

## Green economy empowerment for MSMEs: AI-integrated organic waste processing technology from industry and agriculture to drive innovation in alternative poultry feed products

Dewa Kusuma Wijaya<sup>✉</sup>, Heru Agus Santoso, Ratih Setyaningrum  
Universitas Dian Nuswantoro, Semarang, Indonesia

<sup>✉</sup> [dewa.kuja@dsn.dinus.ac.id](mailto:dewa.kuja@dsn.dinus.ac.id)

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### Abstract

This community service activity aimed to empower Repro Micro, Small, and Medium Enterprises (MSMEs) in Semarang City to process organic waste, specifically, milk protein waste from the bread industry and banana tree waste from agriculture, into poultry feed pellet products. These products are intended to support livestock food security, environmental management, and social empowerment. The problem-solving method was implemented through an applied green economy approach, engineering a series of poultry feed pellet production machines integrated with an Artificial Intelligence (AI) system. The realization of this engineered technology series adheres to several technical standards and is designed with multi-feature mechanisms: coarse chopping, fine chopping, pulverizing, and pellet molding. The integration of the AI system serves as a virtual assistant to guide the partner in optimally composing the raw material mixture and simultaneously predict the resulting content based on quality parameters. This integration aims to enhance process effectiveness through improved quality outcomes while maintaining production efficiency. The results of the program realization show that the partner is able to utilize the technology effectively to independently produce poultry feed pellets at a cost of approximately IDR 5,850 per kg. Furthermore, the program's impact has demonstrated an ability to enhance self-reliance, competitiveness, environmental awareness, and business sustainability, thereby contributing to community welfare and advancing the people's economy at the MSME level.

**Keywords:** Green economy; Milk protein waste; Banana tree waste; Poultry feed pellet production machine; Artificial intelligence

## *Pemberdayaan ekonomi hijau untuk UMKM: Teknologi pengolahan limbah organik industri dan pertanian terintegrasi AI untuk mendorong inovasi produk pakan unggas alternatif*

### Abstrak

Kegiatan pengabdian masyarakat ini bertujuan untuk mendorong UMKM Repro di Kota Semarang dalam mengolah limbah organik berupa limbah protein susu dari industri roti dan limbah pohon pisang pertanian menjadi produk pelet pakan ternak unggas yang mampu mendukung ketahanan pangan ternak, pengelolaan lingkungan dan pemberdayaan sosial. Metode pemecahan masalah direalisasikan melalui pendekatan ekonomi hijau terapan dengan rekayasa rangkaian mesin produksi pelet pakan ternak yang diintegrasikan dengan sistem kecerdasan buatan (AI). Realisasi dari proses rekayasa rangkaian teknologi tersebut mengacu pada beberapa standar teknik serta dirancang secara multi fitur dalam mekanismenya yaitu pencacah kasar, pencacah halus, penepungan dan pencetak

Contributions to  
SDGs

9 INDUSTRY, INNOVATION  
AND INFRASTRUCTURE



12 RESPONSIBLE  
CONSUMPTION  
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pelet. Sedangkan integrasi sistem AI, difungsikan sebagai virtual assistant dalam memandu mitra membuat komposisi campuran bahan baku secara optimal, sekaligus memprediksi hasil kandungan sesuai parameter mutu, sehingga dapat meningkatkan efektifitas proses melalui kualitas hasil dengan tetap mempertahankan efisiensi dalam produksi. Hasil dari realisasi program tersebut, mitra mampu memanfaatkan teknologi secara baik untuk memproduksi pelet pakan ternak unggas secara mandiri dengan biaya sekitar Rp5,850 per kg. Lebih lanjut, dampak program tersebut mampu meningkatkan kemandirian, daya saing, kesadaran lingkungan dan sustainabilitas bisnis sehingga dapat membantu kesejahteraan masyarakat dan memajukan ekonomi rakyat pada tingkat UMKM.

**Kata Kunci:** Ekonomi hijau; Limbah protein susu; Limbah pohon pisang; Mesin produksi pelet pakan ternak unggas; Kecerdasan buatan

## 1. Introduction

This community service program is a collaborative effort between the implementation team, Repro MSMEs as the primary activity partner, and PT. Nippon Indosari Corpindo (Sari Roti) as a supporting partner. Repro MSMEs is a micro-enterprise with significant potential in processing organic waste, specifically protein waste from bakery factories and green waste from agriculture. While the raw materials are available in sufficient and sustainable quantities, the partner's current processing is limited to maggot production and lacks the necessary understanding and technology to further process them into diversified products with high economic value.

The potential of organic waste to produce animal feed is an ideal choice, aligning with government efforts to promote national food security and support the livestock industry. However, Repro MSMEs does not yet possess the technology for comprehensive animal feed production. Consequently, they are unable to produce the final product in the form of ready-to-consume pellets for livestock. The resulting products are still semi-finished materials, lacking standard technical specifications. This limitation results in product selling prices that are uncompetitive and prevents the establishment of a permanent consumer segment among livestock farmers. Furthermore, production facilities are inadequate, limited to simple buildings without industry-standard storage or processing areas. This program, therefore, is a development of a previous initiative ([Santoso et al., 2025](#)), focusing its technological and managerial interventions on strengthening production processes, feed formulation, and management digitalization to support Repro MSMEs' growth as an efficient and independent green business actor.

The utilization of organic waste has become a global trend in producing alternative animal feed, serving as either a supplement or a primary substitute for manufactured feed. This is increasingly appealing to livestock farmers due to the abundant supply of organic waste and the rising cost of commercial feed. The organic wastes available to the partner include various materials proven to be nutritious for livestock, such as corn cobs ([Sosiati et al., 2021](#)) and coconut shell waste ([Managanta et al., 2024](#)). In the aquaculture sector, the use of palm oil waste ([Dalimunthe et al., 2023](#)) and fresh local organic waste has already optimized production ([Liliyanti et al., 2025](#)).

A major resource for Repro is agricultural waste, particularly banana tree waste, which has great potential as a significant source of animal feed ([Kusmana, 2020](#)). Its use can substantially reduce feed costs and supports environmental conservation ([Azar et al., 2022](#)), and it is also effective as an alternative feed ingredient during the dry season

(Yanuartono et al., 2020). The second crucial material is protein waste in the form of liquid milk, a residue of production, expired milk, and unsold milk from PT. Nippon Indosari Corpindo (Sari Roti), which is known for its high protein content. As illustrated in Figure 1, the nutritional profile of this protein waste makes it a valuable component in poultry feed (Nguru et al., 2024), especially when combined with agricultural ingredients like banana tree waste (Nuraini et al., 2024). The combination of high-potential, low-cost resources like banana tree waste and protein-rich milk waste is increasingly popular among poultry farmers (Amalyadi et al., 2024; Jati et al., 2024; Vertygo et al., 2024).



Figure 1. Industrial milk protein organic waste (left side) and agricultural banana stem waste (right side)

Despite the abundance of raw materials, Repro MSMEs faces a number of crucial structural and technical challenges that prevent it from leveraging its resource potential. Upstream, processing is carried out conventionally, lacking the adequate tools and standardized methods to guarantee stable quality and hygiene when processing green waste (banana stems) and protein waste (liquid milk) into consumable feed ingredients. Downstream, mass production and standardization of feed products are impossible due to limited production machinery, a lack of technical knowledge in feed formulation, and the absence of an efficient distribution and marketing system.

Furthermore, the lack of an integrated supply chain management system prevents the continuity of raw material supply and product distribution. Without an information system and production monitoring, business processes are inefficient and production costs are uncertain. This results in the price of the partner-produced feed being uncompetitive compared to commercial feed, inhibiting optimal market penetration. In essence, the partner possesses the necessary raw materials (green waste and protein), relationships with livestock farmers, and a strong motivation to grow, but lacks appropriate production equipment, feed formulation technology, and digital-based management systems. Without integrated technological intervention and mentoring, Repro MSMEs will struggle to increase its productivity and competitiveness in the green economy-based animal feed sector.

The need for cost-effective and nutritious feed is critical, particularly in the poultry sector, which is a key contributor to rural community income and national food security (Nursit et al., 2023). In Indonesia, poultry includes not only chickens but also ducks, a species native to North America (*Anas moschata*). Poultry products, such as eggs, are essential ingredients for various processed goods like salted eggs and pastries (Lingga et al., 2023). Demand for poultry is increasing alongside the growth of the food industry (Oktavia et al., 2023).

Based on a Focus Group Discussion (FGD) with several poultry farmers in Semarang City, broiler poultry requires intensive, high-nutritional feed to accelerate the harvest cycle. For egg-laying poultry, unproductive animals are culled ([Anggraini, 2024](#)) and sold for meat before being replaced ([Andini et al., 2023](#)). Critically, the longer poultry is raised, the more feed is needed, with a cost burden of approximately IDR 400,000 per 50 kg sack of commercial feed for 400 animals, consuming an estimated 50 kg of feed per day. This places a heavy burden on farmers, limiting their profit margins ([Nurmeidiansyah et al., 2025](#)), especially since feed costs contribute 65-80% of total output. Moreover, food supplies in tropical areas suffer from low quality and unstable continuity influenced by the seasons ([Rokhayati et al., 2022](#)).

Based on the field identification, needs mapping, system thinking development, and literacy studies, the solution to the partner's problems is an applied green economic approach. This will be achieved by engineering a series of animal feed pellet production machines integrated with an Artificial Intelligence (AI) system technology. The engineering of the poultry feed pellet production machine prioritizes technical standards and reverse engineering of similar machines, which will then be modified with multi-features to be more ideal for the partner's needs. The machine will incorporate multiple working mechanisms: chopper, chaff cutter, mill, and pelletizer. The accompanying AI system will function as a virtual assistant, guiding partners to create an optimal composition of raw material mixtures while predicting the final content results according to quality parameters. This integration will increase process effectiveness through quality output while maintaining efficiency in production.

## 2. Method

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The main objective of this community service activity was to empower Repro MSMEs through the application of appropriate technology and the digitalization of production management. This was achieved by enabling the utilization of protein waste from the food industry and green waste from agricultural land, converting them into high-value poultry feed. The activity was specifically designed to solve two primary problems faced by the partner: technological limitations in animal feed production and the lack of an efficient, sustainable supply chain management system. Ultimately, the program aimed for the partners to produce feed pellets independently, efficiently, and competitively while adhering to green economy and circular economy principles. The implementation method (preparation, design and development, implementation, evaluation) was supported by the Ministry of Higher Education, Science, and Technology (DPPM KEMDIKTISAINTEK) grant funding for the period of July to December 2025. The core engineering of the machine series took place in the Production System Lab at the Faculty of Engineering, Dian Nuswantoro University. The formal handover and technical training process to the partner, Repro MSME, was conducted at the end of October 2025, followed by a continuous mentoring phase to ensure the partner's independent and proper utilization of the new technology.

To overcome production constraints, the engineering team designed, tested, and handed over a series of technological tools in the form of appropriate animal feed pellet production machines. This technology is crucial for the success of the program as it enables the conversion of waste into viable poultry feed products. The realized machine series includes multi-feature capabilities: a) the ability to crystallize liquid milk protein

waste from bread factories into milk powder; b) roughly chop green waste (banana tree waste) into solid shreds; c) finely chop (chaff cutter) the solid shredded green waste; d) flour (mill) the finely chopped raw materials and dry grains; and e) pelletize all floured raw materials into final animal feed pellets. This approach is supported by extensive research confirming the nutritional value, potential, and effectiveness of utilizing banana tree waste for both poultry ([Aminah et al., 2022](#); [Djawapatty et al., 2024](#); [Jati et al., 2024](#); [Kusmana, 2020](#); [Nuraini et al., 2024](#); [Nursit et al., 2023](#)) and ruminant livestock ([Adriani et al., 2024](#); [Amalyadi et al., 2024](#); [Anggraini, 2024](#); [Azar et al., 2022](#); [Handayani et al., 2023](#); [Nguru et al., 2024](#); [Novieta et al., 2021](#); [Yanuartono et al., 2020](#)). Furthermore, studies validate the technology for feed pellet production across various sectors, including fisheries ([Anshory et al., 2022](#); [Hasdiansah et al., 2023](#); [Praja et al., 2025](#); [Sukma et al., 2024](#)), and confirm the positive effect of using organic waste feed on farmers' knowledge and skills.

The second solution addressed the management problem through the provision of an Artificial Intelligence (AI)-based animal feed formulation information system. The primary objective of this system is to help partners reduce the production costs of feed pellets, making them more affordable for broiler poultry farmers, while simultaneously optimizing their nutritional content. The long-term utilization of this technology is intended to ensure the quality and sustainability of the feed pellet products. The realized AI-based information system includes features that: a) map potential organic waste that lacks economic value but possesses potential nutritional content; b) ensure the optimal formulation of mixed raw materials; and c) ensure quality and efficiency in animal feed production. The integration of AI technology is justified by research demonstrating its potential as an intelligent assistant in the food industry ([Thapa et al., 2023](#)), its ability to advance food science ([Esmaeily et al., 2024](#)) and processing ([Barthwal et al., 2025](#)), and its effectiveness in maintaining food quality ([Singh, 2025](#)) and safety ([Naseem & Rizwan, 2025](#)). Moreover, AI applications in the food industry chain have been shown to minimize food spoilage and waste ([Balta et al., 2025](#); [Ibarra-Munoz et al., 2025](#); [Onyeaka et al., 2025](#)). This technology is also increasingly relevant in the agro-feed industry ([Kutyauripo et al., 2023](#)), supporting the sustainability of agricultural production ([Albaaji & Chandra, 2023](#)) and, when combined with machine learning, enhancing productivity monitoring in the livestock sector, particularly in the poultry industry ([Natsir et al., 2025](#); [Rossi et al., 2025](#)).

## 3. Results and Discussion

### 3.1. Design engineering process and technical design

The design engineering process was focused on creating a series of technological tools in the form of a production machine for manufacturing appropriate animal feed pellets. This engineering process was based on a reverse engineering approach, adapting similar products already on the market but developing them into a series of technologies capable of processing both banana stem waste and milk protein waste from industry to produce viable animal feed products. The technological design was developed with several main functional features.

The first feature involves the processing of liquid milk protein waste from the industry into solid powder. This is achieved using a crystallization machine mechanism. The results of this crystallization machine design engineering process, representing the

technical design of a part of the livestock feed pellet production equipment series, are shown in [Figure 2](#).

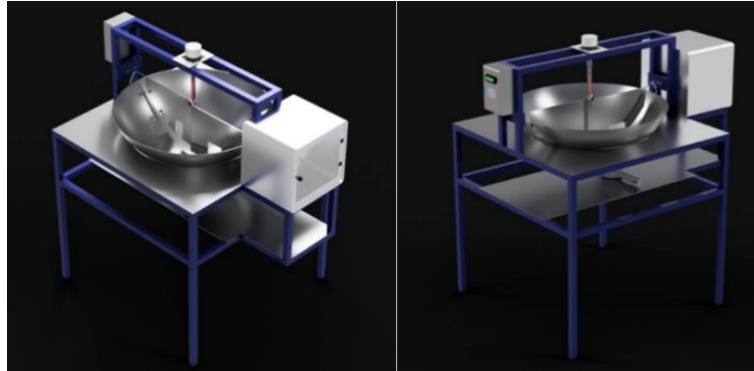


Figure 2. 3D design of liquid milk waste crystallization machine technology

The next phase handles solid organic waste. The system is designed to process solid banana stem waste or other green waste into small pieces using a chopper mechanism. The results of the chopper machine design engineering process, which contribute to the overall technical design of the production series, are shown in [Figure 3](#).

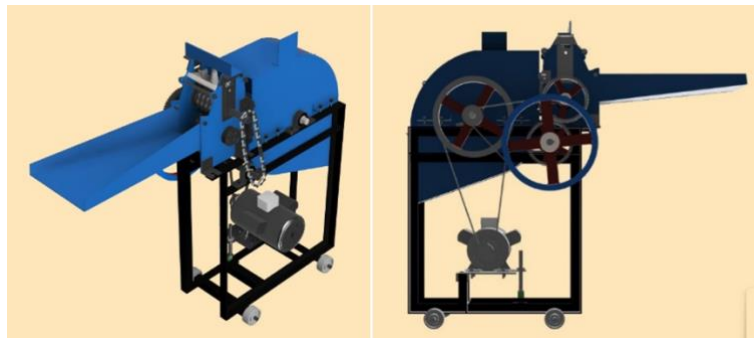


Figure 3. 3D design of banana stem waste chopper machine technology

Following the initial chop, the small pieces of banana stem waste or other green waste are further processed into a fine size using a chaff cutter mechanism. The results of the chaff cutter machine design engineering process for smoothing the shredded products are displayed in [Figure 4](#).



Figure 4. 3D design of chaff cutter machine technology for smoothing shredded products

Finally, the fine ingredients are pressed together and formed into animal feed pellets using a pelletizer machine. The results of the pelletizer machine design engineering process for milling and printing the pellets are shown in Figure 5.

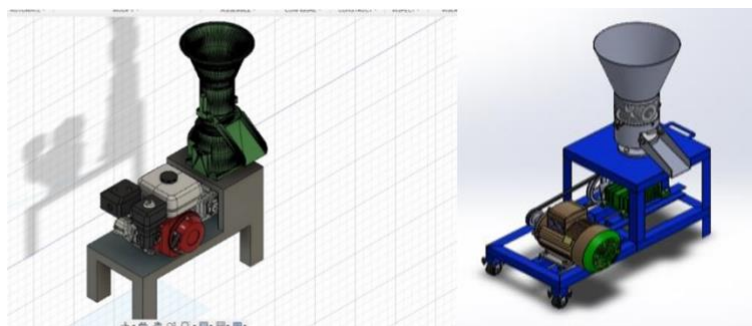


Figure 5. 3D design of pellet milling and printing machine technology

Crucially, the final engineering design of this series of technological tools is modular. This means the machine design is made separately but can be assembled into one unit, ensuring easy mobility. The modular design allows for each machine to be combined with others to create a more efficient tool unit while maintaining functional effectiveness. For example, a chopper machine can be assembled into one unit with a chaff cutter machine, or the pellet machine can be assembled with the chaff cutter machine, as demonstrated in Figure 6.

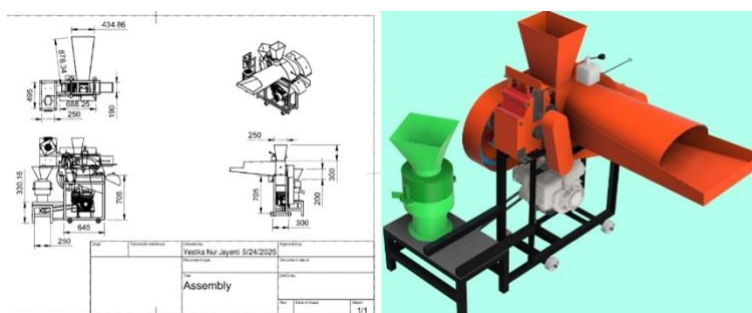


Figure 6. 2D and 3D design of pellet machine and chaff cutter assembly

This modular design increases functional flexibility for users, accommodating different raw material processing needs, and allows the machine series to process various types of organic waste beyond banana stem waste and industrial liquid milk protein waste. It should be noted that for the purpose of this community partnership program, the design focus was only on the chopper, chaff cutter, and pellet machines, as the crystallization machine is merely a development based on previous research activities.

Based on the modular design, the detailed technical specifications for the animal feed pellet production machine technology series are presented in Table 1.

Table 1. Technical specifications of the animal feed pellet production machine technology series

| No                                        | Information                                 | Specification         |
|-------------------------------------------|---------------------------------------------|-----------------------|
| <b>A. Chaff Cutter and Pellet Machine</b> |                                             |                       |
| 1                                         | Fine chopping and flouting process capacity | $\geq 1.200$ kg/hours |
| 2                                         | Fine chopping and flouting blade rotation   | 3.600 rpm             |

| No                                | Information                     | Specification                                                                                                |
|-----------------------------------|---------------------------------|--------------------------------------------------------------------------------------------------------------|
| 3                                 | Blade type                      | Full shredder blade, hardened steel material, vertical type                                                  |
| 4                                 | Screener                        | 4 type                                                                                                       |
| 5                                 | Chaff cutter machine weight     | 120 kg                                                                                                       |
| 6                                 | Chaff cutter machine dimensions | 620 x 450 x 885 mm                                                                                           |
| 7                                 | Chaff cutter machine hopper     | 1 pcs, Ø60 mm                                                                                                |
| 8                                 | Pellet milling process capacity | ≥ 150 kg/hours                                                                                               |
| 9                                 | Milling roller                  | 3 rollers, Ø100 mm, width ±50 mm, hardened steel material                                                    |
| 10                                | Die diameter                    | Ø200 mm, hole Ø5 mm, thickness ±30 mm, material SKD11                                                        |
| 11                                | Main shaft                      | Ø30 mm, length ±300 mm, S45C carbon steel material                                                           |
| 12                                | Gearbox                         | Reducer 1:2                                                                                                  |
| 13                                | Pellet machine weight           | 100 kg                                                                                                       |
| 14                                | Pellet machine dimensions       | 80 x 47 x 96 mm                                                                                              |
| 15                                | Pellet machine hopper           | 1 pcs, Ø30 mm                                                                                                |
| 16                                | Drive                           | Engine 4 T, 16 hp                                                                                            |
| 17                                | Motion transfer                 | Fanbelt and pulley A2                                                                                        |
| <b>B. Chopper Machine</b>         |                                 |                                                                                                              |
| 1                                 | Process capacity                | ≥ 1.000 kg/hours                                                                                             |
| 2                                 | Blade rotation                  | 2.800 rpm                                                                                                    |
| 3                                 | Blade type                      | 4 main blades with shredder blades as secondary blades, hardened steel material, horizontal type             |
| 4                                 | Conveyor                        | Belt type, 1 roll                                                                                            |
| 5                                 | Chopper machine weight          | 50 kg                                                                                                        |
| 6                                 | Chopper engine dimensions       | 640 x 540 x 365 mm                                                                                           |
| 7                                 | Chopper machine hopper          | 1 pcs, 40 x 40 cm                                                                                            |
| 8                                 | Drive                           | Engine 4 T, 8 hp                                                                                             |
| 9                                 | Motion transfer                 | Fanbelt and pulley A1                                                                                        |
| <b>C. Crystallization Machine</b> |                                 |                                                                                                              |
| 1                                 | Process capacity                | 15 kg/hours                                                                                                  |
| 2                                 | Mixer                           | 2 blades, AISI 3195 stainless steel material                                                                 |
| 3                                 | Shaft                           | 1 shaft 40 cm long, material stainless steel AISI 3195                                                       |
| 4                                 | Frames                          | Hollow iron material 30 x 30, fully coated                                                                   |
| 5                                 | Workbench                       | 2 mm thick, 25 cm high from the base, ASTM 2017 aluminum material                                            |
| 6                                 | Wok                             | Ø75 cm, stainless steel material                                                                             |
| 7                                 | Machine dimensions              | 100 x 100 x 130 cm                                                                                           |
| 8                                 | Drive                           | 1 hp, 750W electric motor                                                                                    |
| 9                                 | Motion transfer                 | Fanbelt K-34 and 2 pulleys A1 (4 and 6 cm)                                                                   |
| 10                                | Speed control                   | Variable speed control of 1 phase AC electro motor                                                           |
| 11                                | Heating                         | Rose gas stove 1 burner with high pressure regulator and equipped with 1 crystallization powder heating oven |

### 3.2. Fabrication and assembly

The fabrication and assembly of the animal feed pellet production machine technology series were executed rigorously, strictly adhering to the established design, predefined technical specifications, and referenced technical standards. The entire process followed a distinct sequential workflow, it began with the preparation of raw materials and work tools, proceeded to the material process, transitioned to the main fabrication process, continued with the necessary assembly process, and finally concluded with the finishing process, as systematically visualized in [Figure 7](#).



Figure 7. Fabrication and assembly process

### 3.3. Technology implementation

Following the fabrication and assembly process, a limited-scale technical testing was conducted, leading to a field-scale test, the official equipment handover, and a comprehensive technical education and training session for the partners on the operational and maintenance procedures of the entire technology series. The activity commenced with educating and training partners on the integrated Artificial Intelligence (AI) technology (as shown in [Figure 8](#)), which functions as a virtual assistant for optimal feed formulation.

The AI provided crucial, detailed information regarding the waste characteristics. The technology is able to provide information on the characteristics of banana stem waste which is rich in mineral potential, especially Potassium (K), a high source of hydration because it has a high water content, a source of fiber (important for digestive tract health/gut health), palatability (can be easily processed into pellets), able to be fermented, abundant supply and high sustainability. Meanwhile, milk protein waste from the industry according to AI has a high metabolic energy content (its gross energy can reach above 4000 Kcal/kg higher than corn), moderate crude protein (10% to 12.6%), high crude fat (reaching 13% or more), as a substitute for energy sources for livestock,

high palatability, abundant supply and able to increase feed efficiency. Furthermore, AI technology is also able to provide references for other types of raw materials with parameters of abundant supply, high sustainability, cheap and high nutritional potential.



Figure 8. AI technology education and training for material composition formulation

Crucially, the AI technology is capable of providing optimal composition recommendations using a mix of these materials, which can be specified for several different types of poultry, such as broilers, layers, meat ducks, and layer ducks. This technology not only offers optimal composition recommendations but also predicts the nutritional content of the resulting mixture, which includes key parameters like Crude Protein (PK %), Metabolic Energy (EM), Crude Fiber (SK %), Calcium (Ca %), and Phosphorus (P %), as detailed in Table 2. This capability significantly helps partners in analyzing animal feed quality and efficiency, effectively reducing analysis costs by allowing the AI to function as an efficient virtual assistant.

Table 2. AI-based animal feed mix composition

| Types of Poultry | AI-Based Composition (gr) |                            |      | AI-Based Nutrition Prediction |              |      |      |      |
|------------------|---------------------------|----------------------------|------|-------------------------------|--------------|------|------|------|
|                  | Banana Stem Flour         | Milk Waste Crystallization | Bran | PK %                          | EM (kcal/kg) | SK % | Ca % | P %  |
| Broilers         | 50                        | 550                        | 400  | 24.7                          | 2,980        | 5.5  | 0.45 | 1.01 |
| Layers           | 100                       | 300                        | 600  | 18.8                          | 2,780        | 8.8  | 0.32 | 1.10 |
| Meat Ducks       | 100                       | 450                        | 450  | 22.1                          | 2,870        | 7.15 | 0.41 | 1.01 |
| Layer Ducks      | 100                       | 250                        | 650  | 17.7                          | 2,750        | 9.35 | 0.29 | 1.13 |

Further education and training were carried out for a series of animal feed pellet production machine technologies for partners as shown in Figure 9. This aims to ensure that partners understand the technical and functional aspects of the equipment technology series and are expected to be able to operate it independently and well, thus providing broad benefits related to the appropriate implementation of the equipment.

After completing the series of community-based program activities with partners, the next step was to measure the program's success through an evaluation of the program's implementation results. The purpose of this evaluation process is to objectively measure the effectiveness and efficiency of partner performance related to the program's

implementation. The technical aspects of this evaluation are before-and-after. Table 3 shows the results of the evaluation.



Figure 9. Education and training on animal feed production machine technology

Table 3. Evaluation of the program

| No | Before Activities                                                                                                                                                                                                                                                                               | After Activities                                                                                                                                                                                                                                                                                     |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | <b>Technological aspect</b> , partners do not have the understanding and technology to process milk protein waste and banana stems into appropriate products.                                                                                                                                   | Partners have 1 unit of a series of livestock feed pellet production machine technology for poultry which is integrated with AI technology.                                                                                                                                                          |
| 2  | <b>Economic Aspect</b> , because partners do not have the understanding and technology for processing equipment, the waste cannot be processed into animal feed products that have economic value to support the resilience of the industrial farm.                                             | Animal feed pellet products produced by partners independently through the use of a series of technological tools can be produced at an average price of IDR 5,850 per kg and of course, this price is below the market price of feed, which is around IDR 9,000 per kg.                             |
| 4  | <b>Environmental aspects</b> , the accumulation of organic agricultural waste (banana trees) and industrial waste (liquid milk) has so far only been dumped into the environment and degradation is carried out by the environment naturally.                                                   | By implementing a series of technologies for processing organic waste into animal feed pellets, we are able to support the reduction and conversion of organic waste into value-added products that are beneficial and able to support the resilience of the farm industry.                          |
| 5  | <b>Social aspect</b> , the business activities of previous partners only focused on maggot-based organic waste processing, which of course meant that the absorption of labor was limited to that scope and not many people were interested because this activity required excellent endurance. | By implementing a series of technologies for processing organic waste into animal feed pellets, it can increase the workforce to carry out business activities, and these activities can even partner widely with local or domestic farmers so as to create an ecosystem that is a win-win solution. |

## 4. Conclusion

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The community service program, executed in partnership with Repro MSMEs as the main partner and PT. Nippon Indosari Corpindo (Sari Roti) as a supporting partner, has been successfully completed, demonstrating tangible impacts across technical, economic, social, and environmental dimensions. The core of the program involved implementing a green economy approach by processing organic waste, specifically, protein waste from the bread industry's milk residue and banana tree waste from agriculture, into valuable animal feed pellet products with added economic and environmental value. Technically, the designed and constructed series of multi-feature animal feed pellet production machines successfully processed both types of waste into usable pellet products for the poultry farming industry. Crucially, the integrated Artificial Intelligence (AI) system proved capable of guiding the formulation of these waste raw materials, ensuring the resulting poultry feed pellets are full of nutrients and meet predetermined parameter threshold values. Economically and socially, this program serves as a pilot project for the MSME sector, fostering sustainable business practices, enhancing the partner's self-reliance and competitiveness, and creating potential business opportunities to strengthen the people's economy. Furthermore, the resulting animal feed product is expected to support food security by providing alternative poultry feed ingredients for the local livestock industry.

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## Authors Contribution

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Design of a series of animal feed production technologies: DKW; Development of AI technology for animal feed formulation information systems: HAS; Technical implementation of education and training for partners: RS; Article preparation: DKW, HAS, RS; Article revision: DKW.

## Conflict of Interest

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The authors as the implementer of the program does not have any conflict of interest in any form with the program partners or any party related to the implementation of this program.

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