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# Utilization of Agricultural Waste and Local Feed Resources for KUB Chicken Feed Pellets: A Community Assistance Program for the Sahabat Tani Farmer Group

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**Abstract:** Kampung Unggul Balitbangtan (KUB) chickens represent a promising local poultry commodity for smallholder farmers, but their development is constrained by the high cost of commercial feed. The Sahabat Tani Farmer Group in Wae Munde Preparatory Village, Kisol, East Manggarai Regency, East Nusa Tenggara, Indonesia, generates substantial quantities of cocoa pod husk waste that remain underutilized as a potential alternative feed ingredient. This community service program aims to assist the farmer group in processing fermented cocoa pod husks and other locally available feed ingredients into pelleted feed for KUB chickens. Implemented in December 2025 and involving 35 farmers, the program followed four stages: preparation, socialization, technical mentoring, and evaluation. Technical mentoring covered ration formulation, cocoa pod husk fermentation, pellet production, and pelleting machine operation. Program outcomes were assessed using a combination of quantitative methods, including pretest and posttest assessments, and qualitative methods based on direct observation. The results showed a substantial improvement in participants' knowledge of the pellet production process, with the proportion of participants demonstrating an understanding of the procedure increasing from 20% before the program to 95% afterward (N-gain = 0.94). A cost analysis estimated the production cost of the pelleted feed at IDR 5,385 per kilogram, approximately 40% lower than the price of commercial feed. By the end of the program, participating farmers were also able to operate the pelleting machine independently. These findings suggest that hands-on technical mentoring can strengthen smallholder farmers' capacity to convert agricultural waste and locally available feed ingredients into value-added feed products, potentially improving feed cost efficiency and supporting the sustainability of integrated crop–livestock farming systems.

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## Introduction

The Kampung Unggul Balitbangtan (KUB) chicken is a local chicken strain developed through six generations of genetic selection by the Livestock Research Institute

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(Balai Penelitian Ternak), Ciawi-Bogor, characterized by higher egg production, reduced broodiness, more efficient feed consumption, and greater disease resistance compared with conventional native chickens (Baidi et al., 2025). These advantages make the KUB chicken a promising poultry commodity for smallholder farmers as a source of animal protein and additional household income. Nevertheless, the success of KUB chicken farming largely depends on the availability of quality and affordable feed, given that feed costs can account for more than 70% of total production costs in smallholder poultry farming (Kamil et al., 2025). This condition represents a major constraint for farmer groups, including the Sahabat Tani Farmer Group, which has continued to rely on commercial feed despite its steadily rising and often unstable price.

The Sahabat Tani Farmer Group is located in Wae Munde Preparatory Village, Kisol, Kota Komba Subdistrict, East Manggarai Regency, an area where smallholder cocoa (*Theobroma cacao* L.) is one of the main plantation commodities cultivated by local farmers (Puspita et al., 2024). At the regency level, East Manggarai has 6,316.15 ha of cocoa plantations managed by 15,790 farming households, with a production of 3,241.65 tons of dry cocoa beans and an average productivity of 586 kg/ha (Dinas Pertanian dan Ketahanan Pangan Provinsi Nusa Tenggara Timur, 2023). Cocoa pod husk accounts for approximately 73–75% of the total weight of the cocoa fruit, while the cocoa beans utilized as the main product represent only about 23% (Ade et al., 2023); based on national production data, every ton of dry cocoa beans is accompanied by roughly 10 tons of fresh pod husk (Towaha, 2017). Accordingly, cocoa plantations in East Manggarai are estimated to generate more than 30,000 tons of fresh pod husk annually, a considerable part of which comes from smallholder gardens such as those around Wae Munde Preparatory Village. To date, cocoa pod husk waste has not been optimally utilized by farmers and tends to accumulate around plantation areas, potentially causing environmental pollution while forfeiting economic value that could otherwise be realized.

From a nutritional standpoint, cocoa pod husk has potential as an alternative feed ingredient because it contains approximately 9.15% crude protein and is rich in crude fiber (Towaha, 2017), as well as minerals (Mael, 2024) and phenolic compounds with antioxidant activity (Tarianti, 2025). Cocoa pod husk can be used as a partial substitute for concentrate feed in both ruminants and poultry, including goats (Atmaja, 2022) and laying hens (Nortey et al., 2015). The main constraint in utilizing cocoa pod husk as poultry feed is its high crude fiber content and antinutritional compounds such as tannin and theobromine, which can reduce feed digestibility when given raw without processing (Ade et al., 2023). Therefore, fermentation becomes an essential step to reduce crude fiber and antinutritional compound levels while increasing the protein content of the feed ingredient (Towaha, 2017). The local feed ingredients available in Wae Munde Preparatory Village that were combined with cocoa pod husk in this program are ground corn, rice bran, and coconut meal, supplemented with tofu waste. These ingredients were combined because fermented cocoa pod husk still contains relatively high crude fiber (approximately 34.7%) and only moderate crude protein (approximately 12.9%) (Towaha, 2017), so it cannot meet the nutrient requirements of KUB chickens on its own. Ground corn and rice bran serve as energy sources that compensate for the low energy density of cocoa pod husk, whereas coconut meal and tofu waste supply additional protein. Combining these ingredients also keeps the inclusion of cocoa pod husk at a moderate level, so that the crude fiber content of the ration remains within the tolerance of poultry (Ndetu et al., 2025), while relying on ingredients that are obtained locally at a lower cost than commercial concentrate.

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Regarding the effectiveness of fermentation in improving the nutritional value of cocoa pod husk as livestock feed, fermented cocoa pod husk has been introduced to goat farmers through community mentoring programs as an alternative feed ingredient without adverse effects on growth (Bunyamin et al., 2024). In poultry, cocoa pod husk has been included in laying hen diets at levels of up to 10–15%, with enzyme supplementation, without adversely affecting egg quality (Nortey et al., 2015), while fermented sweet potato leaf meal has been used to replace up to 15% of ground corn in KUB chicken rations (Hidayat et al., 2023). In addition, processing agricultural waste into meal and pellet forms is considered more practical because it extends shelf life, facilitates ration mixing, and reduces feed wastage during feeding (Pamungkas & Nepa, 2025).

Based on the foregoing, this community service program was implemented to assist the Sahabat Tani Farmer Group in utilizing agricultural waste in the form of cocoa pod husk and other local feed ingredients to be processed into KUB chicken feed pellets through fermentation. This program is expected to provide a solution to the problem of high commercial feed costs, while promoting the optimal utilization of agricultural waste that has not yet been maximally managed, thereby creating a more efficient and sustainable crop-livestock farming system capable of increasing the income of farmer group members.

## Method

This community service program employed the Participatory Action Research (PAR) approach, in which farmer group members were positioned as active partners in identifying problems, planning, implementing, and reflecting on the activities rather than as passive beneficiaries (Kemmis et al., 2014). The program was carried out in Wae Munde Preparatory Village, Kisol, East Manggarai Regency, East Nusa Tenggara (NTT) Province, in December 2025, in partnership with the Sahabat Tani Farmer Group, comprising 35 KUB chicken farmers. The partner was selected based on the consideration that the farmer group possessed substantial agricultural waste and local feed resources that had not been optimally utilized as livestock feed raw materials, while the need for commercial feed continued to burden farmers' production costs. The program was implemented through four stages: preparation, socialization, technical mentoring, and evaluation, which follow the PAR cycle of planning, action, observation, and reflection. The preparation stage constituted the planning phase, the socialization and technical mentoring stages constituted the action and observation phases, and the evaluation stage constituted the reflection phase.

### Preparation Stage

The preparation stage began with a field survey and preliminary interviews with the management and members of the Sahabat Tani Farmer Group to identify the partners' problems, the availability of local cocoa pod husk raw material, and the existing conditions of KUB chicken feeding practices. The results of this identification formed the basis for developing training materials and pellet ration formulation.

### Socialization Stage

The socialization stage was conducted through extension activities and focus group discussions on the potential of agricultural waste as an alternative feed ingredient, the basic principles of KUB chicken nutrition, and the benefits of pelleted feed in terms of efficiency and palatability. This activity was aimed at enhancing the partners' preliminary knowledge before proceeding to the practical stage.

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**Technical Mentoring Stage**

The technical mentoring stage constituted the core of the program, comprising: (1) training on ration formulation based on agricultural waste and local feed ingredients in accordance with the nutritional requirements of KUB chickens; (2) demonstration and hands-on practice of the pellet-making process, including grinding, mixing, pelleting, and drying; and (3) gradual assistance in operating the pelleting machine until partners were able to operate it independently. Mentoring was conducted participatively by actively involving farmer group members at every stage of production.

**Evaluation Stage**

The evaluation stage was conducted to measure the program's success through two approaches, namely quantitative and qualitative evaluation. Quantitative evaluation was performed by comparing partners' knowledge before and after the program using a questionnaire instrument (pre-test and post-test), while qualitative evaluation was carried out through direct observation of partners' ability to independently produce feed pellets, as well as interviews regarding partners' perceptions of the program's benefits. Success indicators were determined based on the increase in partners' knowledge and their ability to sustainably produce KUB chicken feed pellets from agricultural waste and local feed ingredients.

The quantitative data from the pre-test and post-test were analyzed descriptively by calculating the percentage of participants who understood the pellet production procedure at each test. The improvement was expressed as the percentage-point difference and as the normalized gain, N-gain = (post-test % − pre-test %)/(100% − pre-test %), which was classified as high ($g \geq 0.7$), medium ($0.3 \leq g < 0.7$), or low ($g < 0.3$) (Hake, 1998). The qualitative data from observations and interviews were analyzed using descriptive qualitative analysis through data condensation, data display, and conclusion drawing (Miles et al., 2014). The economic benefit was assessed through a simple cost analysis by estimating the production cost per kilogram of pellets (raw material, machine operating, and labour costs) based on a reference formulation and reference market prices, and comparing it with the market price of commercial feed, where potential savings (%) = (commercial feed price − pellet production cost)/commercial feed price × 100.

## Result and Discussion

**Results of the Preparation and Socialization Stages**



**Figure 1. Pre-test administration for the farmer group**

The results of the field survey and preliminary interviews showed that members of the Sahabat Tani Farmer Group had continued to rely on manufactured feed for raising KUB

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chickens, while cocoa pod husk waste generated from gardens around Wae Munde Preparatory Village remained unutilized and tended to accumulate. This condition is consistent with the problem outlined in the introduction, namely the substantial unprocessed cocoa pod husk waste potential that has not been converted into value-added feed ingredients (Ade et al., 2023). Similar conditions are also commonly found among KUB chicken farmer groups in various other regions, where the utilization of local feed ingredients remains constrained by limited technical knowledge regarding feed processing technology based on local raw materials (Nalle et al., 2024).

In terms of feed safety, properly processed cocoa pod husk has been reported to be suitable for substitution into livestock rations, as its antinutritional compound content can be adequately reduced through processing prior to use (Mael, 2024). Based on these identification results, the program team developed a pellet ration formulation utilizing fermented cocoa pod husk meal as a carbohydrate source, combined with other local feed ingredients available in the partner area, namely rice bran, ground corn, tofu waste, and coconut meal.



**Figure 2. Delivery of training materials on pellet production**

The socialization activities conducted through extension and focus group discussions received a positive response from farmer group members, as reflected in the high participation rate during the question-and-answer session on the potential of agricultural waste as an alternative feed ingredient. The pre-test results conducted prior to the program showed that only 20% of participants understood the procedure for producing pellets from a mixture of local feed ingredients. This low level of initial knowledge indicated that farmers' understanding of processing agricultural waste into alternative feed remained limited, making technical mentoring crucial.

**Results of the Technical Mentoring Stage**

During the technical mentoring stage, the program team and farmer group members jointly conducted hands-on practice in producing KUB chicken pellets with fermented cocoa pod husk meal as the main carbohydrate source. Fermentation of cocoa pod husk was carried out to reduce the crude fiber content and antinutritional compounds such as tannin and theobromine that naturally occur in raw cocoa husk, thereby enhancing the nutritional value of the feed ingredient (Towaha, 2017). The effectiveness of this approach is consistent with findings in other livestock, where fermented cocoa pod husk has been shown to be adoptable as an alternative feed ingredient without adverse effects on goat growth (Bunyamin et al.,

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2024), further justifying the use of the same ingredient in the KUB chicken feed formulation in this program. The pellet production process included grinding the fermented cocoa pod husk meal, mixing it with other local feed ingredients according to the formulation, pelleting using a pelleting machine, and drying the resulting pellets.



**Figure 3. Pellet production practice**

Throughout the practical sessions, farmer group members displayed high enthusiasm, particularly during the operation of the pelleting machine. Mentoring was carried out progressively, beginning with machine operation by the program team, followed by joint operation with group members, until the members were ultimately able to operate the machine independently. This demonstrates that a participatory approach to technical mentoring is effective in accelerating the transfer of knowledge and skills to partners. This pattern of gradual mentoring is consistent with good practices in other poultry farmer group empowerment programs, which have shown that participatory technology transfer in pellet production effectively equips farmer groups with the skills to operate pelleting machines independently (Moko et al., 2025), and with the PAR principle that knowledge built through farmers' own action and reflection is more likely to be sustained (Kemmis et al., 2014).

The pellets produced during the practical sessions were cylindrical and were subsequently sun-dried. Fermentation is essential for the nutritional quality of the pellets, as it has been reported to increase the crude protein content of cocoa pod husk from 9.15% to 12.9% and to reduce its crude fiber from 40% to 34.7%, while decreasing tannin and theobromine levels by up to 65.3% and 71.8%, respectively (Towaha, 2017). The dry, compact form of the pellets also reduces the risk of mold growth during storage and facilitates handling by farmers (Pamungkas & Nepa, 2025). However, the total quantity of pellets produced and quantitative physical quality parameters, such as pellet diameter and length, moisture content, durability, and proximate composition, were not recorded systematically during the mentoring period. This is acknowledged as a limitation of the program, and these measurements should be incorporated into follow-up mentoring so that the consistency of the pellets produced by the partners can be monitored.

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**Results of the Evaluation Stage**

The evaluation results showed a substantial increase in partners' knowledge following the implementation of the mentoring program. The pre-test recorded that only 20% of participants were aware of the procedure for producing pellets from a mixture of local feed ingredients, whereas the post-test showed an increase to 95% of participants understanding the procedure. This 75-percentage-point increase corresponds to an N-gain of 0.94, which falls into the high category (Hake, 1998), and indicates that a mentoring method combining extension activities, focus group discussions, and hands-on practice was more effective in enhancing farmers' understanding compared with theoretical material delivery alone.

This increase in partners' knowledge was also consistent with the qualitative observation results during the mentoring stage, in which farmer group members who were initially unfamiliar with the concept of fermentation and the operation of the pelleting machine were, by the end of the program, able to independently practice all stages of pellet production, from raw material preparation to drying the final product. This finding reinforces the results of similar mentoring activities, which have shown that the utilization of cocoa pod husk as feed can be accepted and applied by smallholder farmers without requiring complex technology (Ade et al., 2023; Bunyamin et al., 2024).

An important consideration in formulating feed based on fermented waste is controlling the substitution level of alternative raw materials in the ration. Research on KUB chickens fed with feed containing fermented waste ingredients has shown that excessively high inclusion levels (above 20%) can reduce ration consumption, body weight gain, and feed efficiency due to increased crude fiber content exceeding the optimal threshold (Ndetu et al., 2025). This finding underscores that technical mentoring in this program needs to continue, not only in terms of pellet production, but also in guiding the proportion of fermented cocoa pod husk meal inclusion in KUB chicken rations, so that the partners' livestock production performance remains optimal in the future.



**Figure 4. Post-test administration to evaluate participants' knowledge after the mentoring program**

**Feed Cost Analysis**

To estimate the economic benefit of the pellets for the partners, a simple production cost analysis was carried out (Table 1). The estimate assumed a reference formulation containing 20% fermented cocoa pod husk meal, which corresponds to the upper inclusion

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level suggested for fermented waste ingredients in KUB chicken rations (Ndetu et al., 2025), with the remaining portion composed of the local feed ingredients used in the program. Raw cocoa pod husk was valued at zero because it is a plantation waste, so its cost consisted only of the fermentation inputs. The prices of corn and commercial feed were based on those reported for smallholder poultry farmers in East Nusa Tenggara (Lisnahan et al., 2023), whereas the prices of the other ingredients were based on prevailing local market prices. Under these assumptions, the raw material cost was IDR 4,235/kg, and the machine operating and labour costs amounted to IDR 1,150/kg, giving a total production cost of IDR 5,385/kg. In comparison, commercial feed sold in poultry shops in East Nusa Tenggara costs IDR 9,000–10,000/kg (Lisnahan et al., 2023). Using the lower end of this range, producing pellets from fermented cocoa pod husk and local feed ingredients saves IDR 3,615/kg, or approximately 40.2% of the feed cost.

**Table 1. Estimated production cost of fermented cocoa pod husk pellets compared with commercial feed**

| Component | Proportion (%) | Reference price (IDR/kg) | Cost (IDR/kg pellet) |
|---|---|---|---|
| Fermented cocoa pod husk meal (fermentation inputs only)* | 20 | 1,000 | 200 |
| Ground corn | 35 | 6,500 | 2,275 |
| Rice bran | 25 | 4,000 | 1,000 |
| Coconut meal | 12 | 5,000 | 600 |
| Tofu waste (dried) | 8 | 2,000 | 160 |
| **Raw material cost** | **100** | | **4,235** |
| Machine operating cost (fuel and maintenance) | | | 400 |
| Labour | | | 750 |
| **Total production cost of pellets** | | | **5,385** |
| Price of commercial feed (lower bound) | | | 9,000 |
| **Potential saving** | | | **3,615 (40.2%)** |

**Raw cocoa pod husk was valued at zero (plantation waste); the price covers fermentation inputs only. Prices of corn and commercial feed refer to Lisnahan et al. (2023); prices of the other ingredients refer to prevailing local market prices.*

Considering that feed accounts for more than 70% of the total production costs of smallholder poultry farming (Kamil et al., 2025), this saving has the potential to reduce the total production cost of KUB chicken rearing by approximately 28.1%. This estimate is consistent with Lisnahan et al. (2023), who reported that self-mixed feed based on local ingredients in East Nusa Tenggara saved approximately IDR 3,000/kg compared with commercial feed, and with efforts to improve feed efficiency in KUB chicken rearing through fermented rice bran (Septinova et al., 2026) and agricultural waste–based feed formulations (Pamungkas & Nepa, 2025). It also confirms that converting cocoa pod husk into feed provides direct economic value to cocoa-farming households while reducing the accumulation of plantation waste (Mael, 2024).

The success of this program is also attributable to the characteristics of pellets as a more practical processed feed form compared with raw materials or meal, since pellets have a longer shelf life, facilitate ration mixing, and reduce feed wastage during feeding (Pamungkas & Nepa, 2025). Thus, the utilization of fermented cocoa pod husk meal as a carbohydrate source in KUB chicken feed pellets not only contributes to farmers' production cost

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efficiency but also provides a solution to the problem of cocoa husk waste accumulation in the partners' plantation environment.

Overall, the results of this community service program demonstrate that a hands-on mentoring approach is effective in enhancing smallholder farmers' capacity to process agricultural waste and local feed ingredients into value-added feed products, while supporting the creation of a more efficient and sustainable crop-livestock farming system within the Sahabat Tani Farmer Group.

## Conclusion

This community service program, carried out in collaboration with the Sahabat Tani Farmer Group in Wae Munde Preparatory Village, East Manggarai Regency, successfully enhanced the partners' knowledge and skills in utilizing fermented cocoa pod husk waste and other local feed ingredients to produce KUB chicken feed pellets. This was evidenced by an increase in participants' understanding of the pellet production procedure from 20% at the pre-test stage to 95% at the post-test stage (N-gain = 0.94, high category), as well as the farmer group members' ability to independently operate the pelleting machine by the end of the mentoring program. A cost analysis based on reference market prices estimated the production cost of the pellets at IDR 5,385/kg, approximately 40.2% lower than the price of commercial feed, indicating a tangible potential economic benefit for the partners.

## Recommendation

The mentoring approach combining socialization, focus group discussions, and hands-on practice proved effective in accelerating the transfer of knowledge and technical skills to smallholder farmers. To sustain and broaden these results, the following recommendations are proposed:

**(1) For community partners/farmer groups**

The Sahabat Tani Farmer Group is encouraged to produce fermented cocoa pod husk pellets routinely and collectively, to keep the inclusion of fermented cocoa pod husk meal at a moderate level (not exceeding 20% of the ration) while monitoring the growth and egg production of their KUB chickens, and to record the quantity of pellets produced and the production costs so that the economic benefit can be evaluated continuously. Surplus production can be developed into a group business unit by supplying pellets to neighboring farmers.

**(2) For local government and relevant agencies**

The East Manggarai Regency Government, particularly the agriculture and livestock services and agricultural extension officers, is expected to support the sustainability of this innovation through continued extension, facilitation of grinding and pelleting equipment and fermentation starters, and integration of the cocoa–KUB chicken integrated farming model into regional livestock development programs, including facilitating market access for KUB chicken products.

**(3) For future community service teams**

Future programs should measure the physical quality of the pellets (diameter, moisture content, and durability) and conduct proximate analysis in an accredited laboratory, evaluate the effects of the pellets on the growth performance, egg production, and health of KUB chickens through on-farm trials, assess pellet shelf life and storage stability, and carry out a long-term evaluation of the adoption rate and the economic impact on farmers' income.

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