RESEARCH PAPER

Factors Inhibiting the Utilization of Corn Straw Waste as Feed for Beef Cattle

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ABSTRACT
This study aims to identify and analyze the barriers faced by farmers in utilizing corn straw waste as feed for beef cattle. The research was conducted from July to September 2024, with the population consisting of all beef cattle farmers in the area. Samples were randomly selected, including farmers who utilize and those who do not utilize corn straw waste. Primary data were collected through interviews using a structured questionnaire, while secondary data were obtained from relevant institutions. Data was analyzed using the Delphi method to identify inhibiting factors, followed by factor analysis to determine the dominant factors. The results indicate that the main barriers to utilizing corn straw waste include limited storage facilities, inadequate availability and access to processing equipment, low knowledge and technical skills in processing, limited labor availability, and socio-economic constraints. The dominant factors affecting low utilization are the lack of facilities and technical knowledge among farmers. These findings are expected to serve as a basis for local government and related stakeholders to design training programs, extension services, and provision of supporting facilities to enhance the sustainable use of corn straw as a feed resource.
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INTRODUCTION

The beef cattle industry plays an important role in increasing protein intake among Indonesians. The demand for beef continues to increase every year in line with population growth and awareness of protein adequacy, while most beef cattle farming is still carried out traditionally. More than 90% of beef cattle farms in Indonesia are still small-scale, community-based farms with weak capital and are still considered side businesses. However, in terms of consumption share, beef cattle farming has the potential to improve the economic livelihoods of farmers by increasing production to cover the volume of beef cattle imports and their processed products, which reach 600-700 head per year (Rusman et al. 2020).

Meeting feed requirements is one of the key factors in the success of livestock farming, especially beef cattle. The availability of sustainable feed is a challenge, especially during the dry season. One solution to overcome the limitations of forage is to use agricultural waste as alternative feed (Rokhayati, 2024; Rahman et al. 2014). One cheap and abundant alternative to forage is agricultural waste, such as rice and corn straw. Agricultural waste is the part of the plant that remains after the top part has been harvested or taken as the main product. Waste is a by-product of the main product. Agricultural waste can be used as animal feed. Several types of agricultural waste that can be used as feed sources include rice, corn, soybean, peanut, cassava, sweet potato, and other plant waste (Yani, 2011; Nazli et al., 2017).

Rice and corn straw waste, which is abundant during the harvest season, can be converted into high-quality animal feed through simple technological innovations. Rice and corn straw are agricultural wastes that have the potential to be used as feed for ruminants due to their large production throughout the year. In Indonesia, agricultural waste as animal feed is inextricably linked to farming, mainly because most livestock farms are located near agricultural areas (Sudana, 2004). Straw is one type of agricultural waste that has considerable potential for use as a source of fiber for livestock. Corn plants produce abundant straw that has the potential to be used as feed for beef cattle (Liu et al, 2015).

Most farmers in Indonesia provide corn straw in fresh form or directly without any prior treatment or processing. However, when the corn harvest is abundant, it is best to store it for feed stock during the long dry season or when fresh forage is scarce (Hartuatik, 2012). Corn stover production in eastern Indonesia, in addition to being

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provided in fresh form, can be processed into preserved feed such as dried, pellet, or cubed forms and stored as livestock feed reserves (Nulik et al. 2006). Corn stover processing is necessary to ensure continuous feed availability at all times in the form of dried corn stover (hay) or preserved in the form of silage (Hanafi, 2008).

The Mamuju subdistrict in West Sulawesi Province is one of the areas with potential for beef cattle development. This is supported by the fact that the majority of the community's livelihood is corn farming. Agricultural waste in the form of corn straw produced each harvest season should be able to be used as alternative feed, replacing some of the need for forage such as elephant grass and odot, but to date the use of corn straw is still very limited. One of the reasons for this is the low level of knowledge and skills among the community regarding the technology for processing corn straw into animal feed (Churriyahet et al., 2025). Despite its potential and abundant availability, corn straw is classified as low-quality feed due to its high crude fiber content of around 33.58% and low crude protein content of around 5%. In addition, corn stover has low palatability for livestock, so many farmers consider it unsuitable as feed. Therefore, it is necessary to identify the factors that hinder the utilization of corn stover as cattle feed.

METODE PENELITIAN

This research was conducted from July to September 2024 in Mamuju District, Mamuju Regency, West Sulawesi Province. Data collection was carried out through direct fieldwork in the area. The population consisted of 65 farmers/ranchers, who were selected randomly to ensure that everyone had an equal opportunity to participate. Primary and secondary data sources were used in this study. Secondary data came from books, previous research publications, and relevant local government agencies, while primary data came from surveys and interviews.

The data analysis used to determine the obstacles faced by farmers in using corn straw waste as feed for beef cattle is the Delphi method, which aims to collect data and then factor it using the Factor Analysis statistical tool. The Delphi method is used to find out the opinions of farmers, in this case, those who experience obstacles in using corn straw waste as feed for beef cattle. In this way, information is obtained that complements the results of factor analysis.

RESULTS

Factors Hindering the Use of Corn Stalks as Feed for Beef Cattle

Beef cattle, as ruminants, can consume as much as 10 percent of their body weight in forage per day. A 350 kg cow needs to consume 35 kg of grass (forage) every day. This large amount of forage must be available continuously every day. Grass (forage) can be fed to cattle in fresh form or in processed form as hay and silage. Hay is feed derived from dried forage, usually produced when forage production is abundant and can be stored for long periods for use during the dry season when grass (forage) is difficult to obtain. Meanwhile, silage is processed feed derived from forage through an anaerobic preservation process (fermentation), which also increases the digestibility of the feed itself (Syaiful and Nurfitrianti, 2016).

The results of the Delphi analysis show that the use of corn straw waste as cattle feed in Mamuju District is limited by several interrelated factors. These factors include limited storage facilities, inadequate access to feed processing equipment, low levels of technical knowledge among farmers, limited availability of labor, and socio-economic constraints. Similar categories of constraints have been reported in small-scale livestock systems in developing countries (FAO, 2018; Owen et al., 2012).

Limited storage facilities were identified as a major obstacle. Most farmers do not have adequate storage structures to store corn stover after harvest, which leads to a decline in quality and post-harvest losses. This condition reduces farmers' willingness to collect and utilize corn stover as animal feed. According to the FAO (2019), inadequate storage infrastructure is a common constraint in the utilization of crop residues as feed for ruminants, especially in tropical regions.

One of the obstacles faced in implementing silage technology is the limited availability of supporting equipment, particularly the lack of straw choppers. This situation requires participants to chop straw manually, which obviously takes more time and energy, thereby reducing the efficiency of the production process. In addition, although the training succeeded in improving participants' initial understanding, the community still needs further assistance to hone their skills and ensure that silage technology can be applied consistently and independently in the long term. Furthermore, the inadequate availability of processing equipment, such as cutters and silage makers, limits farmers' ability to improve the physical form and nutritional quality of corn straw. Without processing, corn stover remains large in size, low in digestibility, and less acceptable to livestock, which is in line with the findings reported by (Van Soest. 2006) regarding the limitations of unprocessed fibrous crop residues.

The utilization of corn straw by farmers is still low compared to the availability of corn straw. The results of research on corn straw utilization show a figure of 9.09%. The potential for corn stover in Harau District is 62,797.08 BK (tons)/year for mature corn harvests and 1,885.70 BK (tons)/year for young corn harvests. According to (Rochani. 2020), the utilization of corn straw as animal feed can reduce air pollution caused by the burning of corn crop residues in the field and can create a mutually beneficial relationship between agricultural and livestock productivity.

Most farmers in Indonesia provide corn straw in its fresh state or directly without any prior treatment or processing.

However, when the corn harvest season is abundant, it is best to store it for feed stock during the long dry season or when fresh forage is scarce. Chemical treatment using urea (ammoniation) to process straw to improve its quality is very suitable for application in rural areas (Amuda et al. 2017).

The results of the factor analysis show that the identified variables can be grouped into two main factors that explain most of the variation in corn straw utilization. The first main factor relates to facilities and infrastructure, including the availability of storage and access to processing equipment. The second main factor relates to technical knowledge and skills, including farmers' understanding of feed processing techniques, storage methods, and nutrition management.

Other factors, such as labor availability and socioeconomic conditions, were found to have a secondary but still significant influence. Similar findings were reported by (Makkar. 2016), who emphasized that the adoption of technology in the utilization of crop residues is greatly influenced by infr

astructure support and farmers' ability to apply appropriate processing techniques. Dominant Factors Affecting Corn Stalk Utilization

The results of the factor analysis show that the identified variables can be grouped into two dominant factors that explain most of the variation in corn straw utilization. The first dominant factor relates to facilities and infrastructure, including the availability of storage and access to processing equipment. The second dominant factor relates to technical knowledge and skills, including farmers' understanding of feed processing techniques, storage methods, and nutrition management.

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Variable extraction in the study using factor analysis was conducted after grouping the responses to the statements given to respondents through the questionnaire. The grouping of respondents' answers in this study can be seen in Table 1:

Table 1. Respondents' Answers to Variables in Factor Analysis.

No.	Variabel	1	2	3	4	5	Total
1	X1(Limited Knowledge and Information of Farmers/Ranchers)	0	0	4	10	51	65
2	X2(Availability of Technology and Equipment)	0	0	2	21	42	65
3	X3(Economic Aspects and Processing Costs)	0	0	0	28	37	65
4	X4(Extension and Training Support)	0	0	3	21	41	65
5	X5(Habits and Preferences of Farmers/Ranchers)	0	0	1	29	35	65
6	X6(Availability of Labor and Time)	0	2	2	27	34	65

Source: Primary data processed by SPSS, 2025.

First Step Output (Variable Selection)

The initial step in determining the variables to be further extracted can be seen from the KMO MSA, Chi-Square, and Significance values. The requirements or conditions for these values can be seen in Table 2 below.

Table 2. Results of KMO testing Measure of sampling Adequacy (MSA).

First Step Output	**Acquisition Value**	**Terms and Conditions**
KMO MSA	0.577	≥ 0.5
Chi-Square	10.258	≥ 0.5
Significance	0.114	≤ 0.05

Source: Data processed using SPSS 2025.

Table 2 shows that the KMO Measure of Sampling Adequacy (MSA) is 0.577. Because the MSA value is above 0.5, the variable set can be processed further. This is in line with Van Delsen's (2017) opinion, which states that factor analysis is considered feasible if the KMO MSA value is > 0.5, indicating that the sample is suitable for factorization and the factors can be analyzed further.

Next, each variable was analyzed to determine which ones could be processed further and which ones should be excluded. The results of the calculation using SPSS produced a Bartlett Test of Sphericity value of 10.258 with a significance of 0.01. Thus, the Bartlett Test of Sphericity met the requirements because the significance was below 0.05 (5%). Meanwhile, the K-M-O Measure of Sampling Adequacy (MSA) was 0.577. Since the MSA value was above 0.5, the set of variables could be processed further. Next, each variable was analyzed to determine which ones could be processed further and which ones should be excluded.

Anti-Image Matrices

The next step is to see which indicators are suitable for factor analysis. The procedure is that if the MSA value is ≥ 0.5, then the indicator or variable is suitable for use in factor analysis. Anti Image Matrices provide this information to select which variables are suitable. This information is available in Anti Image Correlation marked with an "a" that forms a diagonal line. It can be seen that the MSA value for all variables is above 0.5, so the analysis can proceed (Lingtong et al., 2020).

After the selection process of Anti Image Matrices values that did not meet the requirements for further extraction, particularly in the Anti Image Correlation section, a number of numbers forming a diagonal were observed, marked with "a", indicating the MSA value of a variable with a standard MSA value ≥ 0.5 (Purwaningsih, 2009). For example, the variable of knowledge and information limitations (X1) had an MSA value of 0.555, the variable of technology and equipment availability (X2) had an MSA value of 0.573, the variable of economic aspects and processing costs (X3) had an MSA value of 0.614, and the extension and training support variable (X4) has an MSA value of 0.684. With the MSA values of all variables meeting the specified standard, the extraction process can proceed. The variables that did not meet the requirements with an MSA value < 0.5 were the farmer/rancher habits and preferences variable (X5) with an MSA value of 0.416 and the availability of labor and time variable (X6) with an MSA value of 0.473. Therefore, they could not be included in the next extraction. Thus, from the 6 initial variables analyzed with three repetitions of the analysis, 4 variables that meet the requirements for the factor analysis extraction process are selected.

Total Variance Explained

Total variance explained describes the amount of variance that can be explained by the factors formed. If the total initial eigenvalues ≥ 1, then the factor can explain the variable well and therefore needs to be included in the formation of variables. Conversely, if the initial eigenvalues < 1, the factor cannot explain the variable well and therefore is not included in the formation of variables (Mamahit, et al., 2013).

There are four variables included in the factor analysis. With each variable having a variance of 1, the total variance is . The Total Variance Explained value can be seen in Table 3 below.

Table 3. Results of *Total Variance Explained calculations.*

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.482	37.038	37.038	1.482	37.038	37.038
2	.967	24.176	61.214			
3	.878	21.949	83.163			
4	.673	16.837	100.000			

Source: Data processed using SPSS 2025.

The factor analysis results show that of the four components analyzed, only one main component has an eigenvalue greater than 1, namely the first component with an eigenvalue of 1.482. According to Kaiser's criterion, components or factors that are considered significant and can be retained are those with an eigenvalue > 1, because this value indicates that the component can explain greater variance than one original variable.

This first component explains 37.038% of the total data variance, which means that about one-third of the total information contained in the data can be represented by this single component. Meanwhile, the other three components have eigenvalues below 1 (second component = 0.967; third = 0.878; and fourth = 0.673), so according to the Kaiser approach, they are not considered major factors and are not retained in further interpretation.

Looking at the Cumulative % column in Initial Eigenvalues, the four components together explain 100% of the variance, but since only one component meets the significance criteria, only one factor is extracted. This is confirmed in the Extraction Sums of Squared Loadings section, where only the first component appears with the same value of 1.482 (37.038%).

Thus, it can be concluded that the data structure is quite simple and can be summarized into one main component. Although the information described by this component has not reached 50%, when viewed from a practical approach and based on previous test results (such as Bartlett's Test), factor analysis can still be carried out with acceptable results, especially in exploratory studies.

Matrix Components

Based on the results of the Rotated Component Matrix, it appears that only one main component was successfully extracted from the factor analysis. Therefore, the rotation process cannot be performed. In factor analysis, rotation (such as Varimax, Oblimin, etc.) aims to clarify the factor structure by simplifying the loading patterns between variables on several factors. However, rotation is only relevant and useful when there is more than one component or factor extracted.

Table 4. Results of matrix component calculations.

	Component
Variabel	1
X1	.756
X2	.680
X3	.591
X4	.313

Source: Data processed using SPSS 2025.

Since in this case only one factor meets the criteria (eigenvalue > 1), rotation is not necessary and technically cannot be performed. Thus, interpretation of the results can be focused on the one principal component that has been extracted. Based on the factor analysis results shown in the Component Matrix, it can be seen that variable X1 has a factor loading value of 0.756, X2 of 0.680, and X3 of 0.591. These three variables have loading values above 0.50, which means they have a strong to moderate correlation with the formed component, so it can be said that X1, X2, and X3 are quite representative in explaining this factor. Meanwhile, variable X4 has a loading value of 0.313, which is below the general significance threshold (0.50), so its contribution to the formed factor is relatively low. Thus, the factors resulting from this analysis are more influenced by variables X1, X2, and X3, while X4 does not provide a significant contribution and may be more appropriate if evaluated on other factors through a rotation process or further analysis. This is in line with Baroroh's (2013) opinion, which states that in the context of rotation methods such as Varimax, Oblimin, and others, rotation is used to simplify the factor structure and facilitate interpretation by forming a simple structure. However, if there is only one factor, the concept of a homogeneous simple structure does not apply, so rotation is not applied.

The results of the factor analysis show that the identified variables can be grouped into two dominant factors that explain most of the variation in corn straw utilization. The first dominant factor relates to facilities and infrastructure, including the availability of storage and access to processing equipment. The second dominant factor relates to technical knowledge and skills, including farmers' understanding of feed processing techniques, storage methods, and nutrition management.

Other factors, such as labor availability and socioeconomic conditions, were found to have a secondary but still significant influence. Similar findings were reported by Makkar (2016), who emphasized that the adoption of technology in the utilization of crop residues is greatly influenced by infrastructure support and farmers' ability to apply appropriate processing techniques.

The findings of this study indicate that the low utilization of corn straw waste as cattle feed in Mamuju District is a multidimensional problem involving technical, infrastructural, and socio-economic aspects. Although corn straw is abundantly available due to intensive corn cultivation, its potential contribution to livestock food security has not been optimally utilized, a condition commonly found in small-scale livestock systems globally (Herrero et al., 2013).

Infrastructure constraints emerged as the most significant limiting factor. Inadequate storage facilities limited farmers' ability to store corn stover for use during the dry season, when feed shortages are most severe. FAO (2018) reported that proper storage is a critical prerequisite for the effective utilization of crop residues, as poor storage leads to nutrient loss and reduced feed palatability. Similarly, limited access to processing equipment prevents farmers from applying treatments such as cutting, drying, or acidification, which are known to increase the consumption and digestibility of fibrous feed (Moran, 2005).

Technical knowledge and skills were identified as another dominant barrier. Many farmers lack understanding of proper processing methods and the nutritional benefits associated with processed corn stover. Unprocessed corn stover generally contains high crude fiber and low crude protein, resulting in low digestibility and limited livestock performance (Van Soest, 2006; McDonald et al., 2011). Previous studies have shown that simple treatments, such as acidification or the addition of nitrogen sources, can significantly improve the feed value of corn stover (Khan et al., 2015). However, without effective extension services and training, farmers remain hesitant to adopt these technologies.

Labor availability also plays an important role in shaping farmers' decisions. The process of collecting, transporting, and processing corn stover is labor intensive, which can hinder adoption, especially in households with limited labor resources. These findings are consistent with the research by Owen et al. (2012), which reported that labor constraints often limit the adoption of crop residue-based feeding strategies in mixed crop-livestock systems.

Socio-economic factors, including limited capital and poor access to information, further exacerbate these challenges. Farmers with limited financial resources tend to invest less in processing equipment or storage facilities, especially when the economic benefits are not immediately apparent. According to Herrero et al. (2013), socio-economic conditions significantly influence farmers' ability to adopt innovations related to feed resource management. This highlights the need for institutional support through extension programs, farmer group empowerment, and access to affordable technology.

Overall, the results of the study show that the effective utilization of crop residues as animal feed requires an integrated approach that addresses infrastructure, knowledge, and socio-economic constraints simultaneously. Improving access to processing technology, strengthening extension services, and promoting collective feed management systems can significantly increase the utilization of corn stover as a sustainable feed source. Such interventions are expected to increase feed availability, reduce seasonal feed shortages, and support the long-term sustainability of beef cattle production systems in Mamuju District.

CONCLUSION

The main obstacles faced by farmers include a lack of knowledge and technical skills in waste processing, limited equipment and storage facilities, difficult access to transportation, and socioeconomic factors such as labor availability and the ability to pay labor wages. The analysis shows that factors such as the availability of warehouses, processing equipment, maintenance systems, and waste processing skills are the main determinants that hinder the utilization of corn straw waste by cattle farmers. The involvement of extension workers, farmer organizations, and government support is also still considered inadequate in encouraging the adoption of this waste utilization technology. In terms of the obstacles faced by farmers/ranchers in utilizing corn straw waste as cattle feed in Mamuju District, there are several areas that need improvement, namely Integrated Counseling and Training: Local governments and related services need to increase the frequency and quality of counseling and technical training for farmers on methods of processing corn straw waste into nutritious feed such as hay, silage, and fermentation. Provision of Facilities and Infrastructure: Support in the form of cutting tools, storage warehouses, and adequate transportation is needed to facilitate farmers in processing and transporting corn straw. Government Incentives and Subsidies: The provision of incentives, agricultural equipment subsidies, or small business capital can be a trigger for farmers to be more active in utilizing agricultural waste. Crop-Livestock Integration: The crop-livestock integration approach needs to be applied more widely by involving all stakeholders to improve the efficiency and sustainability of community agriculture and livestock businesses.

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CONFLICT OF INTEREST

"The authors declare no conflict of interest"

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