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Crop Residue Production and Milk Output Level Among Livestock Enterprises in Mubi South Local Government Area, Adamawa State, Nigeria.

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Abstract

This study investigates the effect of crop residue production on milk output among livestock enterprises in Mubi South Local Government Area, Adamawa State, Nigeria. Recognizing the global significance of dairy production for food security and livelihoods, the research specifically assesses how the quantity, frequency of availability, and nutritional quality of crop residues used as livestock feed influence milk yield. The study tests three hypotheses. Employing a quantitative survey design, data were collected via structured questionnaires administered to 150 livestock dealers, with a sample size determined using Cochran's formula. Data analysis incorporated descriptive statistics and regression models to examine effect of crop residue attributes on milk production. Reliability of the instruments was confirmed through Cronbach's Alpha scores exceeding the 0.7 threshold. Findings reveal moderate to high agreement among respondents on variability in crop residue supply and quality, with significant seasonal fluctuations and periods of scarcity affecting feed consistency. Regression analyses demonstrate strong positive effects of crop residue quantity (R^2=0.903), frequency of availability (R^2=0.897), and nutritional quality (R^2=0.971) on milk output, each statistically significant ($p < 0.001$), leading to rejection of all null hypotheses. The study concludes that optimizing crop residue management, including enhanced collection, storage, and nutritional evaluation, is pivotal for improving milk production sustainability in the study area. Based on these findings, the study therefore, recommends improving residue storage techniques to buffer seasonal fluctuations, increasing feed availability reliability, and prioritizing nutritional quality assessment to maximize milk productivity.

Keywords: Crop residue production, Livestock enterprises, Livestock feed, Nutritional quality, Milk output.

Introduction

Globally, dairy production contributes to food and nutrition and livelihoods of millions of households, most of which are in developing countries (FAO, 2021). Increased demand for dairy products has led to the intensification of dairy production in order to meet this demand for food security and economic value (Kumar et al., 2021). Milk yield in livestock systems is affected by various factors such as genetics, animal health, management system, but also on feed quantity and quality (Akintan et al., 2025). Feed represents the most significant expense in any livestock operation and directly influences the amount of milk produced. Hence, the understanding of factors that regulate the quality and availability of feed to the animals are crucial in optimizing milk production.

Crop residues (such as maize stover, sorghum straws, groundnut haulms, and cowpea residues) are the part of the harvested crops that remain after harvesting, and are often used as a significant feed resource in livestock feeding systems especially in situation of feed shortage in tropical and semi-arid regions (Shah et al., 2025). Utilizing crop residues for feed, is one of the globally recommended approaches to improve ruminant nutrition and ultimately milk yield (El-Shater & Yigezu, 2021). The amount of crop residue produced is dependent on size and type of crops planted which varies by agro ecological zone and farming system (Mugabe et al., 2023). Adequate production of crop residue allows consistent supply of feed to the animals thus maintaining the levels of milk production. However, fluctuating seasonal production of residues results in inconsistent frequency of feeding the crop residues to the animals and thus this affects the milk yield (Reproto et al., 2024).

The nutritional quality of the crop residue, such as crude protein, energy, digestibility, is a major factor in its value to support lactation in animals (Aquino et al., (2024). Generally, crop residue is low in nutrient value due to high fibre content and low protein content and it therefore contributes negligibly to milk production if it is not supplemented or treated (Dejene et al., 2024). Several methods for treating and supplementing crop residues has been developed to enhance the nutritional value for milk production, and more localized research into this area would be needed to make such methods more efficient (Aquino, et al., 2024). Integration of crop residues quality management into feed systems in livestock development is therefore very critical.

In Mubi South Local Government Area of Adamawa State, Nigeria the production of crop residue and its effect on milk yield in livestock is important. The production systems in Mubi South are characterized as mixed cropper-pastoralists in which crop residues serve as a very significant supplement feed resource during the dry season when pasture is scarce (Gunawan et al., 2023). The amount, availability frequency and nutritional quality of crop residues determine livestock performance, particularly the volume of milk produced in the systems. However, to date, local data quantifying the contribution of crop residues to milk yield have been minimal, therefore this study addresses the effect of quantity, frequency of availability, and quality of crop residues on milk yield in livestock enterprises in Mubi South.

Statement of the Problem

The production level of milk by livestock enterprises is an important determinant of both productivity and income from the livestock industry. In Mubi South Local Government Area, Adamawa State, Nigeria, milk production constitutes an important source of nutrition and livelihood. Currently, production level of milk is far from the national standard, where the average production rate for lactating animal was around 20% below the optimum level estimated in comparable agro-ecological areas (FAO, 2021). Sub-optimal milk production is detrimental to the profitability and long-term viability of livestock businesses, hindering economic development at the rural level in the area.

Identifying determinants that affect milk production level, therefore, is important for designing intervention measures that enhance production levels. Among those determinants is crop residue, especially crop residue quantity, availability and nutritional quality, which play significant role due to the common system of mixed crop-livestock production in the locality (Ishiaku et al., 2023). In view of this crop residue production quantity, frequency and nutritional quality can be related to milk production level of livestock enterprises. Though crop residue has been recognized as an alternative feeds supplement to livestock during dry seasons particularly in this study area, recent studies have found inconsistency in terms of crop residue production volume and feed quality of crop residue in Mubi South due to differences in the cropping system and crop residue management as well as climatic variations (Ja'afar-Furo et al., 2021; Adamawa Investment Promotion Agency, 2025). Inconsistent availability of crop residue in term of timely basis does not allow continuous feeding regime and therefore leads to nutritional deficiency for the animals (Kubkomawa et al., 2017). There is scarce empirical study that quantifying the effects of crop residue production components, such as volume, availability and nutritional value, to milk yield at Mubi South Local Government Area so as to formulate suitable strategy for livestock producers. This study therefore set out to address this gap by systematically investigating how different dimensions of Crop Residue production affect Milk output level among livestock enterprises in Mubi South Local Government Area, Adamawa State, Nigeria, and the specific objectives were to:

1. evaluate the effect of the quantity of crop residues produced on the milk output levels among livestock enterprises in Mubi South Local Government Area, Adamawa State, Nigeria.
2. assess how the frequency of availability of crop residues as livestock feed influences milk production levels in the study area.
3. analyze the effect of the quality or nutritional content of crop residues on milk yield among livestock enterprises in the specified locality.

Research Hypotheses

H0[1]: There is no significant effect of the quantity of crop residues generated on milk output levels among livestock enterprises in Mubi South Local Government Area.

H0[2]: The frequency of availability of crop residues as feed does not significantly affect milk production levels among livestock enterprises.

H0[3]: The quality or nutritional content of crop residues has no significant effect on milk yield among livestock enterprises in the study area.

Literature Review

Milk Output Level among Livestock Enterprises

The concept of Milk Output Level among Livestock Enterprises refers to the quantitative representation of the milk generated from dairy animals subjected to different farming conditions and management practices. According to Akintan et al. (2025), milk output level is the cumulative output of a herd over time, determined by the genetic merit of the animals and the efficiency of management interventions. Although this conceptualization captures the synergy between inherent animal biology and external factors, it fails to incorporate the impact of the external environment. Aquino et al. (2024) also conceives of milk output level as an index of production performance measured as average milk yield per dairy cow, modified by feed standards, health conditions, and season; hence, a broader range of operational factors is accounted for. This interpretation appears to offer a more holistic understanding of production as it considers modifiable factors influencing output. However, from an economic perspective, Mwanibanza et al. (2026) understand the milk output level as the economically performative milk generated from the enterprise that can be sold after deducting feed for animals, for on- farm usage, or lost. While this understanding integrates a vital economic aspect, it may obscure the biological process of milk generation due to the economic perspective.

Hence, in this study, the concept of Milk Output Level among Livestock Enterprises is hereby operationalized as the average amount of total milk yield of a lactating animal within an enterprise during a standard lactation period after controlling for inputs in management and environment dimensions.

Crop Residue Production

Crop Residue Production refers to the output of unused or leftover plant materials that are generated after harvesting of the main agricultural products or crops. Over time, several researchers have defined this concept in varied perspectives. Dejene et al. (2024) defined crop residue production as the sum amount of plant materials (biomass) left in the agricultural fields following the harvest of the principal agricultural outputs. Similarly, Duncan et al. (2016) regarded crop residue production as the total volume of stalks, leaves, husks and other crop materials left in the agricultural lands following harvest of main crop product, which can be utilized for soil fertility management or energy generation. Furthermore, Mwanibanza et al. (2026) conceived of crop residue production in general terms as any agricultural biomass

produced in excess of the quantity harvested and utilized for specific purpose such as sustainable agricultural production and industrial utilization.

Critical appraisal of these definitions points to their different emphasis. The definition given by Dejene et al. (2024) focuses on total biomass and quantitative aspect but the utilizations are not highlighted. The definition of Duncan et al. (2016) also includes components like stalks, leaves and husks and its utilizes such as soil fertility and energy generation, is added to the definition. The definition by Mwanibanza et al. (2026) includes sustainability and industrial potential also. This study therefore, operationalized the definition of crop residue production as 'the total amount of biomass in the form of stalk, leaves, husk and other plant parts which remain in the agricultural fields after the harvest of the main agricultural produce and this is quantifiable and applicable for improving the agricultural soils, soil fertility and its usage for generation of bioenergy.' This definition covers the components, their source, their leaving behind after harvesting, and most important, their quantification and its future uses which is aligned with the objective of this study.

Quantity of Crop Residues Generated

Quantity of crop residues generated is defined as the quantity of post-harvest residual crop biomass that is generated. El-Shater and Yigezu (2021) defines crop residues as plant residues including stalks, leaves, and chaff that remain in the field after harvest and suggests its use for conservation of soil. Although his definition provides context for the material in question and implies a benefit, it does not offer quantification in quantitative terms. A similar definition from Matiri et al. (2013) states crop residue quantity as the total dry matter weight of crop components remaining in the field after harvest, this definition emphasizes use of dry matter weights to quantify soil organic matter inputs. In an application context Blanco-Canqui and Lal (2009) refer to quantity of crop residue as mass per unit area of crop residue which affects cycling of nutrients and structure of soil.

From the above discussion, El-Shater and Yigezu (2021) gives a broad, subjective measure and may not be suitable for an objective measure. The definition by Matiri et al. (2013) gives a good qualitative quantitative measure of crop residue quantity (dry matter) to be measured for analysis on organic matter contribution. Blanco-Canqui and Lal (2009) integrate the contribution of residue to the ecosystem, in which this measure is used in soil function analysis. Therefore, Quantity of Crop Residues Generated is the total dry matter mass (kg/ha) of all above-ground crop residue in the field immediately after crop harvest.

Frequency of Crop Residue Availability for Livestock Feed

Singh et al. (2018) define frequency of availability of crop residues for feed as how often crop harvest residues are available over a period of time or agricultural year. Another study defined crop residue availability for livestock feeding based on timing of residue generation. Mkwambisi et al. (2020) define frequency of crop residue availability as "the frequency and predictability of supply of residues from agricultural crops". Reproto et al. (2024) suggest the frequency of

availability "as the mean time interval between harvests generating a sufficient biomass residues for animal consumption".

From the definitions analyzed above, while that of Singh et al. (2018) provide an element of timing, it does not define quantity. Mkwambisi et al. (2020) include predictability of availability, which is of significance but may also be constrained by variability of crops or environmental effects. Reproto et al. (2024) provide a concrete quantitative indicator, but may overlook quality of residues or any fluctuation of the quantities. This study therefore, adopt an integrated operational definition for crop residue availability for livestock feed as the intervals within a crop cycle where available quantities of crop residues of viable quality are periodically available to meet feed requirements of livestock.

Quality or Nutritional Content of Crop Residues

The idea of quality or nutritional content of the crop residues for crop residues utilization for the purpose of feeding livestock and for use in improving the soil quality is of paramount importance. Balehegn et al. (2020) described crop residue quality as amount of digestible nutrients in proportion of readily available nutrients to the ruminant based on crude protein and fiber content. Thus, nutritional content of the residues to an animal nutrition view is of prime importance in this definition. Whereas, Baleseng et al. (2023) define the quality of the residues as their chemical and organoleptic quality and states that residues of higher nutrient content and low in lignin have better quality and will promote higher intake. Another definition by Reproto et al. (2024) of quality takes a more inclusive and wider aspect as both nutrients and the decomposition of the residue and its effect on soil organic matter.

However, for this study the most suitable operational definition to define the crop residues quality, to evaluate the use of residues as feed of ruminants was taken based on the definition by Balehegn et al. (2020), who has the most concise and specific definition of nutritive value to be directly applied on this study for residue based animal nutrition. Therefore crop residues quality is considered as concentration and digestibility of nutrients in particular crude protein and fiber fractions.

Conceptual Framework

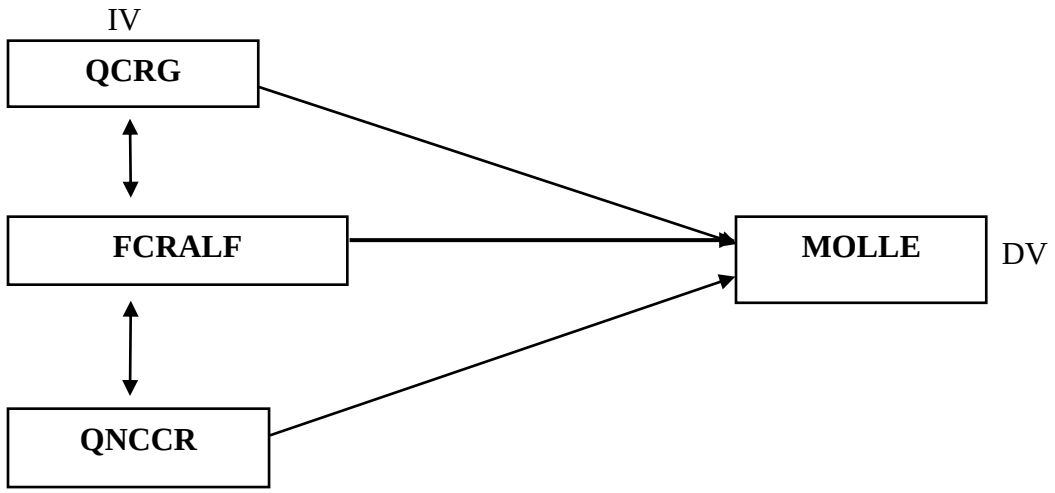

Fig. 1: A Schematic of Conceptual Framework by the Researcher

Empirical Review

In a study conducted by Habib et al. (2016) evaluates the feed supply and demand dynamics for livestock in Pakistan at a national level. The study determined the availability of feed ingredients through analysis of official crop production data, utilizing published harvest indices and extraction ratios, while nutrient supply estimates were derived from local feed composition tables. The findings indicated a significant shortfall in local feed resources needed for livestock and poultry, revealing supply-demand discrepancies of 19.4% for dry biomass, 37.2% for crude protein (CP), and 38.0% for metabolizable energy (ME). The primary feed source was identified as crop residues, accounting for 58.8% of the total feed supply, whereas fodder and grazing to contributed 23.8% and 9.2%, respectively. Additionally, grains and by-products made up 8.2% of the feed supply. In order to address these deficiencies, substantial imports of oilseed meals were made, primarily to support the poultry sector. Notably, maize emerged as the main contributor to poultry and ruminant diets, with these sectors collectively utilizing 79% of the total maize production in the country.

Another study conducted by Gashaw and Defar (2017) in Gasera and Ginnir districts located in the mid to highland regions of the Oromia regional state in southeast Ethiopia, the researchers sought to evaluate livestock feed resources, assess major nutritional values of these feeds, and explore their implications for animal productivity. Findings indicated that the livestock production systems in these districts are of an extensive nature. The annual metabolizable energy (ME) derived from the main roughage feeds was calculated to be 956,094.71 MJ in Gasera district and 980,392.51 MJ in Ginnir district. Roughage feeds, particularly various crop residues (such as aftermath, barley straw, wheat straw, and teff straw), constituted approximately 80.4% and 81.73% of the total annual ME supply in Gasera and Ginnir, respectively, with the remainder sourced from natural grasses. The digestible crude protein (DCP) levels observed in

the sampled feeds were statistically similar across the study districts ($P > 0.05$). Comparatively, crude protein (CP) content and in vitro dry matter digestibility (IVDMD) were significantly greater ($P < 0.05$) in feeds derived from natural grasses than in those from crop residues and aftermath. Conversely, the concentrations of neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were significantly elevated ($P < 0.05$) in crop residues and aftermath. The mean crude protein levels in these residues were found to fall below the critical threshold of 7% dry matter necessary for the optimal operation of rumen microbes, indicating a need for supplementation. Furthermore, while the dry matter availability from major feed sources apparently meets the maintenance requirements of bovines, the inherent bulk of these feeds does not accurately reflect the qualitative aspects of the nutrients they contain.

In a separate investigation, Salo (2017) focused on the estimation of livestock feed and fodder resources in Ethiopia, particularly addressing strategies for mitigating feed shortages which are a significant barrier to cattle production. The primary feed resources identified for cattle included natural pastures, crop residues, crop aftermath, and non-conventional feed options. However, the available animal feed only meets 63% of the national demand. The suggested strategies to combat feed scarcity encompass the usage of fodder trees, integrating forage production into the crop farming system, sustainably conserving hay and crop residues during surplus periods, enhancing proper storage methods, and effective utilization of available feed resources.

The study by Reproto et al. (2024) examined the availability, utilization, and nutrient contributions of feed resources for dairy farmers in the provinces of Batangas and Cavite in the Philippines. The study highlighted that dairy buffalo production in the Region 4A is significantly hindered by the scarcity and inadequate quality of feed resources. The objectives were to evaluate the available feed resources to dairy farmers, analyze their utilization, and assess the nutritional contributions to livestock production, alongside identifying perceived limitations and potential solutions for feed-related challenges. Findings indicated a prevalent integration of crop-livestock systems, with significant feed resources comprising purchased feeds, natural pastures, crop residues, and agro-industrial by-products. Notably, purchased feeds were responsible for over 30% of the nutrient needs, while natural grazing fulfilled more than 60% of the requirements for dairy buffalo. Identified constraints included high commercial feed prices, seasonal shortages, limited land availability, and health concerns.

Kaur, Kataria, and Kaur (2024) also conducted an assessment of livestock feed and fodder resources in the Central Zone of Punjab, focusing on the Ludhiana district. The study used primary data from 90 farmers of varying landholdings to estimate available feed and fodder resources. When compared to the normative requirement of 4.02 kg of dry matter, data indicated that a majority of farmers across all land size categories reported sufficient status in the rainy season (83.3%), reduced to 63.3% in the winter, and a significant drop to 44.4% in the summer. This suggests that a notable proportion, specifically 56%, lacked adequate dry matter availability during the summer months. The observed roughage to concentrate ratios across the three seasons were summer (68.9:31.1), rainy (79.3:20.7), and winter (72.1:27.9), contrasting with the standard ratio of 67:33. Overall, 94.7% of large farmers, 88.5% of medium farmers, and 73.1% of small farmers achieved adequate total dry matter intake. The results highlight that Punjab is relatively

fortunate regarding overall dry matter availability, likely due to heightened awareness of feed and fodder's significance in enhancing livestock productivity. Nonetheless, the nutritionally inadequate dry matter intake from green fodder during lean seasons signals the necessity for improved land resource management practices and careful selection of fodder crops to ensure continual access to green fodder throughout the year.

Furthermore, Mwanibanza et al. (2026) examined the impact of crop residues on both milk yield and methane emissions in dairy cows, particularly in Arusha City. The research indicated that smallholder dairy farms in urban settings increasingly integrate crop residues into their livestock diet. The study highlighted that the quality of these feed materials significantly affects both productivity and methane emissions from dairy cows. Investigating the effects of crop residue supplements on methane outputs from lactating cows, the study monitored sixty crossbred lactating cows over a span of ninety days, encompassing three cycles of on-farm visits with a 30-day interval for each cycle. Feed intake was rigorously tracked during the final 30 days of the investigation, allowing for precise calculations of the amount consumed versus refused. The dietary treatments were categorized based on the type of crop residues used (GM - grass mixture; MSM - maize stover mixture; RSM - rice straw mixture; BRM - bean residues mixture). Methane emissions were directly measured from the nasal passages of the lactating cows utilizing a laser methane detector (LMD) methodology. Measurements of body weight and milk samples coincided with methane assessments. The data analysis was performed using JMP® Pro 18 software, version 2024, under the SAS framework. Performance results indicated that cows receiving BRM showed superior milk yield (14.5 liters per day) and body weight gains (0.928 kg per day) in conjunction with reduced methane concentrations (14.072 and 72.75 ppm) in comparison to other treatments, at a significance level of $P<0.05$. The conclusion drawn from this study suggests that the utilization of bean residues improves cattle diets, enhances animal productivity, and lowers methane emissions, thus advocating for further exploratory studies on the outcomes of feeding dairy cows crop residues treated with additives and enzymes to optimize productivity and mitigate methane emissions.

Theoretical Framework: Resource-Based View (RBV)

The Resource-Based View (RBV) theory, was propounded by Barney in 1991. RBV posits that firms or enterprises attain sustained competitive advantage by effectively utilizing valuable, rare, inimitable, and non-substitutable resources (Barney, 1991 as cited by Ibrahim & Aliyu (2020). In the context of agricultural enterprises, such as livestock production in Mubi South Local Government Area, Adamawa State, Nigeria, crop residues represent a critical resource that can enhance milk output levels. This theoretical lens enables scholars to analyze how the availability and management of crop residues as feed inputs influence production efficiency and sustainability within livestock enterprises (Ibrahim & Aliyu (2020).

Applying RBV to the study of crop residue production on milk output underscores the significance of the resource's characteristics in driving livestock productivity. Crop residues are not merely by-products but constitute integral feed resources that potentially improve milk yield by supplementing the nutritional requirements of dairy animals (Patil et al., 2021). The efficient

exploitation of this resource aligns with RBV's emphasis on leveraging unique internal assets to achieve better performance outcomes compared to competitors who lack access or capability to utilize such inputs effectively. Consequently, the research can elucidate how differing levels of crop residue utilization influence milk production, thereby illuminating pathways to optimize resource management within livestock enterprises in the region (Ibrahim & Aliyu, 2020).

The RBV's relevance to this agricultural study is multifaceted. Firstly, it facilitates an understanding of how endogenous resources like crop residues confer competitive advantages to livestock farmers through enhanced milk production and economic returns (Chukwu & Ibrahim, 2023). Secondly, it encourages policymakers and practitioners to focus on resource development strategies that improve the quality and quantity of crop residues, thereby fostering sustainable livestock farming systems. Lastly, by framing the analysis within RBV, the research contributes to the broader discourse on resource optimization in small-scale agricultural enterprises, highlighting the need for targeted interventions and capacity building to maximize the utility of locally available inputs (Ishiaku et al., 2023). Thus, the RBV offers a robust analytical tool to examine the nexus between crop residue utilization and milk output levels, driving both theoretical and practical insights in agricultural resource management.

Methodology

This study employed a survey research design. Given the lack of precise information on the population size of livestock dealers at Mubi Market, the researcher utilized Cochran's Sample Size Formula ($n_0 = Z^2 \cdot p \cdot (1 - p) / e^2$) to calculate an appropriate sample size, resulting in 150 respondents. This quantitative approach allowed the researcher to systematically gather and analyze data pertinent to the research objectives (Kaur, et al. (2024). Data collection was achieved through structured questionnaires, which were administered directly to livestock dealers operating within the market. These questionnaires were designed to capture detailed information regarding the quantity, frequency, and quality of crop residues used as livestock feed, as well as corresponding milk production levels. For data analysis, both descriptive and inferential statistical techniques were applied to rigorously examine the effect of crop residue attributes on milk output. Descriptive statistics, including measures of central tendency such as mean and dispersion like standard deviation, were used to summarize and describe the dataset effectively. Subsequently, regression analysis was employed as the primary inferential statistical method to evaluate the hypotheses and determine the extent to which variables such as crop residue quantity, availability frequency, and nutritional quality influenced milk yield.

Model specification

$$\mathbf{Y = \beta 0 + \beta 1 x1 + \beta 2 x2 + \beta 3 x3 + \varepsilon}$$

Where:

Y = Milk Output Level among Livestock Enterprises (MOLLE)
X1 = Quantity of Crop Residues Generated (QCRG)
X2 = Frequency of Crop Residue Availability for Livestock Feed (FCRALF)
X3 = Quality or Nutritional Content of Crop Residues (QNCCR)
β0 – β3 = Constant **ε =** Error term

Reliability of Research Instrument

The study employed Cronbach's Alpha to assess the reliability of instruments measuring the quantity, frequency of availability, and nutritional quality of crop residues affecting milk output among livestock enterprises in Mubi South Local Government Area. A coefficient alpha threshold of 0.7 was set to ensure internal consistency, indicating reliable measurement. The questionnaire was adapted from validated sources (Adegoke & Abioye, 2016; Kaur, et al., 2024) relevant to the study. Data analysis and hypothesis testing were conducted using SPSS to evaluate the effects of crop residue factors on milk production levels

Analysis and Results

Out of the 150 questionnaires administered, all were completed and returned.

Table 1: Questionnaires Response Rate

Questionnaires Distributed	150
Questionnaires Returned	150
Not useable	0
Usable Questionnaires	150
Percentage of usable questionnaires.	100%

Source: Researcher's Computation, 2026

Based on Table 1, it can be concluded that 150 questionnaire sheets were distributed and retrieved. With that said, it can be asserted that the questionnaire has a 100% response rate, which means that the respondents were cooperative, and the information retrieved from the questionnaire is sufficient and can be used for analysis.

Table 2: Descriptive Statistics on Quantity of Crop Residues Generated (QCRG)

N = 150

Statement	Percentage					Mean	Std. Deviation
	SA	A	I	D	SD		
The volume of crop residues produced annually from farms is sufficient to meet livestock feed requirements.	30.7	29.3	2.7	16.7	20.7	2.67	1.557
Crop residue yield fluctuates significantly depending on seasonal factors.	40.7	41.3	8.0	8.7	1.3	1.89	0.973
Crop residue production has increased over the past three years on farms.	26.0	34.0	8.0	16.7	15.3	2.61	1.423
Livestock dealers collect and store adequate amounts of crop residues for year-round livestock feeding.	28.0	26.7	7.3	15.3	22.7	2.78	1.554

Composite Mean = 2.48

Composite Standard Deviation = 1.37

Source: Field Survey, August 2026

The data presented in Table 2 offers a quantitative overview related to the effect of crop residue quantities on milk production within livestock enterprises in Mubi South LGA. The composite mean score (2.48) and standard deviation (1.37) indicate moderate agreement among respondents regarding the sufficiency and variability of crop residues for livestock feeding. Notably, a majority acknowledges significant seasonal fluctuations (mean = 1.89), suggesting variability in residue availability. However, perceptions about the adequacy of annual production for livestock needs (mean = 2.67) and year-round collection and storage (mean = 2.78) show more divergence, as reflected in higher standard deviations. The slight increase in residue production over three years (mean = 2.61) may hint at gradual improvements but is not robust. Overall, the data imply that inconsistencies in crop residue supply likely influence milk output variability among livestock enterprises in Mubi South LGA.

Table 3: Descriptive Statistics on Frequency of Crop Residue Availability for Livestock Feed (FCRALF)

N = 150							
Statement	**Percentage**					**Mean**	**Std. Deviation**
	SA	A	I	D	SD		
Crop residues are consistently available throughout the year for our livestock.	20.0	37.3	5.3	22.0	15.3	2.75	1.400
There are periods when crop residues are scarce, adversely affecting livestock feeding.	33.3	40.0	8.7	14.0	4.0	2.15	1.151
Livestock farmers frequently supplement livestock feed due to inconsistent availability of crop residues.	27.3	12.0	40.7	12.7	7.3	2.61	1.220
The timing of crop residue availability aligns well with the nutritional needs of our livestock.	14.0	29.3	12.0	32.7	12.0	2.99	1.293
Composite Mean = 2.71							
Composite Standard Deviation = 1.26							

Source: Field Survey, August 2026

The data in Table 3 examines the influence of the frequency of crop residue availability on milk production within the livestock feeding in Mubi South LGA. The composite mean score of 2.71, with a standard deviation of 1.26, indicates a moderate level of agreement regarding the availability of crop residues throughout the year. Specifically, 57.3% of respondents agree that residues are consistently available, yet 73.3% acknowledge periods of scarcity affecting feeding, reflected in a lower mean (2.15). Moreover, 39.3% frequently supplement feed due to inconsistent residue supply (mean = 2.61), and only 43.3% concur that residue availability aligns with livestock nutritional demand (mean = 2.99). These results suggest that variability in residue availability compromises feed consistency, potentially limiting milk production levels in the study area.

Table 4: Descriptive Statistics on Quality or Nutritional Content of Crop Residues (QNCCR)

N = 150

Statement	Percentage					Mean	Std. Deviation
	SA	A	I	D	SD		
The nutritional quality of the crop residues livestock farmers use is adequate to support livestock health.	14.7	30.0	8.0	16.7	30.7	3.19	1.503
Livestock farmers regularly assess the nutrient composition of crop residues before feeding them to livestock.	20.0	30.0	14.0	21.3	14.7	2.81	1.369
Crop residues from their farm have sufficient protein and energy content for milk production.	17.3	25.3	14.7	12.0	30.7	3.13	1.514
Poor quality crop residues limit the productivity of their livestock.	34.7	10.7	25.3	11.3	18.0	2.67	1.495

Composite Mean = 2.95
Composite Standard Deviation = 1.47

Source: Field Survey, August 2026

The existing data in Table 4 examines the effect of the quality or nutritional content of crop residues on milk yield among livestock enterprises within Mubi South Local Government Area. The composite mean score of 2.95, with a standard deviation of 1.47, indicates a moderate perception regarding the adequacy of crop residues in supporting livestock health and productivity. Notably, statements on the adequacy of nutritional quality (mean=3.19) and sufficiency of protein and energy content (mean=3.13) received relatively higher mean scores, suggesting some agreement on their positive influence. On the other hand, the lower mean for poor residue quality limiting productivity (2.67) and assessments of nutrient composition before feeding (2.81) reflect variability and possible challenges in residue management practices. These findings imply that while crop residue quality is perceived as generally supportive, inconsistencies in nutrient evaluation and residue quality may constrain optimal milk production.

Table 5: Regression Analysis to Test Hypothesis I

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	1.792	.252		7.100	.000	1.293	2.291		
	QCRG	1.052	.028	.950	37.140	.000	.996	1.108	1.000	1.000

a. Dependent Variable: MOLLE

R2 = .903, Adj R2 = .902, F = 1379.363, Sig. = .000 (*appendix ii)*

Source: SPSS Output, 2026

The regression analysis in Table 5 demonstrates a significant positive effect of the Quantity of Crop Residues Generated (QCRG) on Milk Output Levels among Livestock Enterprises (MOLLE) in Mubi South Local Government Area. The model explains approximately 90.3% of the variance in milk output ($R^2 = 0.903$, Adjusted $R^2 = 0.902$), indicating a strong explanatory power. The coefficient for QCRG is 1.052 with a very low standard error (0.028), and the standardized coefficient (Beta = 0.950) signifies a substantial effect size. The t-value of 37.140 and significance level (p = .000) confirm that this effect is statistically significant. Collinearity diagnostics show no multicollinearity concerns (Tolerance = 1.000; VIF = 1.000). Therefore, the null hypothesis ($H0^1$) is rejected in favour of the null hypothesis, confirming that QCRG significantly influences MOLLE.

Table 6: Regression Analysis to Test Hypothesis II

Coefficients[a]										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.796	.285		2.791	.006	.232	1.359		
	FCRALF	1.122	.031	.947	35.979	.000	1.061	1.184	1.000	1.000
a. Dependent Variable: MOLLE										

$R^2 = .897$, Adj $R^2 = .897$, F = 1294.494, Sig. = .000 (*appendix iii)*
Source: SPSS Output, 2026

The presented regression analysis in Table 6 examines the effect of the Frequency of Availability of Crop Residues as Feed (FCRALF) on Milk Production Levels among Livestock Enterprises (MOLLE) within Mubi South Local Government Area. The model demonstrates a high explanatory power, indicated by an R^2 of 0.897, showing that approximately 89.7% of the variance in milk production is accounted for by FCRALF. The coefficient for FCRALF (B = 1.122) is positive and statistically significant (t = 35.979, $p < 0.001$), indicating a strong, direct effect of crop residue availability on milk production. Multicollinearity diagnostics (Tolerance = 1.000; VIF = 1.000) suggest no collinearity issues. Given the statistical significance and high explanatory value, the null hypothesis ($H0^2$), stating that FCRALF does not significantly affect milk production levels, is rejected. This affirms that increased availability frequency of crop residues positively influences milk output in the studied area.

Table 7: Regression Analysis to Test Hypothesis III

Coefficients[a]										
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.488	.150		3.250	.001	.191	.784		
	QNCCR	.978	.014	.986	70.705	.000	.951	1.005	1.000	1.000
a. Dependent Variable: MOLLE										

R2 = .971, Adj R2 = .971, F = 4999.184, Sig. = .000 (*appendix iv)*
Source: SPSS Output, 2026

Table 7 reveals the regression analysis evaluating the effect of the Quality or Nutritional Content of Crop Residues (QNCCR) on Milk Yield among Livestock Enterprises (MOLLE) in Mubi South Local Government Area. The model exhibits a very high coefficient of determination (R^2 = 0.971), indicating that 97.1% of the variance in milk yield is explained by QNCCR. The unstandardized coefficient (B = 0.978) and standardized coefficient (Beta = 0.986) are both positive and significant, with an extremely large t-value (70.705) and p-value (Sig. = 0.000 < 0.05), confirming a strong positive effect. Multicollinearity is absent, as indicated by VIF = 1.000 and tolerance = 1.000. Therefore, the null hypothesis (H03), stating no significant effect of QNCCR on milk yield, is rejected, supporting the conclusion that QNCCR significantly influences milk production among Livestock Enterprises (MOLLE) in Mubi South Local Government Area.

Discussion of Findings

The findings reveal a significant positive effect of crop residue availability on milk output (β = 0.950, p < .001), with 90.3% variance explained, aligning with RBV's assertion that leveraging unique internal resources enhances performance (Barney, 1991). This concurs with Gashaw and Defar (2016), who identified crop residues as critical energy sources, although protein deficiencies necessitate supplementation. Similarly, Mwanibanza et al. (2026) demonstrated improved milk yield from bean residue supplementation, emphasizing resource quality's role in productivity and environmental outcomes. Contrastingly, Habib et al. (2016) documented substantial feed deficits in Pakistan, highlighting seasonal and qualitative constraints echoed by the moderate agreement on residue sufficiency (M = 2.48, SD = 1.37) in Mubi South. These patterns underscore RBV's focus on optimizing endogenous assets like crop residues to bolster livestock output sustainably, informing targeted resource development interventions to mitigate variability in feed supply and enhance dairy production efficiency.

The findings also reveal that the variability in crop residue availability significantly restricts milk production in Mubi South LGA, consistent with the high explanatory power of FCRALF on milk yield ($R^2 = 0.897$, $B = 1.122$, $p < 0.001$). This aligns with Gashaw and Defar (2016), who noted suboptimal nutrient quality in crop residues limiting ruminant productivity due to deficient crude protein (<7% DM). Similarly, Habib et al. (2016) emphasized feed resource shortages undermining livestock performance in Pakistan. Mwanibanza et al. (2026) further corroborate the positive impact of supplemented crop residues on milk yield and environmental benefits. Within the RBV framework, crop residues serve as valuable, rare, and non-substitutable resources, whose effective utilization enhances competitive advantage in livestock enterprises (Barney, 1991). Thus, optimizing residue availability and quality is crucial for improving milk output and sustainability in the studied region.

Lastly, the findings demonstrate a significant positive impact of crop residue quality on milk yield in Mubi South ($R^2 = 0.971$, $B = 0.978$, $p < 0.05$), corroborating Gashaw and Defar's (2016) identification of crop residues as key energy sources constituting over 80% of livestock feed. However, the moderate perception of residue adequacy (mean=2.95) reflects nutrient variability similar to the deficits reported by Habib et al. (2016) and the 37.2% crude protein shortfall at the national level in Pakistan. This aligns with RBV theory, emphasizing the strategic exploitation of valuable and rare resources, in this case, high-quality crop residues, to enhance competitive advantage in milk production (Barney, 1991). Efficient residue management, can optimize endogenous inputs, transforming residue variability from a constraint into a performance driver within livestock enterprises.

Conclusion

The study conclusively demonstrates that crop residue production, encompassing quantity, frequency of availability, and nutritional quality, substantially influences milk output among livestock enterprises in Mubi South LGA, Adamawa State. Empirical evidence reveals that variations in residue supply and quality significantly affect milk yield, with regression analyses affirming strong positive effect (R^2 values > 0.89) and high statistical significance ($p < 0.001$). These findings underscore the critical role of optimizing crop residue management strategies to enhance livestock productivity and sustainable milk production within the study area.

Recommendations

Base on the study's findings, the following recommendations are made:

i. Livestock entrepreneurs in Mubi South LGA should enhance the collection and storage systems for crop residues to mitigate seasonal fluctuations (mean = 1.89) and ensure consistent feed supply, thereby stabilizing milk output.

ii. It is imperative for livestock dealers to increase the frequency and reliability of crop residue availability (mean = 2.71), addressing scarcity periods acknowledged by 73.3% of respondents, to improve feed consistency and milk production.

iii. Livestock enterprises must prioritize the nutritional assessment and quality enhancement of crop residues, given the strong positive effect of residue quality (R^2 = 0.971), to optimize milk yield performance sustainably.

References

Adamawa Investment Promotion Agency (2025). A Report on Adamawa Livestock Wealth; Unlocking Nigeria's Livestock Powerhouse. A publication of Adamawa investment Promotion Agency. https://invest.adamawastate.gov.ng/wp-content/uploads/2025/09/Adamawa-Livestock.pdf

Akintan, O., Gebremedhin, K. G., and Uyeh, D. D. (2025). Linking Animal Feed Formulation to Milk Quantity, Quality, and Animal Health Through Data-Driven Decision-Making [Review of *Linking Animal Feed Formulation to Milk Quantity, Quality, and Animal Health Through Data-Driven Decision-Making*]. *Animals*, *15*(2), 162. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ani15020162

Aquino, D. L., Palacpac, E. P., Molina, A. M., Lacanilao, C. C., Garcia, N. P., Barrio, A. N. D., and Fujihara, T. (2024). Enhancing Growth And Milk Production Of Dairy Buffaloes Through Home-Grown forages and complete nutrient diet. *Online Journal of Animal and Feed Research*. https://doi.org/10.51227/ojafr.2024.12

Balehegn, M., Duncan, A. J., Tolera, A., Ayantunde, A. A., Issa, S., Karimou, M., Zampaligré, N., Kiema, A., Gnanda, I. B., Varijakshapanicker, P., Kebreab, E., Dubeux, J. C. B., Boote, K. J., Minta, M., Feyissa, F., and Adesogan, A. T. (2020). Improving Adoption Of Technologies And Interventions For Increasing Supply Of Quality Livestock Feed In Low- And Middle-Income Countries. *Global Food Security*, 26, 100372. https://doi.org/10.1016/j.gfs.2020.100372

Baleseng, L. B., Madibela, O. R., Tsopito, C. M., Mareko, M., Boitumelo, W. S., and Letso, M. (2023). Morula Kernel Cake (Sclerocarya birrea) as a Protein Source in Diets of Finishing Tswana Lambs: Effects on Nutrient Digestibility, Growth, Meat Quality, and Gross Margin. Animals, 13(8), 1387. https://doi.org/10.3390/ani13081387

Dejene, M., Kehaliew, A., Feyissa, F., Kebede, G., Kitaw, G., Terefe, G., Walelegne, M., Mekonnen, B., Biratu, K., and Geleti, D. (2024). Enhancing Production, Nutritional Qualities and Utilization of Fibrous Crop Residues in Smallholder Crop-Livestock Systems: Potential Intervention Options and Progress toward Sustainable Livestock Production. In *Veterinary medicine and science*. IntechOpen. https://doi.org/10.5772/intechopen.1006058

Duncan, A. J., Bachewe, F. N., Mekonnen, K., Valbuena, D., Rachier, G., Lule, D., Bahta, M., and Erenstein, O. (2016). Crop residue allocation to livestock feed, soil improvement and other uses along a productivity gradient in Eastern Africa. *Agriculture Ecosystems and Environment, 228*, 101. https://doi.org/10.1016/j.agee.2016.05.011

El-Shater, T.; Yigezu, Y.A. (2021). Can Retention of Crop Residues on the Field Be Justified on Socioeconomic Grounds? A Case Study from the Mixed Crop-Livestock Production Systems of the Moroccan Drylands. *Agronomy 2021*, 11, 1465. https://doi.org/10.3390/agronomy11081465

FAO. (2021). Dairy production and products. Food and Agriculture Organization of the United Nations.

Gashaw, M., & Defar, G. (2017). Livestock feed resources, nutritional value and their implication on animal productivity in mixed farming system in Gasera and Ginnir Districts, Bale Zone, Ethiopia. *International Journal of Livestock Production*, 8(2), 12–23. https://doi.org/10.5897/IJLP2016.0297

Gunawan, Winarti, E., Sofyan, A., Putridinanti, A. D., Andarwati, S., Noviandi, C. T., Agus, A., Harper, K., and Poppi, D. P. (2023). Improving growth rates of Ongole crossbred bulls by formulation and level of supplement of by-products. *Animal Production Science*, *64*(1). https://doi.org/10.1071/an23229

Habib, G., Khan, M. F. U., Javaid, S., & Saleem, M. (2016). Assessment of feed supply and demand for livestock in Pakistan. *Journal of Agricultural Science and Technology A, 6*, 191–202. https://doi.org/10.17265/2161-6256/2016.03.006

Ibrahim, A. A., and Aliyu, U. (2020). Assessment of hay and silage production and utilization among livestock farmers in Bauchi State, Nigeria. International Journal of Agricultural Extension and Rural Development Studies, 7(2), 35-44.

Ishiaku, Y. M., Hassan, M. R., Tanko, R. J., Abdu, S. B., Ibrahim, U. M., Garba, S. S., Haruna, M., and Aliyu, A. (2023). Performance of Growing Yankasa Rams fed Ensiled Sorghum almum (Parodi) and Lablab purpureus (L. Sweet) forages and Concentrate Supplement. *Nigerian Journal of Animal Production*, *50*(1), 61. https://doi.org/10.51791/njap.v50i1.3904

Ja'afar-Furo, M. R., Hamid, M. Y., Thlaffa, A. Y., & Sulaiman, A. (2021). Assessing resource utilisation in beef cattle feedlot system in Adamawa State, Nigeria. *Agricultural Science and Technology, 13*(2), 205–211. https://doi.org/10.15547/ast.2021.02.033

Kaur, A., Kataria, P., & Kaur, A. (2024). Assessment of Livestock Feed and Fodder Resources in Central Zone of Punjab. *Forage Research,* 50(2), 134–140. http://forageresearch.in

Kubkomawa, I. H., Adamu, M. S., Ogundu, M. A., Okoli, I. C., & Udedibie, A. B. I. (2017). Socio-cultural, herd structure and reproductive practices of pastoral cattle producers in Adamawa State, Nigeria. *International Journal of Animal Research*, 1(3). http://escipub.com/international-journal-of-animal-research/

Kumar, D., Bhosale, T., Kumar, M., Paswan, V. K., Kumar, K., and Nagori, A. (2021). Impact of Trace Minerals Supplement on Reproductive Performance of Crossbred Cattle. *Asian Journal of Dairy and Food Research*. https://doi.org/10.18805/ajdfr.dr-1573

Matiri, F. M., Kiruiro, E. M., Kang'ara, J. N., & Amboga, S. C. (2013). The Contribution of Crop Residues and Constraints to Utilization in Dairy Production: Case study of central Kenya. In African Crop Science Conference Proceedings (Vol. 11, pp. 931-935). *African Crop Science Society*. https://doi.org/10.4314/acspro.v11i1.72

Mugabe, L. C., Lents, M. P., Pinheiro, E. E. G., and Muchanga, R. A. (2023). Alternative Animal Feeding for Intensive Livestock Farming Systems and Their Impact on Reproductive Performance of Ruminants. In *IntechOpen eBooks*. IntechOpen. https://doi.org/10.5772/intechopen.106061

Mwanibanza, M., Eliamoni L., Daniel K., Raphael, M., Gilbert, M., Alireza E., Neema K., (2026). "Impact of Crop Residue on Milk Yield and Methane Emissions in Dairy Cows: Evidence from Arusha City*". Asian Journal of Research in Animal and Veterinary Sciences* 9 (1):110-20. https://doi.org/10.9734/ajravs/2026/v9i1399.

Patil, P. V., Gendley, M. K., Patil, M. K., Prusty, S., & Ramteke, R. C. (2021). Crop Residue Based Complete Feed For Enhancing Livestock Performance: A Review. *Asian Journal of Agricultural Extension, Economics & Sociology*, *39*(12), 26–32. https://doi.org/10.9734/AJAEES/2021/v39i1230799

Reproto, R. O., Angeles, A. A., Del Barrio, A. N., Sevilla, C. C., & Calalo, F. C. (2024). Availability, Utilization and Nutrient Contribution of Feed Resources to Livestock of Dairy Farmers in Batangas and Cavite, Philippines. *Pakistan Journal of Life and Social Sciences*, 22(2), 12816–12831. https://doi.org/10.57239/PJLSS-2024-22.2.00917

Salo, S. (2017). Estimation of feeds and fodders for livestock population of Ethiopia and mitigation of feed shortage. *Journal of Natural Sciences Research, 7* (11), 1-12. ISSN 2224-3186 (Paper), ISSN 2225-0921 (Online).

Shah, A.M.; Zhang, H.; Shahid, M.; Ghazal, H.; Shah, A.R.; Niaz, M.; Naz, T.; Ghimire, K.; Goswami, N.; Shi, W.; (2025). The Vital Roles of Agricultural Crop Residues and Agro-Industrial By-Products to Support Sustainable Livestock Productivity in Subtropical Regions. *Animals 2025*, 15, 1184. https://doi.org/10.3390/ani15081184

Singh, V., Yadav, S. S., & Kumar, N. (2018). Seasonal variability in crop residue availability and impact on livestock feed sustainability. *Journal of Agricultural Research*, 12(4), 243-252.