circular economy by making productive use of agro-industrial waste and by-products that might otherwise be underutilized (Carrillo-Rodríguez et al., 2025). Accordingly, locally sourced feed is a relevant alternative given the resources available in the partner region.

The importance of this initiative is further supported by the need to improve the productivity of community-based fish farming operations (Rachmawati et al., 2023). Fish feed produced from local raw materials has the potential to improve cost efficiency, enhance feed conversion, and increase economic returns for farmers (Bidayani et al., 2023; Sumarni et al., 2026). Furthermore, utilizing local resources and waste materials aligns with the principles of sustainable aquaculture, which are increasingly important to the development of the fisheries sector (Chary et al., 2024). Thus, local feed production could help address the economic challenges faced by fish farmers while supporting a more self-sufficient, efficient, and environmentally sustainable farming system.

Aquaculture is a strategic subsector that contributes to food security, community income, and economic development based on local resources (Fadhilah et al., 2024). Its success depends largely on the efficient use of production inputs, particularly feed, which represents one of the largest components of farming costs (De Verdal et al., 2018). Studies have reported that feed can account for more than 50 percent of total production costs and may reach 60–70 percent in fish farming systems. Improving feed efficiency can therefore contribute to higher farm profitability and more sustainable aquaculture

operations (Ratnasari et al., 2021; Zega et al., 2024). These costs pose a considerable challenge for small-scale fish farmers with limited capital who are vulnerable to fluctuations in commercial feed prices. Increases in raw material prices and supply chain disruptions can further raise operating costs, potentially reducing the competitiveness of fish farming businesses and limiting improvements in farmers' welfare.

Based on these challenges and opportunities, this community service initiative aims to improve the capacity and skills of members of the Harapan Bersama Fish Farmers' Group to produce fish feed independently using local raw materials. The initiative also seeks to promote the use of resources available in the village to produce high-quality feed at a lower cost than commercial alternatives. Through systematic training and mentoring, the program is intended to help group members adopt sustainable feed production practices and strengthen the self-reliance of their aquaculture businesses. These efforts are expected to help reduce operating costs, improve profit margins, and ultimately contribute to the welfare of group members.

2. METHODS

Partners and Locations for Community Service

This community service activity involved 10 members of the Harapan Bersama Fish Farmers' Group (*Pokdakan*) from Beringin Village, Alalak Subdistrict, Barito Kuala Regency, South Kalimantan, Indonesia. The main equipment used in the activity was a CTK-150 fish feed pellet mill with the following specifications: dimensions of 150 cm × 50 cm × 106 cm, a power rating of 12 HP, a mild steel plate construction, and a production capacity of 100 to 150 kg per hour. The local raw materials used for fish feed production included fish meal, palm kernel meal, fine rice bran, cassava flour, vitamins, and minerals.

Activity Plan

The community service activities were conducted from July to December 2023 in Beringin Village, South Kalimantan, Indonesia. The activities were part of the Matching Fund Program of the Ministry of Education, Culture, Research, and Technology, implemented by Lambung Mangkurat University in collaboration with the Hasnur Foundation Centre (YAC). The program was funded through matching funds from the Ministry and Corporate Social Responsibility (CSR) funds. The activities focused on assisting members of the Harapan Bersama Fish Farmers' Group in producing fish feed independently using locally available raw materials.

Implementation Stages

The Community Partnership Program (CPP) for producing fish feed independently using local raw materials consisted of the following stages: (1) Socialization and coordination with the parties involved in the activity; (2) Preparation of materials and equipment, including local raw materials for fish feed production and a CTK-150 pellet mill with a reported production capacity of 100 kg per hour; (3) Technology dissemination through lectures and focus group discussions (FGDs); (4) Demonstrations and hands-on training in fish feed production technology for members of the Harapan Bersama Fish Farmers' Group in Beringin Village, South Kalimantan; (5) Evaluation of monthly feed production volumes, comparison of production costs between self-produced and commercial feed, assessment

of business profitability, and evaluation of participants' knowledge and skills following technology dissemination.

Science and Technology Delivery Methods

Technology transfer was conducted in three stages to support fish feed production using locally available raw materials., such as: (1) Lectures and focus group discussions. The first stage involved lectures supported by pamphlets containing concise explanations of the technology. The information was presented in accessible language to help participants understand the production process. After the presentation, participants could discuss the material through FGDs and question-and-answer sessions; (2) Demonstrations and practical training. The second stage involved three activities. First, the Community Service Team demonstrated the production process. Second, participants practiced the process under the team's guidance. Third, participants independently practiced the skills they had learned; (3) Guidance and mentoring. The Community Service Team provided ongoing guidance to participants in producing fish feed from locally sourced raw materials. Assistance covered ingredient selection, feed formulation, mixing, kneading, pellet formation, sun-drying, packaging, and storage.

Indicators of Success and Evaluation

The program's success was assessed using the following indicators. First, monthly fish feed production. Feed production was measured in kilograms per month using the formula (Equation 1/Eq. 1) attributed to Wardono & Prabakusuma (2017).

Feed production = Monthly self-produced fish feed (kg/month) (Eq. 1)

Second, efficiency of self-produced feed. Feed production efficiency was assessed by comparing the production cost per kilogram of self-produced feed with the price per kilogram of the commercial feed currently used (Sinansari et al., 2019). Self-sustaining feed efficiency measured with Equation 2 (Eq. 2).

$$\text{Self-Sustaining Feed Efficiency} = \frac{Cost\ of\ self-produced\ feed\ per\ kg}{Cost\ of\ commercial\ feed\ per\ kg} \quad \text{(Eq. 2)}$$

Third, participants' knowledge and skills. Participants' knowledge and skills in applying the transferred technology were assessed by comparing their performance before and after the program. A t-test for equality of means was used for this comparison (Equation 3/Eq. 3).

$$t = \frac{X1 - X2}{s\sqrt{\frac{1}{n1}\frac{1}{n2}}} \text{ and } S^2 = \frac{n(n-1)x^2}{2!} \quad \text{(Eq. 3)}$$

In the equation, (X_1) and (X_2) represent the sample means, (S_1^2) and (S_2^2) represent the sample variances, and (n_1) and (n_2) represent the sample sizes of the respective groups.

Implementation Schedule and Stages

The schedule and stages of the community service activities are presented in Table 1.

Table 1. Stages of community service implementation

Activity	Description and Objective	Schedule
Preliminary survey	Survey of commercial fish feed use among members of the Harapan Bersama Fish Farmers' Group in Beringin Village. The objectives were to identify issues related to commercial feed use and calculate production costs and profits.	Third week of July 2023
Discussion with the funding partner	Discussion between the Community Service Team and the funding partner to determine strategic measures for addressing the group's challenges. The activity also involved coordination of equipment procurement, including pellet-making machines, supporting equipment, and locally sourced feed materials.	Fourth week of July 2023
Theoretical presentation and focus group discussion	Presentation of theoretical material and an FGD on the technical aspects of independent fish feed production using locally sourced raw materials. The objective was to provide participants with a sound technical understanding of the practical application of the technology.	Second week of August 2023
Procurement of materials and equipment	Procurement of essential equipment, construction of a feed storage facility, acquisition of supporting equipment, and procurement of feed raw materials. The objective was to provide the facilities, equipment, and materials needed to implement the technology in practice.	Third week of August to second week of September 2023
Practical training in self-produced feed manufacturing	Guided practice in producing fish feed from local raw materials. The objective was to transfer the necessary production skills to members of the Harapan Bersama Fish Farmers' Group.	Third week of September 2023
Application of self-produced feed in pond-based fish farming	Application of the feed production techniques learned during training to fish reared in the group members' ponds. The objective was to demonstrate whether feed made from local raw materials was less expensive and more efficient than commercial feed, with the potential to increase profits.	Fourth week of September to December 2023
Monitoring and evaluation	Monitoring and evaluation of self-produced feed, fish growth, and participants' skills. The objective was to assess implementation progress and determine whether the program was proceeding according to its targets.	First week of October to third week of December 2022, as stated in the original manuscript

3. RESULTS AND DISCUSSION

Results

Theoretical presentation and focus group discussion

During the theoretical presentation and focus group discussion (FGD), participants received information about fish feed production using locally sourced raw materials. The training combined theoretical explanations, demonstrations, and hands-on practice. The topics covered (1) preparing the equipment, including the pellet-forming machine and its accessories; (2) preparing the fish feed

ingredients; (3) formulating the feed; (4) weighing the ingredients according to the formulation; (5) mixing and kneading the ingredients; (6) forming the feed pellets; (7) drying; and (8) packaging and storage. The Community Service Team delivered the material through lectures and focus group discussions, with team members taking turns according to their respective areas of expertise, as shown in Figure 1.



Figure 1. Training and focus group discussion on fish feed production using locally sourced raw materials

The theoretical presentation provided a schematic overview of the process of producing fish feed using locally sourced ingredients.

Demonstrations and practice

The demonstrations covered weighing and mixing the ingredients, kneading the mixture, and forming fish pellets. The demonstrations and practical sessions were conducted in four stages: (1) Demonstration by the Community Service Team; (2) Practice by participants under the team's guidance; (3) Independent practice by participants; and (4) application of the demonstrated process on a business scale. The team used demonstrations, simulations, and hands-on practice, as shown in Figure 2.



Figure 2. Practical training in fish feed production using locally sourced ingredients

Production output and feed efficiency

The ingredients used during the practical feed-making sessions were locally available and could be obtained continuously. They were selected to meet the nutritional requirements of fish feed and included dried fish offal, palm kernel meal, fine rice bran, starch, and added vitamins and minerals. To formulate pellets with a target protein content of 30 percent, the ingredient proportions were calculated using Pearson's square method, as shown in the schematic diagram.

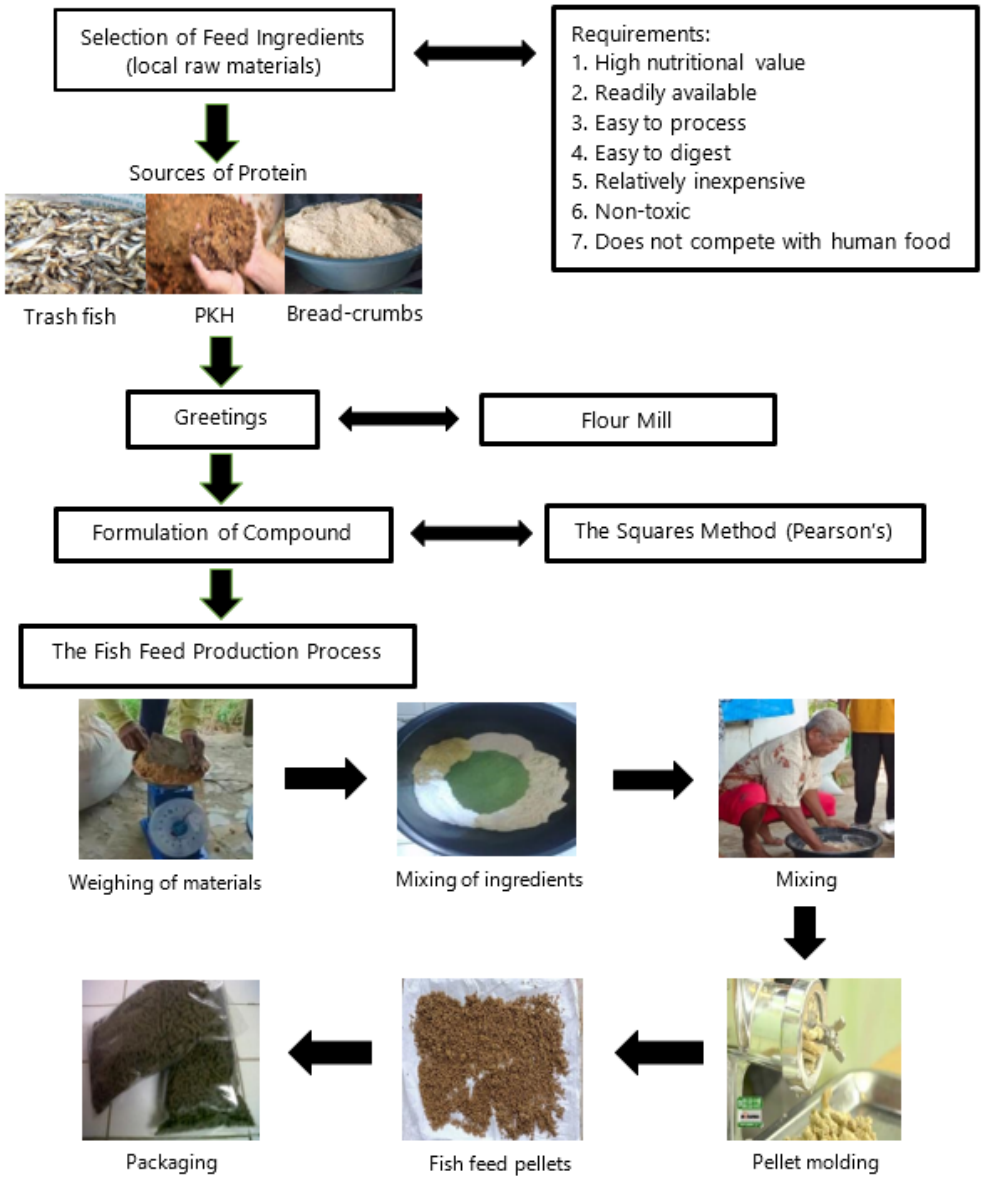


Figure 3. Schematic diagram of the process for producing fish feed pellets from locally sourced raw materials

The calculations yielded the ingredient composition shown in Table 2.

Table 2. Composition of fish feed made from local raw materials

Raw Materials	Percentage (%)	1 kg of feed (grams)
Mixed trash fish	38.45	384.5
Palm kernel	35.77	357.7
Fine rice bran	18.62	186.2
Starch flour	6.16	61.6
Vitamins and minerals	1.00	10.0
Total	100.00	1,000.00

As part of this community service initiative, the team calculated the output of self-produced feed over the three-month implementation period, from September to November 2023. Average production was 946 kg per month, as shown in Table 3.

Table 3. Self-produced fish feed by the Harapan Bersama Fish Farmers' Group during the community service program, September to November 2023

Production timeline	Production (kg)
September 2023	805
October 2023	1056
November 2023	977
Total	2,838
On average	946

The team also calculated the material and operating costs of self-produced feed, including fixed costs, operating costs, and interest on capital. Fixed costs included machinery depreciation (CTK-50 model; see Figure 3), fuel, and other supporting equipment, estimated at IDR 2,500.00 per kilogram of daily production, as well as labor costs of IDR 1,500.00 per kilogram. The reported fixed cost was therefore IDR 4,000.00 per kilogram of self-produced feed.



Figure 4. Pellet-making machine used to produce fish feed from local raw materials

Variable (operating) costs are presented in Table 4.

Table 4. Calculation of production costs for self-produced fish feed

Raw Materials	Percentage composition (%)	Price of Raw Materials per kg (IDR)	Price based on composition per kg (IDR)
Mixed fish meal	38.45	8,000.00	3,076.00
Palm kernel	35.77	6,000.00	2,146.20
Fine rice bran	18.62	6,000.00	1,117.20
Starch flour	6.16	12,500.00	770.00
Vitamins dan minerals mix	1.00	99.375.00	993.75
Total	100.00		4,530.35 8,102.95

The reported total production cost was IDR 8,105.35 per kilogram, although IDR 8,102.95 per kilogram is also listed in the original calculations. Commercial catfish feed with a roughly equivalent protein content of 30 percent cost IDR 12,000.00 per kilogram. The manuscript reports that self-produced feed was cheaper, with a calculated cost efficiency of approximately 32.48 percent. Almost all the feed produced at the site was used to raise catfish in earthen ponds managed by members of the partner group. Sampling data from one member's pond showed that the average catfish weight increased from approximately 15 grams per fish at stocking to approximately 50 grams per fish after about one month.

This growth was described as relatively similar to that achieved in catfish farming using commercial feed with a protein content of 30 percent. The original manuscript also states that self-produced feed was 28.30 percent cheaper than commercial feed.

Fish growth

All members of the *Pokdakan* tested the self-produced feed in their catfish farming operations. Figure 4 shows the growth of catfish in one pond belonging to a group member. The stocked catfish fry had an average initial weight of 15 grams per fish and a stocking density of 20 fish per square meter.

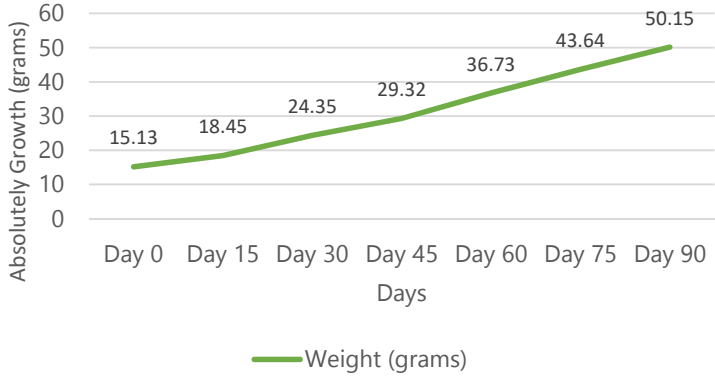


Figure 5. Growth of catfish fed with feed produced by the Harapan Bersama Fish Farmers' Group over a 90-day rearing period

Improving partners' knowledge and skills

In addition to producing fish feed, the program increased the knowledge and skills of members of the Harapan Bersama Fish Farmers' Group in producing feed from locally sourced raw materials. The activity results indicate that group members acquired skills in selecting raw materials, formulating feed, mixing ingredients, kneading, forming pellets, drying, and packaging. These skills were developed through technology dissemination, training, and mentoring. All group members participated in practical sessions at the activity site.

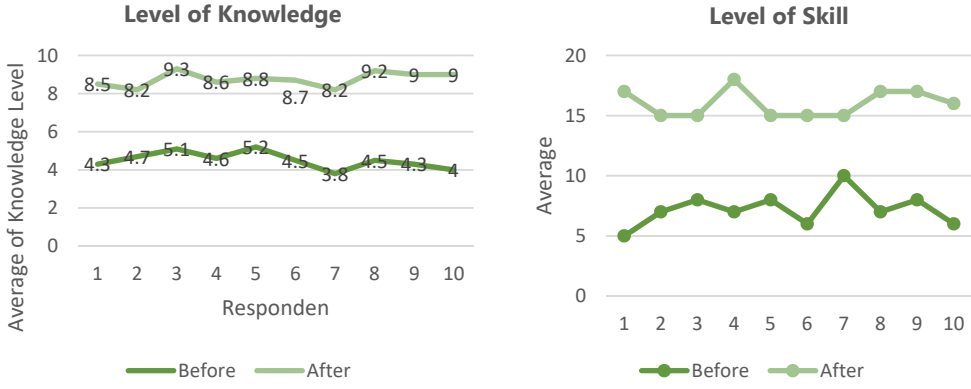


Figure 6. Changes in participants' knowledge (left) and skills (right) following training on fish feed production using local raw materials

Changes in participants' knowledge and skills were analyzed using a two-tailed t-test comparing the data collected before the activity (pretest) with the data collected afterward (posttest). The analysis showed that participants' knowledge level increased by 199.44 percent and their skill level increased by 183.22 percent. These results indicate that the program improved participants' knowledge and skills in producing fish feed independently using local raw materials. The changes in knowledge and skills before and after the activity are illustrated in Figure 6.

Discussion

The identification of the problems faced by the partner is consistent with the findings, indicating that the feed is the largest cost component in fish farming. Previous studies have reported that feed costs can account for 60 percent to 70 percent of total fish production costs (Eizenberga & Proskina, 2025; Magondu et al., 2025). Therefore, developing the group's capacity for independent feed production is a relevant approach to address the needs identified in this program. These findings highlight the alignment between challenges encountered in the field and recommendations from aquaculture research emphasizing feed cost efficiency as an important factor in improving business profitability (Syandri et al., 2026).

The training and mentoring activities conducted through this program demonstrate the importance of technology transfer in empowering fish farming communities. The combination of theoretical instruction, hands-on practice, and technical guidance provided group members with opportunities to develop both conceptual understanding and practical skills in fish feed production (Priambudi et al., 2025; Sudita, 2022). All members of the Harapan Bersama Fish Farmers' Group participated in training covering raw material selection, feed formulation, ingredient mixing, kneading, pellet molding, drying, and packaging. Their participation indicates that the technology transfer process addressed the major stages of independent feed production.

Previous studies have also highlighted the effectiveness of practice-based training and ongoing mentoring in strengthening fish farmers' technical capacity (Affandi et al., 2025). Combining training sessions, technology demonstrations, and hands-on practice can provide greater opportunities for participants to adopt innovations than lecture-based instruction alone (Dhehibi et al., 2022). This approach was reflected in the program, as participants applied the knowledge they acquired by producing feed using the facilities provided.

The results indicate that group members developed the skills needed to use locally available raw materials in fish feed production. One of the program's main objectives was to reduce dependence on commercial feed by making use of resources available in the surrounding area. The materials used in this activity included fish bycatch, palm kernel meal, fine rice bran, tapioca flour, and a vitamin and mineral mixture. When appropriately formulated, locally available ingredients can provide economical and sustainable sources of nutrients for fish feed (Kartina et al., 2024).

Filali & Ezzahir (2025) reported that using local raw materials can improve cost efficiency by reducing dependence on imported ingredients and lowering transportation costs. Furthermore, using locally available materials can support the utilization of agro-industrial waste and by-products, an approach relevant to sustainable fisheries development (Kari et al., 2023). Accordingly, the group's ability to identify, select, and use local raw materials represents an important achievement in relation to the program's objectives (Liliyanti et al., 2025).

The production results provide evidence that the technology transferred through the program was applied in practice. According to the program report, the group produced an average of 946 kg of

fish feed per month between September and November 2023. This output indicates that the activities progressed beyond training and were incorporated into the group's production operations. Independent feed production may help fish farmers reduce their reliance on commercial products and strengthen their capacity to manage feed supplies (Rachmawati et al., 2023). Bidayani et al. (2023) also reported that producing feed independently can provide opportunities to lower production costs compared with purchasing commercial feed. By producing its own feed, the group has established an alternative supply that can be adjusted to its aquaculture needs. These results suggest that the program's objective of strengthening feed production capacity was supported by the training and mentoring activities.

During the three-month catfish rearing period, the average fish weight increased from approximately 15 g to 50 g per fish when the group-produced feed made from local raw materials was used. This increase indicates that the fish grew during the rearing period. However, determining whether the feed performed similarly to commercial feed requires a direct comparison under comparable rearing conditions. The program report also indicates that producing feed from local raw materials could reduce production costs by up to 28.3 percent. Properly formulated feed containing locally available ingredients may support fish growth when it meets the fish's nutritional requirements (Mustapha et al., 2023). The use of group-produced feed in the rearing activity also indicates that the transferred technology progressed to the operational stage of fish farming (Apriansyah et al., 2020; Liliyanti et al., 2025).

The activities helped members of the Harapan Bersama Fish Farmers' Group develop skills across the main stages of fish feed production. These skills are important for the sustained use of the transferred technology and represent one indicator of the success of community empowerment initiatives (Wahid et al., 2024). The knowledge and technical abilities acquired by group members can serve as social and technical capital to support the program's sustainability. Another important outcome was the provision of production facilities. The program supplied a pellet-making machine with a capacity of 100 kg per hour and installed it at the group's premises. Access to this equipment may improve the group's ability to continue production after the program ends. Providing operational equipment alongside capacity-building activities can offer more practical support for sustained production than training without access to the necessary facilities. The integration of skills development and production infrastructure is therefore a key strength of this program.

The practical implications of this initiative include the group's increased capacity to produce fish feed using locally sourced raw materials. This capability creates opportunities to develop a feed production business that serves the group's own needs and potentially supplies other fish farming groups in the surrounding area. The availability of local raw materials near the production site may also help maintain cost efficiency over time. More broadly, the use of local ingredients can contribute to the development of efficient and competitive aquaculture businesses (Poulton, 2025). Thus, the program's potential benefits extend beyond skills development to include the longer-term strengthening of the group's economic capacity (Verma, 2024).

Despite these achievements, the initiative faces several limitations. The supply of fish bycatch is not consistently available throughout the year because it depends on fishing seasons. In addition, these materials are used by other sectors, creating competition for their availability. These conditions indicate that the sustainability of independent feed production remains partly dependent on a reliable supply of raw materials (Sunarno et al., 2024). The successful use of local ingredients also depends on material quality, supply continuity, and the group's ability to substitute ingredients when shortages occur (Mustapha et al., 2023). Future programs could therefore explore alternative feed formulations using a wider range of locally available ingredients to reduce dependence on materials with seasonal supply constraints.

Overall, the program addressed the partners' main challenges by strengthening their capacity to produce fish feed independently using local raw materials, thereby responding to concerns about the high cost of commercial feed and limited feed production capacity (Hertika et al., 2024). The outcomes included improved technical skills, greater utilization of local ingredients, access to production facilities, and the production of feed for aquaculture activities. Independent feed production offers a promising approach to improving cost efficiency and supporting fish farming productivity when combined with appropriate technology transfer, suitable raw material selection, and continued technical assistance. The initiative therefore contributes to strengthening the capacity of fish farmers' groups and illustrates the relevance of practical training and technology transfer in community service programs in the aquaculture sector.

4. CONCLUSION AND RECOMMENDATIONS

The implementation of a self-sufficient fish feed production system using local raw materials by the Harapan Bersama Fish Farmers' Group in Beringin Village, South Kalimantan, Indonesia, resulted in an average monthly production of 946 kg of fish feed. The program also achieved a reported cost efficiency of 78 percent compared with commercial feed. In addition, technology dissemination increased participants' knowledge by 194.44 percent and their skill levels by 183.22 percent.

Ongoing monitoring and evaluation by the Barito Kuala Regency Food Security and Fisheries Agency are recommended to support the sustainability of the program and help improve fish farmers' profitability.

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