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Application of Fermented Feed Technology to Improve Beef Cattle Business Efficiency and Student Agribusiness Learning

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Abstract: Feed costs in beef cattle farming can reach more than 60-70% of total production costs. Therefore, feed technology innovation is crucial to improve the efficiency and sustainability of livestock businesses. The objective of this study was to determine the level of adoption of fermented feed technology and how this impacts the efficiency of beef cattle farming. The method used in this research is quantitative descriptive method. The method of determining the research area using purposive method, so that Bontonompo Subdistrict, Gowa Regency was chosen. The method of determining the sample using purposive method, with a total sample of 40 farmers as respondents. Data collection methods used were observation, interview, and questionnaire. The results showed that the level of adoption of fermented feed technology was in the medium to high category. The use of this technology is proven to improve business efficiency, with better livestock yields and lower feed costs. The results show that the adoption of fermented feed technology has a positive and significant effect on beef cattle business efficiency. Fermented feed technology can be an alternative option to increase the productivity of beef cattle farms. This study contributes significantly to improving business efficiency in beef cattle farming through cost-effective feed strategies, while also serving as a practical learning model that enhances the entrepreneurial competence of animal husbandry students. The integration of fermented feed technology into the curriculum supports experiential learning, preparing students to apply sustainable agribusiness innovations in real-world livestock industries.

Keywords: Beef cattle; Business efficiency; Fermented feed; Technology adoption

Introduction

Sustainable farming sytems were agricultural practices that do not harm, create a balance, and work in harmony with nature, which can be realized through four different systems (Salikin, 2011; Rasyid et al., 2024). One of the models that can be used in the implementation of sustainable agriculture is the integrated farming system (Mukhlis et al., 2023).

The integrated farming system, or IFS, is an agricultural approach that merges two or more sectors of agriculture (Channabasavanna et al., 2009; Ugwumba et al., 2010; Jaishankar et al., 2014). This system facilitates connections between different products, promoting a cycle of biological recycling (Prajitno, 2009; Changkid, 2013; Thorat et al., 2015). It relies on minimal external inputs (Devendra, 2011; Nurcholis & Supangkat, 2011; Hilimire, 2011) and maximizes resource efficiency (Bosede, 2010; Balemi, 2012; Soputan, 2012). Various methods are implemented to enhance agricultural output, boost productivity, increase farmers' earnings, and promote sustainability (Gupta et al., 2012;

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Manjunatha et al., 2014; Thorat et al., 2015; Mukhlis et al., 2024). One form of integrated farming system implementation is crop and livestock integrated farming, which is one of the technologies currently being developed in order to sustain crop and livestock production. One form of integrated crop and livestock farming is an integrated farming of rice and beef cattle (Mukhlis et al., 2022).

Beef cattle farming is a strategic sector in national agricultural development because it plays an important role in providing animal protein and a source of income for the community. Gowa District, South Sulawesi, is known as one of the places that produces a lot of beef cattle. But this sector faces many problems to improve production efficiency, mainly due to high production costs, especially feed costs. According to Kusnadi et al (2018), the cost of animal feed can reach more than 60-70% of the production cost of beef cattle. Therefore, feed technology innovation is crucial to improve the efficiency and sustainability of livestock businesses.

Feed fermentation is the result of feed processing with the help of microorganisms such as Lactobacillus spp., Saccharomyces cerevisiae, and Aspergillus niger to increase the digestibility and nutritional content of feed (Sutrisno & Widodo, 2020). Fermented feed becomes higher quality and more efficient for ruminants such as beef cattle because it can break down crude fiber and increase crude protein content (Asikin & Sulistiyono, 2018).

Several studies have shown that fermented feed can increase daily weight gain and reduce feed costs through the utilization of local agricultural waste (Fauzi & Muda, 2020; Yusuf & Roni, 2022). Although fermented feed technology has great potential to increase beef cattle productivity, few farmers in Indonesia, especially in rural areas, use it. Fermented feed technology has not been fully implemented by many farmers, who still use conventional feed methods. Not only a lack of knowledge and skills in making fermented feed, but also limited access to the raw materials required for fermentation are some of the causes of this (Amalyadi et al., 2019).

Fermented feed can increase livestock production, especially daily body weight gain (PBBH) and better feed conversion compared to conventional feed (Yusuf & Roni, 2022). In addition, feed fermentation also helps reduce feed costs because it uses agricultural waste or local green plants as the main raw material (Fauzi & Muda, 2020).

In addition, the application of science in the form of fermented feed technology is also relevant in the context of education and capacity building for livestock students. Through the application of this technology, students not only understand scientific concepts in the classroom, but are also able to apply this knowledge in livestock business practices. This can improve entrepreneurial competence and understanding of the efficiency of sustainable livestock agribusiness (Soekartawi, 2005; Sudiyono, 2016).

The ratio between outputs (meat production, body weight, and income) and inputs (cost of feed, labor, medicine, etc.) used during the production process is called beef cattle farming efficiency. Low production costs and high profits are signs of effective farming (Kusnadi et al., 2018). Inexpensive and highly nutritious feed is essential for improving beef cattle business efficiency. This is because feed is the largest cost component of the business (Prabowo & Susanti, 2016).

Feed costs are often a major obstacle for beef cattle farmers. As a result, economical and sustainable feed management strategies are needed. One way to improve business efficiency is to use fermented feed that is cheap and easy to make. Reproduction, housing management and cattle health care also improve overall efficiency.

Technology adoption refers to the decision-making process undertaken by farmers to accept, try and use innovations regularly in their production systems. The innovation adoption process consists of five stages, according to Rasyid et al. (2016): knowledge, persuasion, decision, implementation, and confirmation.

Factors that influence the level of technology adoption by farmers include the level of education, farming experience, access to information, availability of training, perception of benefits and risks, and institutional support such as extension and technical assistance (Yanuartono et al., 2019). Farmers who have access to training and information are more likely to adopt new technologies, including fermented feed technology.

The objective of this research is to study how the application of fermented feed technology affects the efficiency of beef cattle business in Bontonompo District, Gowa Regency. This research will also investigate the factors that influence the application of the technology and provide an overview of the economic benefits that farmers can obtain from the application of the technology. In addition, this study also aims to analyze the extent to which the adoption of fermented feed technology has an impact on the efficiency of beef cattle business and its potential application as a business learning medium for animal husbandry students.

This research is expected to help farmers, policy makers and related parties in developing more efficient strategies to improve the efficiency and productivity of the livestock sector in Indonesia by knowing how fermented feed technology affects the efficiency of beef cattle business.

Method

Research Approach and Type

The type of research used in this study is explanatory research. The approach used is quantitative research (Sugiyono, 2018), used to investigate how the adoption of fermented feed technology correlates with the efficiency of beef cattle farming.

Location and Time of Research

The location of this research was Bontonompo Subdistrict in Gowa Regency, South Sulawesi Province. The research location was determined using a purposive method with the consideration that one of the areas that has a large beef cattle population and has started the use of fermented feed technology, and the same research has not been conducted at that location. This research was conducted for 2 months starting from February to March 2025.

Sampling Method

Sampling in this study used a purposive method or done intentionally. The sample in this study involved all beef cattle farmers in Bontonompo District. Respondents of cattle farmers in purposive sampling used must meet the following criteria requirements: a) Beef cattle farmers who have been operating for at least the last two years; b) Have used fermented feed in their business. The number of respondents who met these criteria in this study was 40 farmers.

Data Collection Method

The research data used in the study consisted of two types of data, namely: a) Primary data, namely: data obtained directly from farmers through surveys by direct interviews and using questionnaires; b) Secondary data, namely: power sourced from livestock service reports, academic literature, and other related sources.

The data collection methods used in the study include: a) Closed and open questionnaire method used to measure the level of technology adoption and business efficiency indicators; b) structured interview method used to obtain more information and mandala about the experience of farmers in using fermented feed; c) direct observation method used to see how the application of fermented feed technology in the field.

The research variables used in this study consisted of two (2) main variables: a) Independent variable (X): Adoption of feed fermentation technology measured by indicators such as knowledge, skills, attitude towards technology, facilities and infrastructure, and business efficiency; b) Dependent variable (Y): Beef cattle farming business efficiency measured through production costs, net income, feed conversion, and daily body weight gain (PBBH).

Data Analysis Methods

The analysis methods used in the research include: a) Descriptive analysis used to describe the characteristics of respondents and the level of adoption of fermented feed technology (Rianse & Abdi, 2013); b) Pearson Correlation Analysis used to determine how much correlation or relationship between the level of adoption of fermented feed technology to the efficiency of beef cattle farming; c) Simple Linear Regression Analysis used to determine the significant influence between variable X on variable Y.

Result and Discussion

Respondent Characteristics

Age, education level, business scale and farming experience were the metrics measured among 40 beef cattle farmers in Bontonompo sub-district, Gowa district. The following is a summary of the attributes:

Table 1. Respondent Characteristics

Characteristics	Category	Frequency	Percentage (%)
Age	35–45 years	25	62.5
	> 45 years	15	37.5
Last Education	Elementary School	9	22.5
	Yunior High School	19	47.5
	Senior High School	12	30.0
Farming experience	5–10 years	24	60.0
	> 10 years	16	40.0
Business Scale	< 5 tails	14	35.0
	5–10 tails	17	42.5
	> 10 tails	9	22.5

Table 1 shows that the majority of respondents were between 35 and 50 years old, had secondary education (elementary, junior and senior high school). Most of them had more than 10 years of farming and business experience with between 5 and 10 cattle. This indicates that respondents are at a productive age and have sufficient experience and business capacity to manage livestock.

Adoption Level of Fermented Feed Technology

In this study, the adoption of fermented feed technology was measured through the cumulative score of several indicators, namely: 1) Knowledge of fermented feed technology; 2). Views on the use of fermented feed; 3). Ability/skills in making and feeding fermented feed; 4). Ability to gain access to tools and information on the technology.

The level of adoption is divided into three categories: low, medium, and high, based on the tabulated results of 40 respondents. For more details on the distribution of adoption levels, see Table 2 below:

Table 2. Distribution of Adoption Level

Adoption Category	Frequency	Percentage (%)
Low	7	17.5
Medium	20	50.0
High	13	32.5
Total	40	100

Table 2 shows that the results indicate that most of the participants were in the medium category in the level of adoption of feed fermentation technology (50%), and 32.5% of the respondents were in the high category, indicating that they have been actively using fermentation technology in their livestock enterprises. Meanwhile, 17.5% of the respondents were in the low category, indicating that they still lack knowledge, skills, or access to fermentation technology.

There is great potential for the development and dissemination of fermented feed technology in this region, especially if supported by better training programs, extension, and access to facilities. It is shown that the high proportion of respondents in the medium to high category. For more details can be seen in the figure 1.

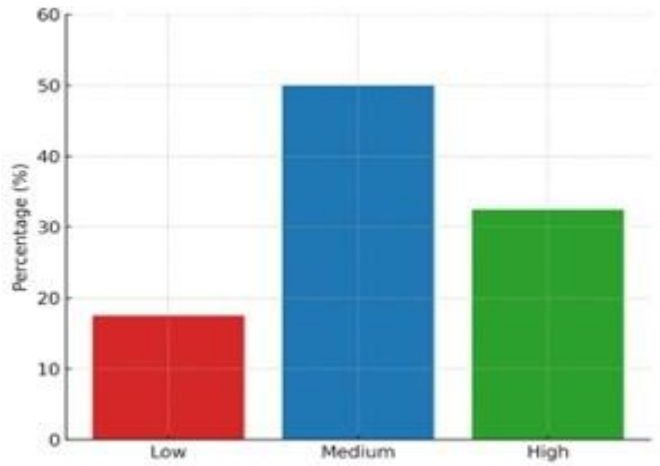

Figure 1. Adoption level of fermented feed technology

Average Adoption Score

Each category is given a score to determine the average position of the adoption level: Low = 1, Medium = 2, and High = 3. The average adoption score can be obtained as follows:

$$\text{Average Adoption Score} = \frac{(7 \times 1)+(20 \times 2)+(13 \times 3)}{40} = \frac{86}{40} = 2{,}15$$

Efficiency Level of Beef Cattle Business

This study also measured the efficiency level of beef cattle through various indicators, including: Livestock productivity, Feed cost reduction, Average daily gain, Capital turnover, and Net profit from business. In addition, business efficiency was categorized into three levels based on the survey results, for more details see Table 3.

Table 3. Efficiency Level of Beef Cattle Business

Adoption Category	Frequency	Percentage (%)
Low	6	15.0%
Medium	18	45.0%
High	16	40.0%
Total	40	100%

Most participants (45.0%) were in the medium efficiency category, indicating that their businesses were profitable but not yet maximized, while 40.0% were in the high category, indicating that their businesses were already running efficiently in terms of costs and yields. Finally, 15 percent of respondents remained in the low category, indicating that there are still inefficiencies, perhaps due to feed management, operational costs, or production yields. For more details can be seen in the figure 2.

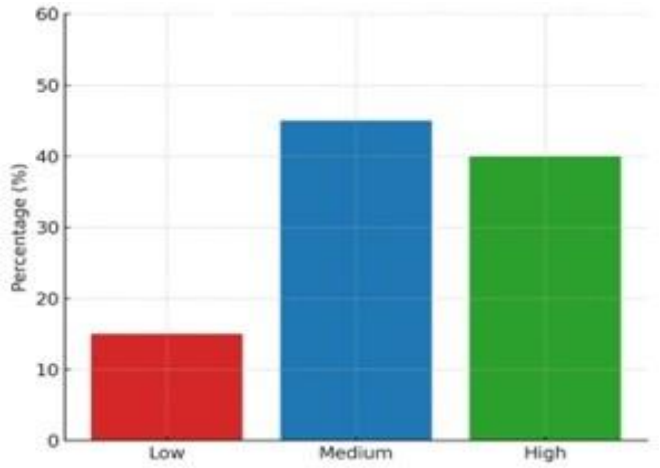

Figure 2. Efficiency level of beef cattle business

Average Business Efficiency Score

As with the adoption variable, each efficiency category is given a score: Low = 1, Medium = 2, and High = 3. The following is the calculation of the average score for business efficiency:

$$\text{Average Efficiency Score} = \frac{(6 \times 1)+(18 \times 2)+(16 \times 3)}{40} = \frac{6+36+48}{40} = \frac{90}{40} = 2{,}25$$

In general, beef cattle enterprises tend to have a high level of efficiency, with an average score of 2.25.

Analysis of the Relationship between the Level of Adoption of Fermented Feed Technology and Beef Cattle Business Efficiency

Pearson correlation analysis was used to determine the extent of the relationship between the level of adoption of fermented feed technology and beef cattle business efficiency. These two variables have been converted into numerical values representing Low, Medium, and High categories, and then evaluated based on each participant's score.

Hypothesis

H_0 (Null hypothesis): There is no significant correlation between beef cattle business efficiency and the level of adoption of fermented feed technology; H_1 (Alternative hypothesis): It is clear that there is a significant correlation between the level of adoption of fermented feed technology and beef cattle business efficiency.

Pearson Correlation Analysis Results

The following correlation values were obtained based on the results of calculations carried out using statistical programs such as SPSS: a) Correlation Coefficient (r) = 0.721; b) Significance value (p-value) = 0.000;

Interpretation: a) A strong positive relationship between the level of adoption of fermented feed technology and beef cattle business efficiency is indicated by the value of r = 0.721; b) significance value p = 0.05. This relationship is considered statistically significant.

Thus, it can be concluded that the adoption of fermented feed technology by farmers is positively correlated with their level of livestock business efficiency.

Simple Linear Regression Analysis, to Determine the Significant Effect of Variable X on Variable Y

To determine the influence between the adoption of fermented feed technology (X) on beef cattle business efficiency (Y), a simple linear regression analysis was conducted. The regression calculation results obtained the following equation:

$$Y = 1.07+0.55\ X \quad (1)$$

Where:
Y : Efficiency of beef cattle business
X : Level of adoption of fermented feed technology
a = 1.07: Constant/intercept
b = 0.55: Regression coefficient

A positive b value indicates a positive relationship between X and Y; in other words, the more farmers use the technology, the more efficient their business becomes.

Interpretation: The regression results indicate that: A one unit increase in technology adoption will increase the livestock efficiency score by 0.55 points; the intercept value of 1.07 indicates that basic efficiency is at the level of 1.07 (low category) when there is no technology adoption at all; There is also a positive regression coefficient value.

The results of this study show that the application of fermented feed technology is very important to improve the efficiency of beef cattle farming businesses. This technology is known to improve feed quality, accelerate the process of livestock growth, and reduce feed costs because it uses local fermented raw materials.

These results are consistent with the diffusion of innovation theory by Rogers (2003), which states that the adoption of new technologies in agriculture and animal husbandry can accelerate productivity and efficiency. The fact that there is a significant positive relationship between technology adoption and business efficiency indicates that farmers in the study area have successfully adopted fermented feed innovations.

Overall, these findings suggest that mentoring, extension, and easy access to technology are essential to ensure that farmers in other areas also benefit from technology. Technology adoption is not just the application of a new tool or technique; it also means that farmers understand, behave and believe in its long-term benefits.

Business Learning for Students

The application of fermented feed technology also reflects the applied science approach in animal husbandry. Fermented feed involves biological and chemical principles in the process of preserving and increasing feed nutrients that can be used as case studies in student learning. Animal husbandry students can be involved in the practice of making, testing, and analyzing the impact of fermented feed on livestock performance, which ultimately forms a comprehensive understanding between theory and field practice (Haryanto & Sutrisno, 2018; Sudiyono, 2016). By involving students in the development and testing of fermented feed, this activity is also a means of scientific data-based business learning.Students can develop micro business models based on fermented feed technology and apply agribusiness management principles, thus producing graduates who are ready to enter the modern livestock industry. This is in line with the needs of vocational and applicative higher education in the field of animal husbandry.

Thus, this research not only contributes to the improvement of beef cattle business efficiency, but also

has direct implications for improving the quality of education and business learning for livestock students.

Conclusion

Based on the research results it can be concluded: Most farmers have used fermented feed technology in the medium to high category. This indicates that this technology has been widely recognized and used by farmers. In addition, there is a positive trend in beef cattle business efficiency; the majority of respondents are in the medium and high categories, indicating improved business performance. The results of simple linear regression analysis show that the adoption of fermented feed technology (X) has a positive and significant effect on beef cattle business efficiency (Y). The regression coefficient of 0.55 indicates that the adoption of technology will increase business efficiency by 0.55 points per point. Fermented feed technology has proven to play an important role in improving beef cattle farm productivity and more efficient feed management.

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Author Contributions
K.A.: Developing ideas, analyzing, writing, reviewing, responding to reviewers' comments; A.H., A.T., S.A, A.J.: analyzing data, overseeing data collection, reviewing scripts, and writing; M.K.: reviewing and writing scripts.

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Conflicts of Interest
The authors declare no conflict of interest.

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