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Community Empowerment for Sustainable Cattle Farming on Post-Mining Coastal Land: A Case Study from Batu Berdaun Village, Riau Islands

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ABSTRACT

Batu Berdaun Village on Singkep Island, Lingga Regency, Riau Islands Province, faces serious challenges in developing sustainable livestock after the end of the tin mining era. The main problems include the decline in the Bali cattle population due to limited forage feed, the farmers' limited knowledge of cattle fattening management, and the lack of utilization of livestock waste as fertilizer. Through a community engagement program, the solutions offered included training in the cultivation of odot grass (Pennisetum purpureum cv. Mott) as the main source of feed on former mining sandy lands, compost production from cow and chicken manure, and feed fermentation technology to increase nutritional value and production efficiency. The methods applied consisted of problem identification through interviews and observations, participatory training, and field demonstrations. The program results showed an increase in farmers' understanding of forage cultivation, waste management, and sustainable cattle fattening techniques. This initiative is expected to encourage the independence of livestock groups in building a productive and competitive livestock system on post-mining coastal land.

Keywords: Batu Berdaun Village, odot, post-mining coastal

INTRODUCTION

Hypertension Batu Berdaun Village on Singkep Island is one of the villages in Singkep District, Lingga Regency, Riau Islands. This area is generally an area with a history of glory days as a producer of tin mines for almost two centuries from 1812-1992 (Swastiwi, 2015). However, since the area experienced the closure of the tin mine, there have been many changes ranging from the loss of jobs that have resulted in people's income. This is also why Lingga Regency is ranked first as the poorest area based on the lowest ADHB (Gross Regional Domestic Product on the Basis of Applicable Prices) GDP in 2022 in the Riau Islands (BPS Kabupaten Lingga, 2018). In 2018 the local government reclaimed Lingga Regency to become a development area in the fields of agriculture, livestock and fisheries, this was supported by the Ministry of Agriculture Directorate General of Livestock providing assistance for 500 cows (Dellta Kepri, 2018). The development of cattle in the region from year to year has decreased, where in 2018 there were 2,098 heads (BPS Kabupaten Lingga, 2018) and in 2023 it decreased to 1738 cows (BPS Kepulauan Riau, 2024). The decline in the cattle population is influenced by several aspects such as social

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aspects in terms of society, namely the lack of enthusiasm of the community in raising livestock due to lack of motivation, lack of knowledge in livestock breeding, in terms of livestock welfare such as low grass production and lack of production of agricultural waste as additional feed for livestock, livestock health, while economic aspects such as lack of capital and labor and Environmental aspects such as soil quality (soil nutrient unsure), so that these three aspects greatly affect the sustainability of the cattle farming business in the area (BPS Kepulauan Riau, 2024).

Batu Berdaun Village has an area of 39.83 km2 or equivalent to 61.3% of the area of Singkep Island and consists of seven community units. Based on information from the results of the interview with the Head of Batu Berdaun Village (Figure 1), there are two groups of livestock consisting of poultry and Bali cattle commodities. The Rw 7 livestock group focuses on Bali cattle cultivation, has 9 members chaired by Mr. Arifin and formed since 2022 through non-governmental organizations with the approval of the Village government (evidence of livestock groups in the attachment) and has a total of 70 Bali cattle (Dellta Kepri, 2018). The number of Bali cattle populations is one of the areas with the largest number of cattle populations in the sub-district in Lingga district (BPS Kepulauan Riau, 2024). The purpose of the program is the production of breeding and fattening Bali cattle with periodic distribution of female cows (bloodstock) to each member of the livestock group (Figure 2) (Sulfiar, Guntoro, Atmoko, & Budisatria, 2022). Bali cattle cultivation in the RW 07 livestock group uses a shepherd system by placing cows next to the forest or the side of the highway to get grass during the morning until noon and then moved to an open cage in the afternoon before Maghrib. The Rw.07 livestock group of Batu Berdaun Village faces challenges in fulfilling forage feed that affects the cattle fattening program and the sustainability of their livestock business. Preliminary studies of the geographical conditions of the coastal area of Batu Berdaun village have the type and structure of sandy land and soil containing lead, making forage for animal feed difficult to cultivate. Lack of knowledge and planning in forage management makes it difficult for farmers to provide quality feed independently, so they rely on additional feed that is more expensive and less efficient (Rochaeni, Nuraeni, Adi, & Sari, 2023). As well as the lack of agricultural waste as additional feed to sustain the needs of livestock.

The long history of tin mining in Batu Berdaun Village has left significant negative impacts on the land, particularly the dominance of sandy soil with low fertility and the presence of heavy metal residues. These conditions have reduced the soil's ability to support the growth of high-quality forage, which is essential for sustaining cattle feed. Before the introduction of odot grass (Pennisetum purpureum cv. Mott) during this community engagement activity, local farmers generally relied on naturally available grasses and limited agricultural residues, which were often insufficient in both quantity and nutritional quality. In addition, the presence of cattle and poultry in the village provides a continuous source of cow and chicken manure that can be processed into organic compost. This resource availability ensures that compost-making training can be directly implemented to rehabilitate degraded soil, increase forage productivity, and address the problem of poor soil quality caused by mining activities.



Figure 1. Interview with the head of Batu Berdaun Village

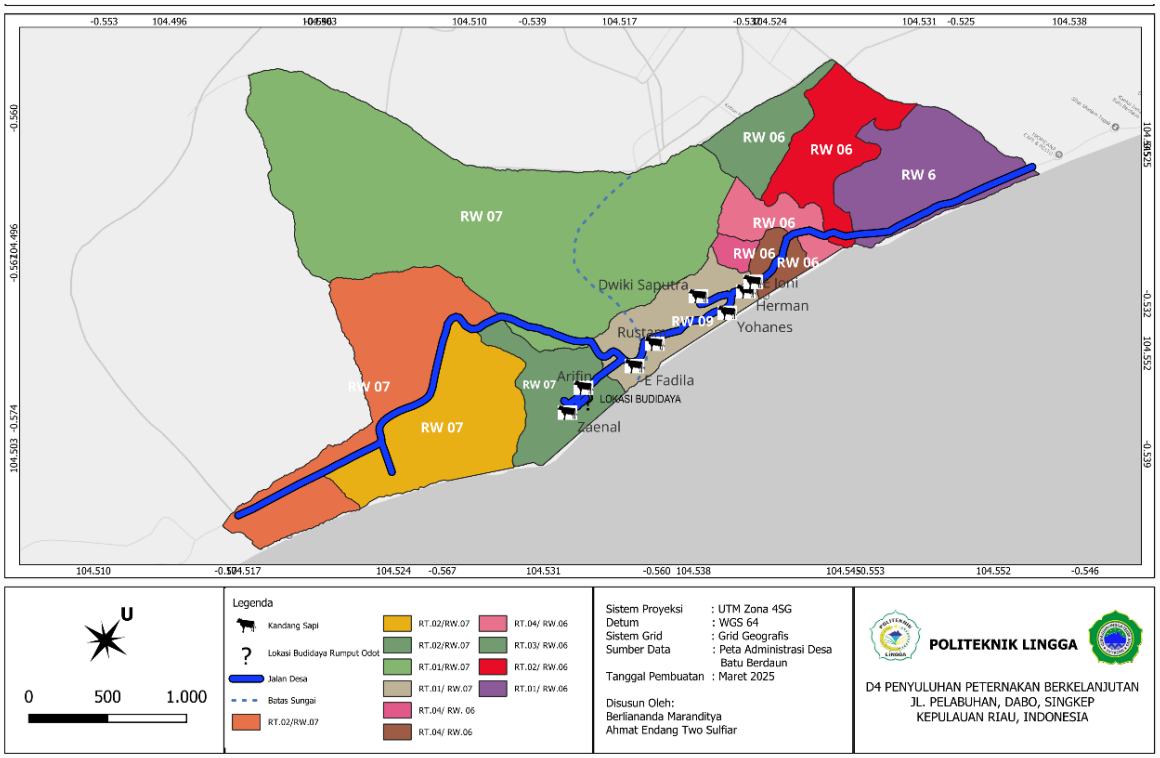


Figure 2. Map of the distribution of cages in RW 07 Batu Berdaun

Based on an interview with the head of the livestock group, Mr. Arifin (Figure 3), the main challenges faced by cattle farmers in Batu Berdaun Village are the shortage of forage feed due to limited land and poor soil quality, as well as the lack of access to alternative feed resources. The problem of providing forage feed caused by limited land dominated by sandy soil and the absence of concentrated feed in the area causes low body weight growth / ADG (Average Daily Gain), resulting in longer maintenance periods or low productivity. Another challenge faced is the lack of understanding in effective cattle fattening techniques and feed management. Many farmers do not understand the appropriate feeding strategies in accelerating livestock growth and increasing the body weight of cows optimally. This ignorance results in slow growth of cattle, increased operational costs, and low efficiency of livestock businesses, which ultimately has an impact on profits that are not maximized for farmers. In addition, the lack of assistance from livestock extension workers has resulted in

farmers' knowledge in livestock maintenance management. Farmers do not have access to the latest information, livestock technology, and best practices that can help farmers increase livestock productivity more efficiently (Budisatria, I.G.S., H.M.J. Udo. & Lers., 2010); (Sulfiar, A. E. T. B A Atmoko, B. Guntoro, 2020) The solution offered is the management of forage cultivation of livestock feed (Odot grass) by utilizing cow and chicken manure fertilizer (compost) produced by the Batu Berdaun livestock group which is then managed periodically and available throughout the year in the compost house belonging to the RW 07 livestock group (Figure 4). Through training in insight and skills, fermented feed technology can increase the nutritional content of feed and anticipate the scarcity of concentrates made independently.



Figure 3. Observation and interview with the chairman of the RW.7 Livestock Group



Figure 4. Survey of forage feed locations and compost houses

The results of the study are that odot grass grows on various types of resistance, and is very responsive to fertilization so that it is very easy to grow as a high nutrient feed recommendation and odot grass can be cultivated on coastal land that was once a tin mine 8. In addition, the results of the previous study (Rochaeni et al., 2023) stated that the protein content of odot grass is 10-15% and has a low crude fiber content so that the nutrient content is quite high and has high palatability for ruminant livestock (L URRIBARRÍ, 2016). The following will be given how to manage forage feed (preparation of chicken and cow compost), processing (fermentation) to improve the quality of waste and complete feed formulation (Rochaeni et al., 2023) so that the provision and provision of feed in quantity and quality according to the needs of livestock available throughout the year, is expected to accelerate the fattening period or increase livestock productivity. The solutions offered include forage cultivation management and techniques, land cultivation

with soil chemical and microbial analysis, processing of livestock waste into compost, hay processing (Muchlis, A. Sema, Jasmal, A. Syamsu, 2023) and complete feed processing that can be used throughout the year. This will have a positive impact on the productivity and sustainability of the livestock business, so that the Batu Berdaun livestock group can develop into a more independent and competitive group of breeders in the sustainable livestock industry.

METHOD

This Community Service in Batu Berdaun Village, Singkep District, Lingga Regency was carried out with exploratory methods and active community participation. The exploratory method is carried out with a special dialogue with partners to explore all the problems experienced and the basic needs that must be addressed immediately (Reifsnider, 2024). Observations and special dialogues are intended to collect and identify problems in what the members of the livestock group want. The active participation of partners as service subjects is carried out by training and direct practice ("demonstration plot").

The implementation of the community engagement program in Batu Berdaun Village, Singkep District, Lingga Regency was carried out using exploratory methods and active community participation. The exploratory method was conducted through special dialogues with partners to identify problems and urgent needs that had to be addressed (Reifsnider, 2024). Observations and discussions were intended to collect and analyze the issues experienced by members of the livestock group. Active participation was emphasized through training and direct practice (“demonstration plots”). The implementation of the program was divided into three stages: (1) coordination and preparation, (2) implementation of science and technology, and (3) evaluation and monitoring. The coordination and preparation stage included coordination with the village government and the Batu Berdaun Livestock Group as well as the management of activity permits. Preparation of training materials and teaching aids was carried out according to the type of technology to be applied. This included the preparation of odot grass seeds, land tillage with soil quality analysis, and fertilizer production. Partners underwent in-depth training on forage cultivation and livestock management. The program also evaluated the management of cattle productivity, while partners were encouraged to continue applying the introduced technologies independently with ongoing mentoring support to ensure sustainability (Figure 5).

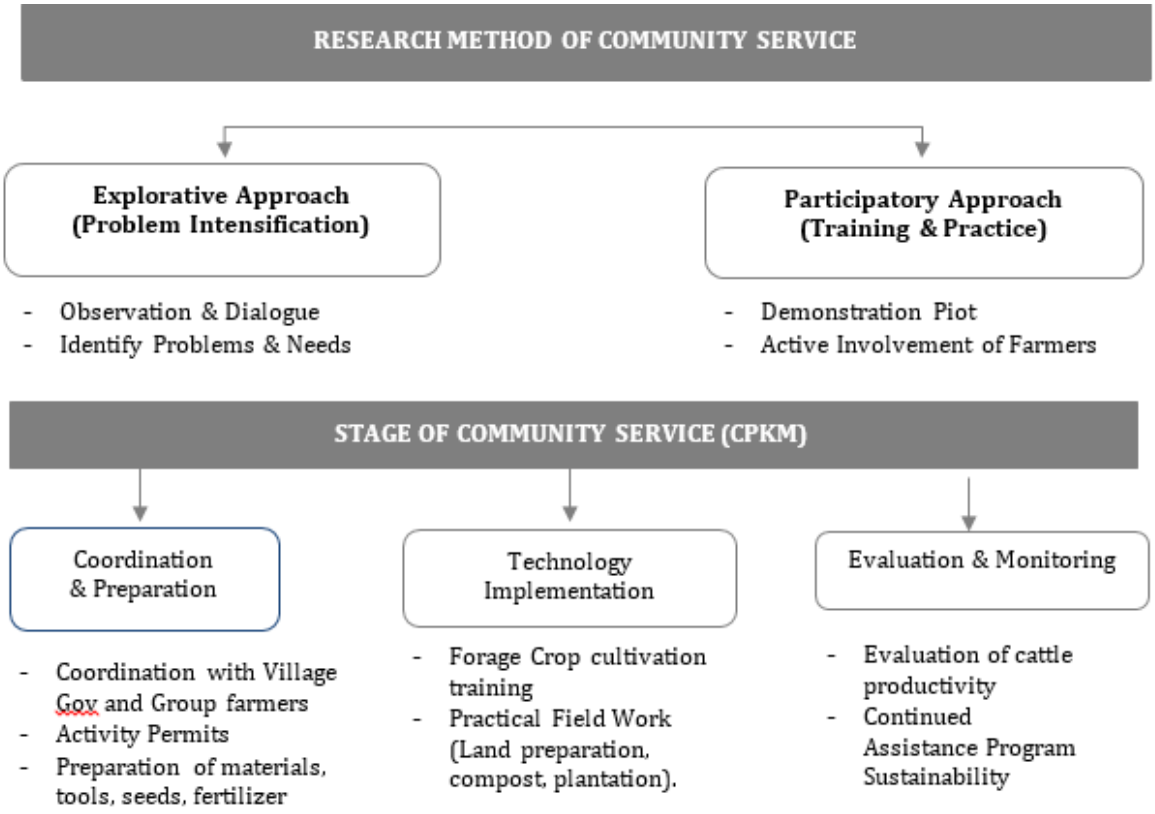


Figure 5. Empowerment methods in Batu Berdaun Village, Lingga Regency

RESULTS AND DISCUSSION

This Based on the observations and evaluations that have been carried out by the proposer and partners, in general, problems can be identified as follows:

1. The type of sandy coastal land and former tin mines are the main problems in the cultivation of forage for livestock feed (Forage Feed) as a source of fibber for ruminant livestock and the lack of management control in forage feed cultivation, especially odot grass, its preservation and warehousing so that it can be used to meet the shortage of forage feed in Batu Berdaun Village.
2. Do not know the technology of complete feed formulation from local feed ingredients, both forage feed, agricultural waste for fattening cows as needed in order to obtain decent business profits.
3. Not knowing the effective management of Bali cattle fattening.

Rural communities in general and in Batu Berdaun Village in particular have many livestock, for cattle are generally raised in groups and not caged. According to the observation of the proposing team based on observations in the field: there is no good application of forage cultivation technology (forage feed), so that it can meet the needs of both the rainy and dry seasons. Furthermore, after there is an improvement in the production of animal feed forage, it is continued to coach/assist the use of organic fertilizers and for the improvement of forage feed cultivation, the processing technology and complete feed formulation for cattle cultivation are continued. Based on previous research, it is said that (L URRIBARRÍ, 2016) odot grass cultivation can be carried out on sandy land and the criteria that have been agreed upon by the proposing team (as an "Integrated Farm" i.e., a livestock environment that is integrated with agricultural cultivation, food industry), the above group was selected as the priority of the PKM location sample.

Furthermore, organic fertilizers and the results of the training need to be used to increase forage feed production in order to fulfill forage feed throughout the maintenance period (sustainable). For this purpose, the service intends to provide assistance to farmer groups in terms of: 1. Technical aspects of production in dealing with the problem of lack of forage for livestock feed (forage feed) and mastery of cultivation technology and its preservation so that it is available throughout the year in a sustainable manner (including sandy land processing, and livestock waste). 2. Management of forage feed yield management and local agricultural waste to deal with the shortage of concentrated feed because the price is always rising with the application of fermentation technology and complete feed formulation for fattening or breeding according to the needs of livestock in order to obtain decent business profits.

Table. 1 Descriptive statistics

Problems, solutions and output targets for solving partner problems are described in the following table:			
No	Problems	Solution	Output
1	Lack of Forage Animal Feed (forage feed)	forage feed production management with counselling methods and demonstration plots such as: - Providing Odot Grass seeds as forage feed - Land tillage (chemical and microbial analysis of soil before and after tillage). - Providing education on how to plant odot grass, fertilization, planning/timing for planting and harvesting so that periodic grass harvests with good yields, care, harvesting, preservation/drying are obtained. - Providing education on the preservation of forage feed or complete feed (burger) made during the production of excess feed ingredients. - Equipping facilities and infrastructure of odot grass plantation mini land such as: water reservoirs, water machines, pipes, freshwater reservoirs in coastal areas (coastal areas)	- The establishment of a mini odot grass garden land as a source of feed and odot grass seeds to be distributed to each member of the livestock group. - There are conditions and soil quality from chemical and biological tests before and after the cultivation of former tin mining land. - Able to independently develop grass plantation land for each member of the breeder. - Able to independently develop feed supply by preserving each member of the livestock group. - The availability of fresh water facilities and infrastructure for watering odot grass in the dry season.
2.	Lack of utilization of livestock waste as fertilizer.	- Science and Technology training for livestock groups in processing feces into compost. - Manufacture of ready-to-use compost.	- Livestock groups have an understanding and knowledge of handling waste independently and environmentally friendly. - Availability of compost products.

3.	There is no training/coaching to improve the skills of livestock groups	Providing education/training on good beef cattle fattening productivity management such as: - Seed supply management. - Livestock rearing management (extensive, semi, and intensive) - Feed and drink management. - Slag health management. - Livestock cage management. - Livestock production management. - Marketing and economic management.	- Members of the livestock group have knowledge about the production management of cattle fattening independently and sustainably.

Source: Researcher Analysis Results, 2025

Processing Livestock Waste into Compost

The management of livestock waste into compost is an ecological approach that not only reduces environmental pollution, but also produces organic fertilizers that can be reused to support the cultivation of odot grass (Suryani, Nurhayati, & Hadist, 2021). By processing cattle and chicken manure into organic fertilizer, the soil's nutrient content and structure are improved, making it more suitable for forage cultivation. Farmers were trained in simple composting techniques, including mixing manure with green materials, regulating moisture, and applying local bio-activators to accelerate decomposition. This approach not only reduces environmental pollution but also provides a sustainable and locally available fertilizer. The availability of cattle and chicken manure in Batu Berdaun Village ensures that compost production can be maintained continuously, thus strengthening the long-term sustainability of the program. In this activity, the community was given direct training on simple composting techniques (Figure 6), including mixing cow feces with green materials (such as odot grass waste), humidity regulation, and fermentation process using local bio-activators. This activity has a dual impact, namely creating the circulation of resources in an integrated livestock system and adding economic value from livestock waste. This practice also strengthens the sustainability aspect because it reduces dependence on chemical fertilizers, which are economically and environmentally disadvantageous for small-scale farmers in coastal areas.



Figure 6. Compost making training with livestock groups and D4 students sustainable livestock counseling

Processing cow manure into organic compost is an important strategy in supporting sustainable agriculture. A study by (Castro-Herrera, D., Prost, K., Kim, D. G., Yimer, F., Tadesse, M., Gebrehiwot, M., & Brüggemann, 2023) shows that the addition of biochar in the composting process of cow feces can reduce non-CO_2 greenhouse gas emissions by up to 71%, as well as accelerate decomposition and improve compost quality. In addition, research by (Kaca et al., 2019) revealed that the composting process can reduce antibiotic resistance in cow feces, but the application of compost to the soil still requires attention to the potential transfer of such resistance. These findings support composting practices in Batu Berleaf, with an emphasis on the importance of proper processing to produce high-quality, environmentally safe compost.

Forage Feed Production Management and Cultivation of Forage (Odot Grass) on Post-Mining Land

Management of the production of Animal Forage (Forage Feed), especially odot grass (Pennisetum purpureum cv. Mott), is an important part of building sustainable livestock systems, especially in post-mining coastal lands that experience fertility degradation (N. Sholikah, W. Auliya, D. Ismayasari, A. S. Bachrul, 2021). After improving soil quality with compost, odot grass (Pennisetum purpureum cv. Mott) was introduced as the main forage crop. Odot grass is well-suited to marginal and sandy soils, especially when supported with organic fertilization. Training covered land preparation, planting techniques, fertilization, maintenance, and efficient harvesting systems. Farmers also learned how to preserve forage through drying and fermentation to ensure feed availability throughout the year. The results showed a significant increase in forage productivity, with odot grass yielding higher biomass and nutritional value compared to local grasses used previously. This improvement directly addresses the feed shortage problem faced by cattle farmers in Batu Berdaun Village.Through the participatory counseling method, the people of Batu Berdaun Village are equipped with an understanding of odot grass cultivation techniques starting from land preparation, seed selection, planting techniques, organic fertilization, to efficient harvest rotation.

The type of coastal sandy soil and contamination of lead residues cause difficulties in the cultivation of forage feed naturally. However, with the application of land cultivation techniques and fertilization using compost from cow and chicken manure, the growth of odot grass shows good results (Figure 7). This is in line with previous research which stated that odot grass is able to grow on marginal land with high protein content (10-15%) (N. Sholikah, W. Auliya, D. Ismayasari, A. S. Bachrul, 2021) and low crude fiber, making it very suitable as the main feed of ruminants. Training on compost processing and feed fermentation technology also has a positive impact (Ratriyanto, Dwi, Wara, Sigit, & Widyas, 2019). Farmers are beginning to understand how to increase the nutritional value of feed from local agricultural waste such as cassava stalks, corn husks, and dry foliage. Products such as hay and fermented burger feed allow for the availability of quality feed all year round, especially during the dry season.

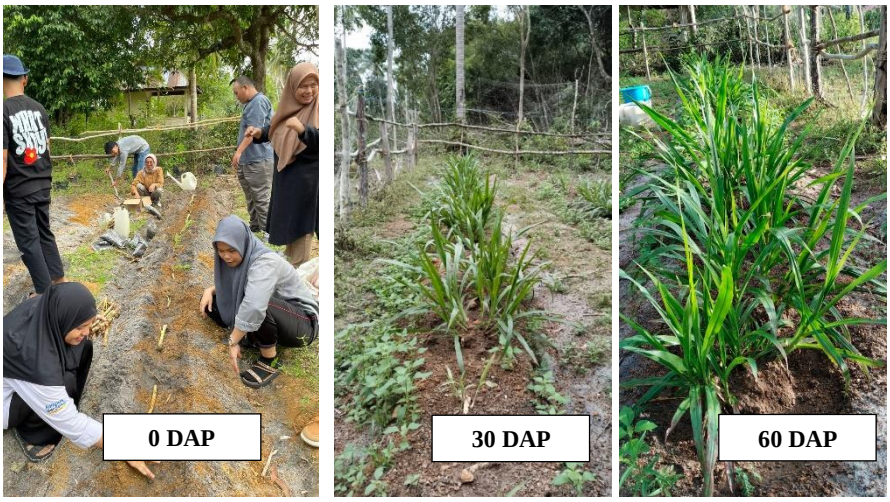


Figure 7. Cultivation of Odot Grass in Batu Berdaun from 0, 30 to 60 DAP (days after planting)
Source: Researcher Data Analysis, 2025

The results of the extension activities showed an increase in farmers' understanding of the importance of forage feed as the main feed source in the cattle fattening system. The productivity of Odot Grass (Forage Feed) increased significantly after the extension method was applied, from 3.2 tons/ha/year to 7.8 tons/ha/year. The Compost quality of cow manure improves, shown by a decrease in the C/N ratio from 4.7 to 1.5 (the lower it is, the better it is for soil fertility) (Figure 8). Figure 8. Farmers actively participating in compost-making training, supported by students, to ensure they acquire practical skills and are able to independently produce organic fertilizer for forage cultivation. In addition, the direct involvement of the community in aquaculture practices strengthens the empowerment aspect and increases local ownership of the program. Counseling also functions as a medium for technology transfer that is adjusted to coastal agroecological conditions, such as water management and adjustment of planting patterns to the characteristics of former mining sandy land (N. Sholikah, W. Auliya, D. Ismayasari, A. S. Bachrul, 2021).

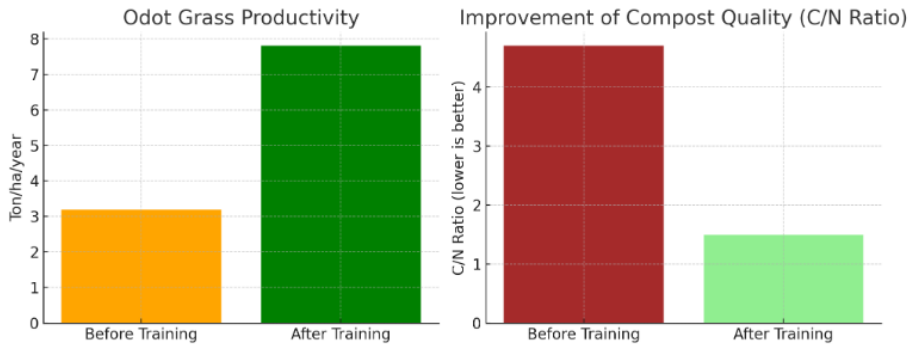


Figure 8. Odot Grass Productivity Graph (Forage Feed) and Compost Quality Improvement (Source: Researcher Data Analysis, 2025)

In the context of managing the production of Animal Forage (Forage Feed) such as odot grass on post-mining land, the participatory extension approach has been proven effective in increasing the capacity of farmers. A study by (Gracia. & B. Charles, 2023) developed technology-based cattle fattening management system using a fuzzy diagnosis system and genetic algorithms to optimize grazing rotation. Although this approach is more

automated and data-based, the basic principles applied, namely efficient and sustainable feed management, are in line with the objectives of the extension in Batu Berdaun. This shows that technology integration and participatory approaches can complement each other in increasing livestock productivity.

Training on Good Beef Cattle Feed Productivity Management

Following the improvements in feed availability, the program continued with training on cattle fattening and overall livestock management. Farmers were introduced to efficient feeding strategies, health management, and record-keeping of cattle growth performance. Special emphasis was given to the use of complete feed processing (instead of "burger complete feed"), integrating odot grass, compost-enriched forage, and locally available agricultural residues. This holistic approach increased feed conversion efficiency, reduced costs, and enhanced cattle growth rates. The participatory training model ensured that farmers were actively involved in applying these techniques, thereby improving their technical knowledge and motivation to continue livestock farming sustainably.

The participatory approach in the form of demonstration plots accelerates the technology adoption process because farmers are directly involved in every stage, from land tillage, planting, fertilization, to feed preservation. The existence of mini odot grass land and compost houses is also the starting point for the independence of the RW 07 livestock group in managing the feed system in a sustainable manner. The active involvement of farmers also encourages the birth of collective awareness about the importance of holistic livestock business management (Kaca et al., 2019). They are not only trained in cattle rearing techniques, but also in production management, livestock health, marketing, and business economics. Thus, strengthening this capacity is expected to increase the productivity and sustainability of livestock groups in the long term (Xu et al., 2025). Overall, this service activity shows that an integrative approach between agriculture, livestock, and appropriate technology is able to answer the specific challenges of the post-mining area. Batu Berdaun has great potential to become a model for community-based sustainable livestock development, especially in the context of coastal areas with marginal land characteristics.

Beef cattle productivity management training is focused on understanding the fattening cycle, selecting seeds, scheduling feeding, managing animal health, and recording cow body weight growth on a regular basis. The training method is carried out interactively with a learning while practicing approach, which makes it easier for farmers to directly apply the techniques learned in their respective cages. The impact of this training can be seen in increasing farmers' awareness of the importance of data-based management, such as recording weight gain and feed consumption. In addition, increasing efficiency in feeding grass-based odot also increases the ratio of feed conversion to cow body weight. This activity also opens up a space for discussion between farmers and facilitators regarding local challenges faced, such as access to markets and veterinary medicines, so that training is not only technical but also strategic.

The beef cattle productivity management training conducted in Batu Berdaun is in line with the findings of a study by (Fan, Zhang, Shi, & Chang, 2023) which emphasized the importance of technical and allottative efficiency in cattle fattening in the era of the digital economy. The research shows that government training and support can improve production efficiency, with a focus on feed management, animal health, and recording body weight growth. This strengthens the training approach in Batu Berdaun which is based on direct practice and data recording, in order to increase the productivity and sustainability of the livestock business.

CONCLUSION

This community engagement program demonstrated that composting cattle and chicken manure is a practical and sustainable solution to rehabilitate post-mining sandy soils in Batu Berdaun Village. Improved soil fertility enabled the successful cultivation of odot grass (Pennisetum purpureum cv. Mott) as a high-quality forage source, ensuring feed availability throughout the year. Training in cattle fattening and complete feed management further enhanced farmers' technical skills and livestock productivity. By integrating composting, forage cultivation, and livestock management, the program not only addressed immediate challenges but also built the foundation for a sustainable, community-based livestock system on marginal post-mining land.

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