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Research Article

Correlation between dry matter intake and weight gain in bali cattle

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Abstract

Beef cattle productivity is strongly influenced by the quality and quantity of feed provided. Dry matter intake (DMI) is a key indicator of nutritional adequacy. Previous studies have been largely descriptive and have not emphasized the quantitative relationship between DMI and growth performance of Bali cattle under intensive smallholder farming systems.

This study analyzed the correlation between dry matter intake and body weight gain in male Bali cattle raised intensive management. The research was conducted in Kutai Kartanegara Regency, East Kalimantan Province, involving 45 respondents, with a total of 180 male Bali cattle. Data were collected through field surveys, body weight measurements, and laboratory analyses of the feed dry matter content. Statistical analyses were performed using Pearson's correlation and simple linear regression.

The results indicated that the average daily body weight gain of the Bali cattle reached 0.48 kg/head/day. Dry matter intake was positively and significantly correlated with body weight gain ($r = 0.777$; $p < 0.01$) using the regression equation $Y = 8.159 + 0.483X$. These findings confirm that increasing the DMI directly enhances the growth performance of Bali cattle.

The study concluded that feed management emphasizing dry matter intake optimization is essential to support the productivity of local beef cattle.

Keywords: Bali cattle; dry matter intake; body weight; livestock growth; productivity

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1 Introduction

The livestock sector makes a significant contribution to the provision of animal protein to support global food security. The demand for beef continues to rise in line with population growth, urbanization, and changes in consumer consumption patterns [1]. Beef cattle production faces increasingly complex challenges owing to limited feed resources, high production costs, and low management efficiency at the smallholder farmer level [2]. Optimizing nutrient utilization through dry matter intake (DMI) is key to successfully increasing ruminant livestock productivity.

Dry matter intake is a key indicator of nutritional adequacy that affects growth performance and meat production efficiency. DMI is directly correlated with the intake of energy, protein, and other nutrients required by livestock to achieve optimal growth [3]. Barriers to meeting dry matter requirements result in decreased Average Daily Gain (ADG), leading to a significant drop in beef cattle productivity [4]. This highlights the importance of monitoring DMI as the basis for efficient feed management.

Bali cattle play a strategic role in the national meat supply, as one of Indonesia's leading genetic resources. Their adaptive characteristics to tropical environments, efficiency in utilizing fibrous feed, and resistance to disease make Bali cattle highly potential for widespread development [5]. Nevertheless, quantitative research on the relationship between DMI and Bali cattle growth under intensive maintenance systems at the smallholder farmer level remains limited. This gap in literature creates an urgent need to provide field-based empirical evidence.

Recent studies have indicated that the DMI is a primary predictor of beef cattle growth. found that feed quality is significantly related to DMI utilization and the performance of tropical livestock [6]. emphasized that consistent increases in DMI improve ADG and feed conversion efficiency [7]. Reported that variability in the availability of local feed in Indonesia affects dry matter intake levels and smallholder cattle growth. These findings underscore the urgent need for further research to understand the DMI consumption patterns in local cattle.

The development of DMI prediction models has also become the focus of recent studies. [8] proposed a more accurate energy requirement-based nutrition evaluation model. [9] developed a dry matter intake prediction algorithm by integrating big data from livestock farms, which is capable of improving the efficiency of ration formulation. [10] emphasized that precision nutrition approaches based on actual DMI data can enhance beef cattle production efficiency, while reducing the carbon footprint of livestock systems. These innovations demonstrate the relevance of field-based research for enriching global prediction models.

This research gap is evident in the scarcity of empirical studies on the quantitative relationship between DMI and weight gain in Bali cattle at the smallholder farmer level. Most previous studies have focused on large-scale commercial cattle or imported breeds, whereas evidence for Bali cattle in tropical agroecosystems remains limited. This lack of data hinders the formulation of contextual nutritional policies and feed management innovation. Field-based research is needed to support the development of sustainable strategies for Bali cattle husbandry.

This study aimed to analyze the quantitative relationship between dry matter intake and weight gain in male Bali cattle under intensive management systems in East Kalimantan. The novelty lies in providing empirical field evidence that illustrates the correlation between the DMI and ADG in smallholder Bali cattle. The research contribution is expected to enrich the literature on tropical livestock nutrition, while serving as a basis for formulating feed management strategies and policy development for local beef cattle in Indonesia.

2 Method

2. 1 Research Materials and Data

This study utilized primary data obtained through field surveys and direct measurements of male Bali cattle. The research sample included 180 Bali cattle aged 1.5-2 years, raised intensively by 45 farmers in the Kutai Kartanegara Regency, East Kalimantan. Feed data included the types of forage, concentrates,

and supplements provided daily. Additional data included age, initial weight, and duration of cattle rearing. The field data-based approach is highly relevant, as suggested by, who stated that local feed sources play an important role in the variation in dry matter intake in smallholder cattle.

2. 2 Data Collection Procedure

Data collection was carried out through direct observation of the farmers' feeding practices. The researcher weighed the amount of feed given and the daily feed remnants to calculate the dry matter intake. The body weight of the cattle was measured using a digital livestock scale with a capacity of 1,000 kg and an accuracy of ±0.5 kg. Body weight measurements were performed twice, namely at the beginning of the study and every 30 days up to 90 days of maintenance. The body weight measurement procedures followed the recommendations of, which emphasized the importance of data validity for DMI and ADG in beef cattle nutrition evaluation models.

2.3 Instruments and Equipment

The main instruments used in the study included a digital livestock scale, feed sample collection bags, and a drying oven for dry matter analysis in the laboratory. Nutrient content analysis of the feed was performed using the proximate method [11], which includes measurements of moisture, crude protein, crude fat, crude fiber, ash, and Nitrogen-Free Extract (NFE). Laboratory analysis followed the approach, which emphasizes that evaluating ration quality is key to understanding the relationship between dry matter intake and beef cattle performance. Field data were recorded using standard forms and processed using Microsoft Excel 2021 and SPSS version 26 software for statistical analysis.

2.4 Data Analysis Methods

Dry matter intake was calculated by subtracting the amount of feed left over each day from the total amount of feed given and then expressed in kilograms of dry matter per animal per day. Average daily gain (ADG) was calculated by dividing the difference between the final and initial body weights by the duration of the maintenance period. The relationship between dry matter intake and average daily gain was analyzed using Pearson's correlation test. The effect of dry matter intake on average daily gain was analyzed using a simple linear regression. Significance testing was conducted at a 95% confidence level ($P < 0.05$). This statistical approach followed the recommendations of, who used Pearson correlation and linear regression to examine the relationship between DMI and ADG in tropical beef cattle.

2.5 Research Replication

The research design was structured so that it could be replicated in different contexts by adjusting the sample size, animal age, and local feed composition. Standardization of body weight measurement instruments and dry matter analysis is the primary requirement to ensure consistent research results. Replication allows cross-location evaluation to strengthen the generalization of the relationship between dry matter intake and weight gain in Bali cattle. This is in line with the findings of, who stated that large-scale field data are required to develop more accurate DMI prediction models.

3 Result and Discussion

Data analysis showed variations in dry matter intake (DMI) of male Bali cattle raised intensively by smallholder farmers in the Kutai Kartanegara Regency. The average dry matter intake reached 6.2 ± 0.8 kg/head/day, ranging from 5.1 to 7.4 kg/head/day. These values indicate that most cattle receive feed intake according to their physiological needs, although there are variations due to differences in the quality of forage and concentrates provided.

The measurement of average daily gain (ADG) showed an average of 0.48 ± 0.07 kg/head/day. The daily growth pattern was relatively stable, but cattle with a higher dry matter intake exhibited a more consistent increase in ADG. Growth variation was mainly influenced by the availability of concentrates and quality of the local forage.

Table 1. The relationship between dry matter intake (DMI) and average daily gain (ADG) in Bali cattle

No	Cattle Group	DMI (kg/head/day	ADG (kg/head/day)
1.	Low DMI	4.5	0.38
2.	Currently DMI	6.2	0.48
3.	High	7.0	0.57

Three groups of Bali cattle were identified based on the level of dry matter intake (Table 1): low group (5.5 kg/head/day), medium group (6.2 kg/head/day), and high group (7.0 kg/head/day). The average daily weight gain (ADG) in the low group was only 0.38 kg/head/day, increased to 0.48 kg/head/day in the medium group, and reached 0.57 kg/head/day in the high group. These data confirm that an increase in dry matter intake is consistently followed by an increase in daily growth of Bali cattle.

Pearson correlation analysis showed a strong positive relationship between dry matter intake and weight gain in Bali cattle ($r = 0.777$; $p < 0.01$). This relationship indicated that an increase in dry matter intake was directly followed by an increase in body weight. These findings reinforce the empirical evidence that DMI is a determining factor in the growth of beef cattle.

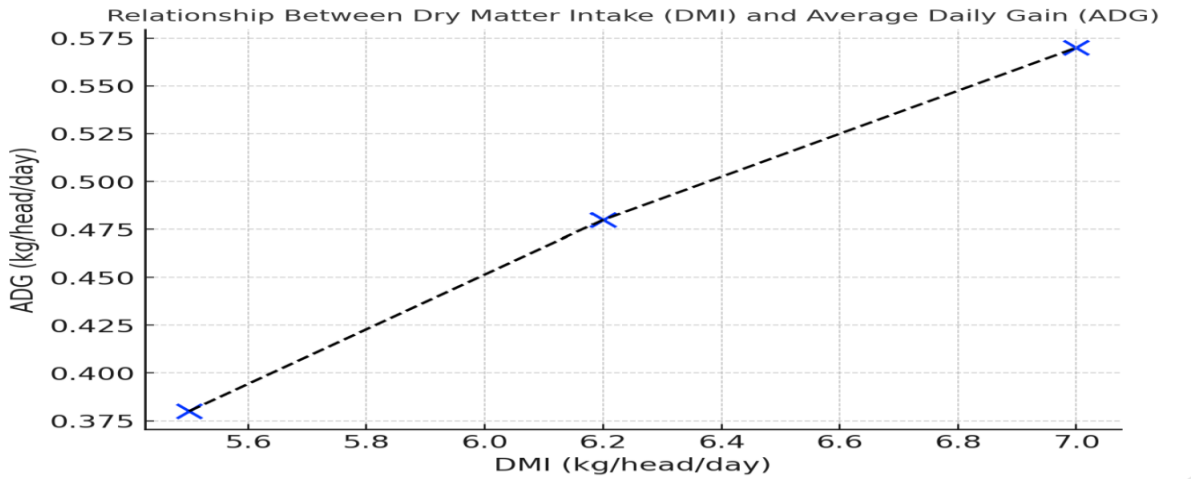

Figure 1. Graph of the relationship between dry matter intake (DMI) and average daily gain (ADG) in Bali cattle

The relationship between the DMI and ADG (Figure 1) showed a clear positive linear pattern. Every increase in dry matter intake of approximately 0.7-0.8 kg/head/day results in an additional increase of approximately 0.1 kg/head/day. The regression trend line confirms the consistency of this relationship; thus, it can be concluded that DMI is a strong determinant variable for the growth performance of Bali cattle.

Scientific interpretation of the positive linear relationship between dry matter intake and body weight gain aligns with ruminant nutrition theory, which identifies DMI as a key factor in providing metabolizable energy and protein. The ADG values of 0.48–0.57 kg/head/day found in the medium and high DMI groups are consistent with the report by [12], which states that local energy supplementation in the rations of Bali cattle can increase ADG up to 0.57 kg/day. The consistency of this pattern indicates that variations in DMI within smallholder farming systems can explain the differences in livestock productivity.

The practical interpretation of these results emphasizes that optimizing dry matter requirements can be a simple, yet effective strategy to increase Bali cattle productivity. Small-scale farmers should pay attention to both the quantity and quality of feed given daily, as well as balance forage and concentrates, to maintain high dry matter intake. Feed strategies based on local resources, such as corn silage or a combination of leucaena and cassava, have been proven to increase the DMI and improve Bali cattle growth [13].

The results of the simple linear regression showed the equation Y= 8.159 + 0.483X, where Y is the body weight gain and X is the dry matter intake. This equation indicates that every additional 1 kg of dry matter intake per animal per day will increase the body weight by approximately 0.48 kg/day. The coefficient of determination (R^2) of 0.60 indicates that 60% of the variation in Bali cattle growth can be explained by variations in dry matter intake, while the remaining 40% is influenced by other factors such as management practices and feed quality.

These findings indicate that groups of cattle with higher dry matter intake exhibited more uniform daily growth, while groups with lower intake tended to show greater variation in growth. This suggests that inconsistencies in feed quality among farmers affect variation in growth performance. The overall results of this study confirm that dry matter intake plays a significant role in determining the growth of Bali cattle under intensive smallholder farming systems. Optimal weight gain can only be achieved if dry matter requirements are consistently met.

The pattern of a positive linear relationship between dry matter intake (DMI) and average daily gain (ADG) is shown in Figure 1. Each increase in DMI resulted in a significant increase in ADG, with an average value of 0.48-0.57 kg/head/day. This relationship is consistent with the findings of Hidayat et al. (2024), who reported that supplementation with cassava-based energy in a leucaena-corn straw ration increased the ADG of male Bali cattle by up to 0.57 kg/day. The graph in this study supports the conclusion that increasing the DMI from high-quality local feed is directly correlated with daily growth.

Studi also shows that the use of complete feed based on corn silage improves digestibility while increasing dry matter intake. The graph from the study shows a trend of increasing ADG approaching 0.55-0.60 kg/day in the group of cattle that received corn silage, similar to the positive linear trend illustrated in Figure 1.

A comparison with the meta-analysis [14] on tropical beef cattle confirmed the consistent pattern that dry matter intake is closely related to growth. The DMI-ADG relationship graph in that meta-analysis shows an almost identical slope, although the average ADG value is higher (0.60-0.65 kg/day) because the cattle studied were commercial Bos indicus breeds with larger body weights. This indicates that even though Bali cattle have smaller body sizes, the biological relationship between DMI and ADG remains consistent.

Abu Tani reported that administering Indonesian herbal mixtures (IHM) to Bali cattle experiencing transportation stress increased DMI and ADG by up to 0.58 kg/day. Their growth chart showed a similar pattern to that of this study, namely that the higher the dry matter intake, the more stable the daily growth. This comparison strengthens the hypothesis that increasing the DMI, either through local feed or herbal additives, is a key factor in improving the performance of Bali cattle.

The overall graphs in the study show a consistent positive linear trend, in line with previous studies. The main contribution of this research is the presentation of empirical evidence based on small-scale farming systems, demonstrating that the DMI-ADG pattern reported in experimental or international studies also applies to smallholder livestock in East Kalimantan.

Research findings indicate that increased dry matter intake (DMI) is positively correlated with average daily gain (ADG) in Bali cattle under smallholder intensive management. This relationship pattern arises because the availability of energy, protein, and other nutrients from the dry matter is the main factor for body tissue deposition. Recent reviews on supplementation technology emphasize that strategies to increase energy and protein in ruminant feed are indeed the most direct levers for growth performance [15].

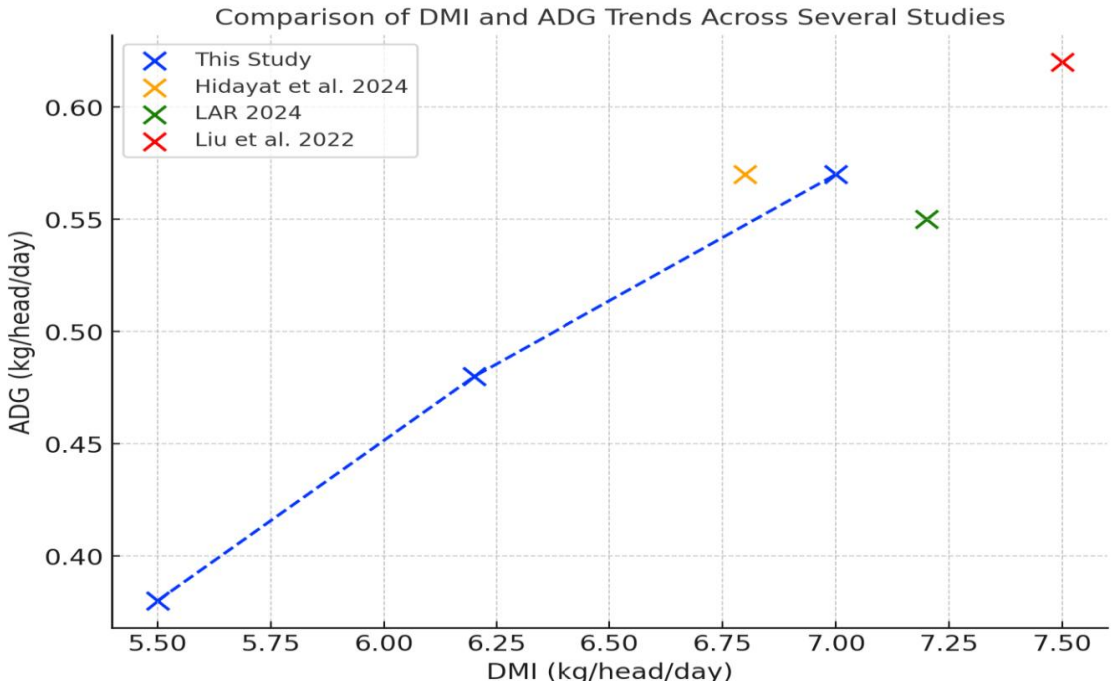

Figure 2. The comparison chart above shows the trend of the DMI-ADG relationship

The results of this study, when compared with those, Wei et al. (2024), and Liu *et al*. (2022), show that all studies display a consistent positive linear pattern: the higher the dry matter intake (DMI), the greater the average daily gain (ADG). The ADG values for Bali cattle in this study (0.38-0.57 kg/head/day) are in line with those reported by Hidayat (2024) and LAR (2024), although they are slightly lower than the meta-analysis by on tropical beef cattle (0.62 kg/head/day).

Comparison of the trend in the relationship between dry matter intake (DMI) and average daily gain (ADG) between the current study (Figure 2) and several previous studies. The graph pattern shows a consistent positive linear relationship in all studies, although there were variations in ADG levels due to differences in livestock conditions and feed formulations. The ADG values in this study (0.38-0.57 kg/head/day) fall within a similar range to the results of Hidayat et al. (2024), who reported an increase in ADG of male Bali cattle up to 0.57 kg/day through energy supplementation based on cassava in a leucaena-corn straw ration. A similar trend was reported by, in which the use of a total mixed ration based on corn silage resulted in an ADG of approximately 0.55 kg/day. Both studies support the finding that increased dry matter intake, particularly through well-formulated local rations, can improve the productivity of Bali cattle.

The meta-analysis by Liu et al. (2022) showed that the average ADG was higher, approximately 0.62 kg/day, in other tropical beef cattle breeds raised under intensive commercial systems. This difference can be explained by the larger body size and higher feed efficiency of Bos indicus cattle than that of smaller-sized Bali cattle. However, the graph still shows a consistent biological trend in that every increase in DMI is always followed by an increase in ADG, both in Bali cattle and other tropical beef cattle breeds.

The visual interpretation of Figure 2 confirms that the results of this study are relevant to the latest literature and enrich empirical evidence from the context of smallholder livestock farming in Indonesia. The fact that the trend of DMI-ADG in smallholder Bali cattle aligns with findings from large-scale experimental studies and international meta-analyses demonstrates the validity of these findings, while also underscoring their contribution to strengthening the foundation of locally based nutritional policies.

A comparison with the research by showed consistent results that supplementation with local energy sources based on cassava or corn flour in leucaena-corn straw rations increased the dry matter intake and improved the ADG of Bali bulls by up to ±0.57 kg/day. These findings are in line with field

research showing that each 1 kg increase in dry matter intake contributes to a body weight gain of approximately 0.48 kg/day.

emphasized that the use of a complete feed based on corn silage improves both the digestibility and growth of male Bali cattle. These results support field data, indicating that increasing DMI is more effective when the feed is formulated uniformly and is palatable, as this maintains rumen pH stability and increases the availability of fermentable carbohydrates.

The discussion also needs to consider the role of feed additives. A meta-analysis conducted by reported that the addition of essential oils tends to increase DMI and ADG, although a systematic review by showed more heterogeneous results owing to the influence of additive type, dosage, and basal diet composition. The results of this study support the view that improving the quality of the basal ratio remains more decisive than relying solely on phytogenic additives.

More specific evidence about Bali cattle was presented by, who found that administering a herbal mixture (Indonesia Herbal Mixture) increased DMI and ADG by up to 0.58 kg/day under transportation stress conditions. Research showed that supplementation with nutrient-rich concentrate accelerated recovery from post-FMD symptoms while normalizing feed intake and improving BCS. Therefore, interventions to increase DMI have strategic value not only for productivity, but also for livestock health resilience.[16]

Environmental and genetic factors also contribute to variations in the outcomes. Research showed that phenotypic plasticity in DMI traits and respiration rate changes according to heat stress; therefore, breeding value rankings may differ between climate conditions. This fact helps explain why the coefficient of determination for the DMI-ADG relationship in field studies is only 60%, as other factors, such as microclimate, animal health, and variations in farm management, also affect performance.[17]

The role of heat stress was further emphasized by Duan et al. (2025), who reported that DMI decreased significantly when beef cattle were exposed to heat stress, although supplementation with electrolytes and anti-stress additives restored feed intake. This finding is consistent with field research, which shows that variation in ADG among farmers is not solely caused by feed quantity but is also influenced by the environmental conditions of livestock management.[18]

Precision technology-based DMI monitoring offers opportunities for more accurate feed management. [19] demonstrated that the use of machine learning with feeding behavior data and environmental variables could predict dry matter intake with a relative error of only approximately 10%. emphasized that the integration of feed-water sensors and body weight data into precision livestock systems can improve nutritional efficiency both at the industrial scale and on small farms.[19]

The contribution of this research lies in providing quantitative empirical evidence of the DMI-ADG relationship in Bali cattle under smallholder farming systems. These results complement the previous literature, which has largely focused on imported cattle or large-scale commercial systems. This finding also strengthens policy recommendations that efforts to improve smallholder cattle productivity should prioritize the use of local resources such as leucaena, corn silage, and cassava by-products, which have been proven to increase DMI. Future research agendas may examine ready-to-use feed packages based on local ingredients, while integrating them with precision monitoring technology to minimize DMI variability due to weather and management factors.[20]

4. Conclusion

The results indicate that dry matter intake (DMI) is closely related to the average daily gain (ADG) of Bali cattle raised intensively in smallholder farming systems. An average DMI of 6.2 kg/head/day yields an ADG of 0.48 kg/head/day, whereas an increase in DMI to 7.0 kg/head/day raises the ADG to 0.57 kg/head/day. Statistical analysis confirmed a strong positive correlation ($r = 0.777$; $p < 0.01$) with the regression equation: $Y = 8.159 + 0.483X$. This pattern is consistent with previous research, both on an experimental scale and in international meta-analyses, further strengthening the validity of the findings.

Research has confirmed that DMI is a determining variable in the productivity of Bali cattle. Variations in growth among farmers are partially influenced by forage quality, concentrate availability,

environmental conditions, and management skills. The main contribution of this study is the provision of empirical evidence based on field data on smallholder farming systems, which has rarely been examined quantitatively. Recommendations

1) For Farmers
a. Meeting the dry matter requirements should be the main focus of feed management.
b. A combination of high-quality forage and local concentrates (such as cassava, bran, or corn) is recommended to maintain a high DMI.
c. Feed conservation practices, such as corn silage and the use of legumes (Leucaena and Gliricidia) can be implemented to ensure year-round feed availability.
2) For Researchers
a. Further studies are needed to test variations in feed formulas based on local ingredients to improve the DMI and ADG.
b. Research can be developed by utilizing precision nutrition technology, such as feed intake sensors and machine learning modeling, to estimate the individual DMI requirements.
c. A long-term evaluation needs to be conducted to assess the impact of increased DMI on the economic efficiency and environmental footprint of smallholder livestock systems.
3) For Policy Makers
a. Development programs for Bali cattle need to incorporate feed management strategies based on DMI as an indicator of productivity.
b. The provision of support in the form of nutrition counseling, assistance with local concentrate feed, and the development of silage processing units will help farmers increase their dry matter intake.
c. The national meat self-sufficiency policy must consider the optimization of the DMI as part of efforts to increase the productivity of local beef cattle.

5. Declarations

5.1 Acknowledgements (Optional)

The authors would like to thank the local farmers in Kutai Kartanegara and the laboratory team at Mulawarman University for their support and assistance in data collection and analysis for this research.

5.2 Author contributions

1. Ika Wahyuningsih, the first author, conducted field data collection and preliminary analysis, and prepared the initial draft of the manuscript.
2. Hamdi Mayulu, as the second author as well as the corresponding author, played a role in designing the study, writing the article, and was responsible for the validity of the data analysis.
3. Both authors have read, reviewed, and approved the final manuscript for publication.

5.3 Ethics

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5.4 Conflict of Interest

The authors declare that there are no conflicts of interest in the research or writing of this article.

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