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Evaluation of Lablab Silage Substitution for Maize Silage as a Basal Feed on Dry Matter Intake, Milk Yield, and Composition on Crossbred Dairy Cows

Woganie Birhane Aklil*, and Zenebe Tesfa

Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Agricultural Research Center, P.O. Box 32, Bishoftu, ETHIOPIA

*Corresponding Author: wogeniea@gmail.com

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Abstract

This study evaluated the effects of substituting maize silage with lablab silage on total dry matter intake, milk yield, and composition in crossbred Holstein Friesian cows at Debre Zeit Agricultural Research Center. A Latin square design tested four treatments: T1 (100% maize), T2 (80% maize, 20% lablab), T3 (70% maize, 30% lablab), and T4 (60% maize, 40% lablab). Increasing lablab significantly enhanced dry matter intake, with T4 reaching 15.82 kg/day ($p < 0.01$). Milk yield and protein content improved, with T4 producing 15.1 L/day ($p < 0.05$) and 2.88% protein ($p < 0.1$). T1 had the highest SNF (7.6%, $p < 0.01$). Higher lablab inclusion increased the nutritional content of the basal feed, crude protein (13.1%), fat (2.11%), and calcium (1.63%), particularly in T4. T2 offered the highest Benefit-Cost Ratio (2.84), making it cost-effective, while T4 had the highest Marginal Rate of Return (6.44), maximizing profitability for higher investments.

Keywords: Crossbred, Holstein Friesian, Cows, Lablab Silage, Total Dry Matter Intake, Milk Yield, Cost-Benefit Ratio.

Introduction

Dairy production is critical to household income and food security in Ethiopia, where a growing urban population increases the demand for milk and dairy products (Abate & Fikiru, 2015). However, consistent dairy productivity is challenged by fluctuating feed availability and quality, which impacts milk yield and composition (Ayele *et al*., 2019). Maize silage is widely used as a primary forage in dairy systems because of its high yield, consistent energy content, and relative nutritional stability (Cheruiyot *et al*., 2018). Nevertheless, maize silage alone lacks sufficient crude protein (CP) for high milk producer dairy cows, which indicated the need for additional protein sources feed in the diet (Getabalew *et al*., 2021).

Lablab purpureus, a tropical legume crop, presents a promising forage option due to its adaptability, drought resistance, and protein-rich profile. Literature indicates that intercropping maize with lablab, and make a silage from this mixture can boost silage protein content, improve fermentation characteristics, and create a more balanced diet for dairy cows (Gelayenew *et al*., 2020). Compared to grass-only silage, legume-mixed silages have shown higher levels of acetic and lactic acids with lower fiber content, which enhances palatability and digestibility in ruminants (Mekuriaw & Asmare, 2018). The nutrient profile of legume silages, particularly lablab, is thus beneficial for providing the protein-rich diets required to meet dairy cows milk production needs during dry seasons or in areas with limited access to quality forage (Kamat & Patil, 2020).

Increased feed intake and nutrient absorption are essential for sustaining dairy cow performance, especially in low-quality forage periods. Studies indicate that supplementing tropical diets with legume-based forages, like lablab, can improve dry matter intake (DMI) and nutrient utilization, ultimately supporting milk yield and quality (Mekonnen *et al*., 2021). The addition of lablab to maize silage has shown potential to increase DMI and nutrient intake by providing a balanced protein-to-energy ratio that aids rumen digestion and nutrient absorption (Tesfaye *et al*., 2018). Despite the clear benefits of legume-based silages, there is limited research on the use of lablab silage and its effect on dairy cow performance in Ethiopian. This study, therefore, aims to evaluate the impact of feeding crossbred Holstein Friesian cows with different proportions of maize silage substitution with lablab silage, on total dry matter intake, milk yield, and composition.

Materials and Methods

Study Area

The experiment was conducted at the Debre Zeit Agricultural Research Center, located at 08°44′ N latitude and 38°58′ E longitude, with an altitude of 1,884 meters above sea level. The area has a temperature range from 8.9°C to 24.3°C, and an average annual rainfall of 851 mm, making it suitable for year-round agricultural activities (Ayele *et al*., 2019).

Experimental Animals and Management

Four Boran x Friesian crossbred cows were selected from the existing Debrezeit dairy cattle research herd and used for the experiment. Prior to start of the actual feeding trial, broad spectrum dewormed ivermectin was administered to control both internal (worms) and external parasites (ticks, lice, and mites), ensuring optimal health and uniformity among experimental animals. The study period was divided into four lactation stages, each lasting 60 days, with 7 days for adaptation and 14 days for data collection. The experiment commenced at the middle of each lactation stage, which is after the 20 days of each lactation stage up to 40th days of lactation in the specific lactation to target mid-lactation performance for a total of 21 days. The cows were milked twice daily at 6:00 AM and 4:00 PM, with unrestricted access to fresh water and mineral licks. Provision of both basal treatment feeds and concentrate feeds were done three times daily, with an eight-hour interval between provision, and concentrate feed was offered one hour after silage provision.

Experimental Feed Preparation

The forage crops used in the experiment are Bako Hybrid-660 maize and Lablab *purpureus*, they were grown at the Debre Zeit agricultural research center. Maize was harvested at the milk stage, while lablab was harvested at full flowering and first pod forming stage. The two forage crops were chopped manually into 15 mm pieces using a chopper machine and ensiled separately in different silos, with lablab silage enriched with 2% molasses and 2% cracked maize to provide immediate sources of energy and improve fermentation (Cheruiyot *et al*., 2018). The silages were closed in the silo for 21 days before use, as this period allows for optimal fermentation and stabilization of the silage (Kung & Shaver, 2001). During feeding, silage from each silo was weighed, mixed according to the substitution proportions in dry matter base for each treatment, and left overnight for ventilation. It was aerated under shade for 12 hours to enhance palatability before being fed to the lactating cows. In the current study silage (treatment feed) served as the basal diet. The concentrate feed was a mixture of 67% wheat bran, 32% nug seed cake, and 1% common salt, provided at a rate of 0.5 kg per liter of milk produced, as recommended for optimal milk production and nutrient supplementation (NRC, 2001). The treatment diets were formulated as follows:

T1: (100% maize silage) basal feed *ad libtum* + concentrate feed (67% wheat bran, 32% nug seed cake, and 1% common salt) and the concentrate feed was supplied at a rate of 0.5 kg per liter of milk produced.

T2: (Mixture of 80% maize silage + 20% lablab silage) basal feed *ad libtum* + concentrate feed (67% wheat bran, 32% nug seed cake, and 1% common salt) and the concentrate feed was supplied at a rate of 0.5 kg per liter of milk produced.

T3: (Mixture of 70% maize silage + 30% lablab silage) basal feed *ad libtum* + concentrate feed67% wheat bran, 32% nug seed cake, and 1% common salt) and the concentrate feed was supplied at a rate of 0.5 kg per liter of milk produced.

T4: (Mixture of 60% maize silage + 40% lablab silage) basal feed *ad libtum* + concentrate feed 67% wheat bran, 32% nug seed cake, and 1% common salt) and the concentrate feed was supplied at a rate of 0.5 kg per liter of milk produced.

Experimental Design

In the current study 4x4 Latin square design was applied, using parity and lactation stage as blocking factors. This design minimizes effects from variables like lactation stage and cow parity, ensuring reliable data collection on feed intake and milk yield (Ayele *et al*., 2019). The treatments were fed ad libitum alongside a concentrate mix with 91.17% dry matter and 22% crude protein (CP). Concentrate amounts were adjusted weekly according to each cow's milk yield, at a rate of 0.5 kg per liter of milk produced.

Data Collection

Feed Intake

Feed intake data were recorded daily. Silage offered and refusals were recorded to determine total daily intake. Silage allowances were set to allow for 15% refusal, adjusted weekly based on cow consumption. Intake was calculated by subtracting refusals from the feed offered, refusal were collected and weighed in the morning before the provision of the next day feed , and subsamples were taken daily, bulked for each treatment, and stored at -20°C for subsequent chemical analysis (AOAC,1990; Van Soest *et a*l.,1991).

Milk Yield and Composition

Milk yield was recorded twice daily during the 14-day data collection phase of each lactation stage. The daily milk yield was calculated by summing up the morning and evening milk yield of each cow. Three milk samples from each experimental animals were collected for milk chemical composition analysis Milk samples were collected on the 1st, 7th, and 14th days for analysis of protein, fat, solids-not-fat (SNF), lactose, and ash content. 500ml of morning and afternoon representative milk samples were taken by mixing thoroughly and stored at 4°C until analysis. Milk fat %, protein%, SNF, and lactose (% Lactose = % Total solid- (% Protein + % Fat +% Ash) was determined according to O'Connor (1994). The Ash content the milk was calculated as percent of ash = (weight of residue) × 100 /Weight of sample (AOAC, 2000).

Chemical Analysis

The chemical composition of maize silage (the control treatment) and maize-lablab silage mixtures (treatment feeds) was analyzed at the National Veterinary Institute (NVI) using standardized methods. Dry matter (DM) was determined by oven drying samples at 105°C. Total nitrogen was measured by the Kjeldahl method, with crude protein calculated as nitrogen × 6.25, in line with the protocols of the Association of Official Analytical Chemists (AOAC, 1990). Other parameters such as crude fiber (CF), crude fat, ash, and calcium were analyzed to assess the nutritional profile of each treatment feed (AOAC, 2005)

Statistical Analysis

The data on feed intake, chemical composition of treatment feeds, milk yield, and composition were analyzed using the General Linear Model (GLM) procedure in SAS (Version 9.0). Least-square analysis of variance was applied, with significant differences determined using the LSD test at, $p < 0.05$. The statistical model used was:

Yijk = μ+Ti+Pj+Lk+eijk

Where, Yijk, represents the response variable, μ = overall mean,

Ti: the treatment effect, Pj; the parity effect, Lk: the lactation effect, and eijk the random error.

Partial Budget Analysis

A partial budget analysis was performed to evaluate economic feasibility. Feed costs and milk sale prices were assessed using current market price Gross margin and benefit-cost ratios were calculated to determine the cast benefit for each treatment, following economic assessment methods outlined by Tinsae & Mengistu (2019).

Results and Discussion

The chemical composition of the four treatment feeds (T1-T4) demonstrated that increasing the proportion of lablab in the silage led to significant improvements in nutritional quality across all parameters. Table 1 summarizes the chemical composition of each treatment feed.

Table 1: Chemical composition of treatment and supplementary feeds

Feeds	**Chemical Composition**					
	DM	**Ash**	**CP**	**CF**	**C fat**	**Ca**
CM	91.97	11.53	22.00	10.00	4.46	0.91
T1	23.75	11.38	7.28	35.95	1.39	1.05
T2	24.32	11.20	9.32	32.75	1.62	1.06
T3	25.13	11.43	11.89	31.00	1.82	1.43
T4	25.73	15.94	13.10	23.01	2.11	1.63

** DM (Dry matter), CP (crude* protein*), CF (crude fiber) Cfat (crude fat), Ca (Calcium)*
** CM (concentrate mix 67 %* wheat *bran + 32 % Nuge seed cake + 1% salt), T1 (maize silage only), T2 (80% maize silage &20%lablab silage) T3 (70 % maize silage &30 % lablab silage) and T4 (60 % maize silage &40 % lablab silage),*

In Table 1. It is indicated that the dry matter (DM) content of the experimental feed increased with higher lablab proportions, from 23.75% in T1 to 25.73% in T4. This trend is consistent with findings by Cheruiyot *et al*. (2018), who observed increased DM levels in legume-enriched silage due to legumes' inherently lower moisture content compared to grasses. Additionally, the inclusion of cracked maize and molasses supported higher DM content by promoting efficient fermentation, which minimizes nutrient losses and enhances silage preservation (Gelayenew *et al*., 2020). In the current research work the crude protein (CP) content similarly increased with lablab inclusion, rising significantly from 7.28% in T1 to 13.1% in T4 (Table 1). Higher CP levels are essential for meeting the protein requirements of lactating cows, supporting milk yield and quality by addressing the increased protein demands of lactating cows (Mekonnen *et al*., 2021). The observed trend aligns with Mekuriaw and Asmare (2018), who reported that legumes like lablab, when included in silage, provide an additional protein source, enhancing the CP profile of the silage. Furthermore, the cracked maize and molasses included in the ensiling process contributed to protein preservation by creating an anaerobic environment, reducing protein degradation and ensuring consistent protein availability (Ayele *et al*., 2019). On the other hand reduction in crude fiber (CF) was observed across treatments, with CF content decreasing from 35.95% in T1 to 23.01% in T4 (Table 1). The lower CF levels in lablab-inclusive treatments may be because, legumes typically have a lower fiber structure than grasses, resulting in a more palatable and digestible forage (Tesfaye *et al*., 2018). The decreasing crude fiber (CF) content with increasing levels of lablab in the treatment feeds highlights the dilution effect of replacing maize with a leguminous forage. CF content dropped from 35.95% in T1 (100% maize) to 23.01% in T4 (60% maize, 40% lablab), reflecting the inherently lower structural fiber concentration of lablab compared to maize. This finding is consistent with Tolera and Sundstøl (2000), who reported that legume supplementation in cereal-based diets reduces fiber fractions, Similarly, Gusha *et al*. (2015) observed that legumes like lablab and cowpea have lower fiber fractions than cereal grains.

Additionally in the current study the crude fat content of the treatement feeds are increased significantly with the the increasing substitiution of lablab, from 1.39% in T1 to 2.11% in T4. Fat contributes to the energy density of the feed, which is crucial for lactating cows with high energy demands. According to Kamat and Patil (2020), high-energy diets support milk fat synthesis and overall milk yield, especially in dairy cows with increased energy requirements. The increasing crude fat content observed with higher levels of lablab in the silage treatments may result from both the naturally higher crude fat content of legumes compared to grasses and the addition of cracked maize and molasses during silage preparation. Crude fat content increased progressively from 1.39% in T1 (100% maize) to 2.11% in T4 (60% maize, 40% lablab), Legumes such as lablab are known to contain higher levels of lipids than grasses, contributing to the observed increase. This result is related with the result of Bunglavan and Dutta (2013), who indicates that legumes generally have higher crude fat content than grasses due to their biochemical composition, which includes a greater concentration of lipids. In addition McDonald *et al*. (2010), also showed the addition of energy-dense feed ingredients like maize and molasses improves the fermentation quality of silage and may contribute to a higher overall fat content in the final feed. In this study, replacing maize silage with lablab silage from 0% to 40% led to a significant increase in ash content, peaking at 15.94% in T4, and Ca content, rising from 1.05% in T1 to 1.63% in T4. These findings are consistent with studies showing that legumes like lablab and cowpea enhance feed quality by supplying higher mineral concentrations than grasses (Ramachandra *et al*., 2007). Similarly, Rao *et al*. (2013) emphasized that grass silages like maize are generally have lower mineral levels, including ash and calcium, as indicated in this study.

Dry Matter (DM) Intake

The dry matter intake (DMI) results in Table 2 show differences across the treatments, highlighting the positive effect of adding lablab to maize silage. As the proportion of lablab in the silage increased, the cows consumed more silage (basal feed) and also the supplement concentrate, and because of this total dry matter intake also increased with increasing proportion of lablab silage. T4, which contained 60% maize and 40% lablab, had the highest total dry matter intake (TDMI) at 15.82 kg per day, while T1, with 100% maize, had the lowest intake at 12.20 kg per day. This increase in intake with higher lablab content was significant ($p < 0.01$), showing that lablab makes the feed more digestible than the maize silage.

Table 2: Silage intake, concentrate intake, and total dry matter intake (TDMI) accros treatemenmts

Treatment Feeds	SI (kg DM/day)	CI (kg DM/day)	TDMI (kg DM/day)
T1 (100% Maize)	6.56 ^{c}	5.63 ^{c}	12.20 ^{c}
T2 (80% Maize, 20% Lablab)	7.00 ^{b}	6.47 $^{b\,c}$	13.45 ^{b}
T3 (70% Maize, 30% Lablab)	7.60 ^{b}	6.94 ^{b}	14.54 ^{b}
T4 (60% Maize, 40% Lablab)	8.11 ^{a}	7.71 ^{a}	15.82 ^{a}
Mean ± SE	7.32 ± 0.18	6.69 ± 0.52	13.65 ± 0.68
CV (%)	5.6	5.0	4.7
Significance (p-value)	< 0.01	< 0.01	< 0.01

Where SI(Silage intake), CI (concentrate intake accross treatement feed) , TDMI (total dry mater intake accross treatement feeds), Different superscript letters (a, b, c) indicate statistically significant differences at p < 0.01.

The higher intake in treatments with increased substitiution of the lablab silage can be explained by its better nutritional quality. Lablab is rich in protein and lower in fiber compared to maize, which helps improve digestion and makes the feed more palatable. Mekonnen *et al*. (2021) also found that legume-based silages, such as those with lablab, promote better feed intake due to improved digestibility and nutrient availability. Similarly, Tesfaye *et al*. (2018) reported that including legumes like lablab in silages increases feed intake because of their high protein content and ability to enhance rumen fermentation. Cheruiyot *et al*. (2018) supported these findings, showing that cows consumed 15-20% more when fed maize-legume silages compared to maize-only silages.

Milk Yield and Chemical Composition

The milk yield and chemical composition of lactating Holstein-Friesian crossbred cows fed increasing substitution of lablab silage in maize silage based basal feed are presented in Table 3. Results showed that milk yield increased significantly as the proportion of lablab silage in the maize silage increased, with lactating cows on T4 (60% maize, 40% lablab) yielding 15.1 L/day, compared to 11.16 L/day for cows on T1 (100% maize). This increment is statistically significant ($p < 0.05$), with T4 showing an increase of 3.94 L/day over T1.

Table 3: Milk yield and composition parameters of lactating crossbred Frisian cows fed on substitution of lablab silage on maize silage based basal diet across treatments

Treatment Feeds	Milk Yield (L/day)	Milk Chemical composition				
		Protein	Fat	Ash	SNF	Lactose
T1 (100% Maize)	11.16 c	2.804 b	3.76	0.618 c	7.73 a	4.23
T2 (80% Maize, 20% Lablab)	12.94 b	2.83 b	3.68	0.628 bc	7.605 b	4.24
T3 (70% Maize, 30% Lablab)	13.6 ab	2.842 ab	3.64	0.638 ab	7.59 b	4.21
T4 (60% Maize, 40% Lablab)	15.1 a	2.88 a	3.48	0.640 a	7.586 b	4.15
Mean ± SE	13.20 ± 0.89	2.84 ± 0.03	3.64 ± 0.18	0.63 ± 0.01	7.63± 0.04	4.20± 0.07
CV (%)	0.94	1.00	4.91	1.08	0.56	1.58
Significance (p-value)	< 0.01	< 0.06	0.21	0.02	< 0.01	0.52

Different superscripts (a, b, c) indicate *statistically significant differences at p < 0.05.*

The significant increase in milk yield for T4 compared to T1 can be attributed to the enhanced nutrient intake resulting from higher protein and lower fiber with increased substitution of lablab silage from 0 to 40 % in the maize silage based basal feed. Studies by Yongli *et al*. (2013) support these results, showing that mixture of maize lablab silages boost milk yield by providing a balanced nutrient profile that improves digestibility. Dewhurst *et al*. (2003) also demonstrated that cows fed on legume silages produce higher milk yields than those on grass silages due to increased dry matter intake (DMI) and enhanced protein utilization. Study by Edson et al. (2018) also demonstrated that feeding lactating cows with maize-legume mixed silages at 70 to 30 percent ratio (maize:cowpea, maize:velvet bean, and maize:lablab) resulted in significantly higher milk yields compared to sole maize silage. Additionally, the mixed silages improved milk protein content without affecting butterfat levels, highlighting their nutritional advantage over sole maize silage. In similar study Cows fed legume silage had higher milk production than those on grass silage (Steinshamn, 2010). In terms of milk composition, protein levels in milk were significantly higher in cows fed T4 (2.88%) compared to T1 (2.804%; $p < 0.10$). This outcome aligns with findings from Contreras-Govea *et al*. (2009), who noted that legume-based silages improve milk protein content, attributed to the higher nitrogen availability and better rumen degradability of legume proteins. Similarly, a review by Steinshamn (2010) highlighted that legumes in the diet of dairy cows enhance milk protein due to the increased rumen protein supply and lower dietary fiber, which together support efficient protein synthesis. Ash content in milk was also significantly higher in T4 (0.640%) compared to T1 (0.618%; $p < 0.05$). This trend may be due to the greater mineral content in lablab-inclusive silages, particularly calcium, which supports milk synthesis. According to Murphy and Colucci (1999), legumes, including lablab, are high in essential minerals like calcium, which contribute positively to milk composition and support higher milk ash content in cows fed legume-inclusive diets. While the trend for fat content showed slight reductions with higher lablab inclusion, these differences were not statistically significant. However, the decrease in SNF (solid-not-fat) content with increased lablab silage in the diet was significant ($p < 0.01$). Ewonetu and Feyisa (2019) found a similar trend, suggesting that SNF levels may vary inversely with dietary fiber levels, as higher legume inclusions generally reduce total fiber content, thus affecting milk SNF. From the current study it is concluded that higher proportion of lablab in maize-based silages enhance milk yield and improve milk protein and ash content. The findings align with research from Yongli *et al*. (2013), Contreras-Govea *et al*. (2009), and Steinshamn (2010), indicating that legume-inclusive silages provide an effective nutritional strategy for improving milk production in dairy cows. These results emphasize the potential of maize-lablab silage mixtures, particularly at 40% lablab inclusion, as an optimal feed choice for dairy systems focused on maximizing milk yield and composition

Cost-Benefit Analysis

A partial budget analysis was performed to evaluate economic feasibility. Feed costs and milk sale prices were assessed using current market rates: maize and lablab silage at 13 and 14 Birr/kg respectively, concentrate at 35 Birr/kg, and milk at 70 Birr/liter. Marginal rate of return (MRR) and benefit-cost ratios were calculated to determine profitability for each treatment, following economic assessment methods outlined by Tinsae & Mengistu (2019).

Table 4: Partial budget analysis for treatment feeds

Item	T1 (100% Maize)	T2 (80% Maize, 20% Lablab)	T3 (70% Maize, 30% Lablab)	T4 (60% Maize, 40% Lablab)
Maize Silage (Birr/kg)	13.00	13.00	13.00	13.00
Lablab Silage (Birr/kg)	14.00	14.00	14.00	14.00
Concentrate Feed (Birr/kg)	35.00	35.00	35.00	35.00
Maize Silage Intake (kg/day)	6.50	5.60	5.32	4.87
Lablab Silage Intake (kg/day)	0.00	1.40	2.28	3.24
Concentrate Feed Intake (kg/day)	5.63	6.47	6.94	7.71
Milk Yield (L/day)	11.16	12.94	13.60	15.10
Milk Sale Value (Birr/L)	70.00	70.00	70.00	70.00
Total Feed Cost (Birr/day)	281.55	318.85	350.85	374.40
Total Revenue (Birr/day)	781.20	905.80	952.00	1,057.00
Benefit cost Ratio (BCR)	2.78	2.84	2.71	2.82
Marginal Return (MRR)		4.50	3.87	6.44

The table above indicated that T2 (80% Maize, 20% Lablab) provides the highest Benefit cost Ratio (2.84), making it the most efficient option in terms of returns per unit of feed cost. This treatment is particularly suitable for producers with limited investment capacity, as it balances moderate feed costs with good returns. On the other hand, T4 (60% Maize, 40% Lablab) offers the highest Marginal Rate of Return (6.44), demonstrating that investing in this treatment yields the greatest profitability in terms of additional feed cost and milk production. While T2 is recommended for producers seeking cost efficiency, T4 is ideal for those with greater financial capacity who aim to maximize milk yield and overall profitability, even with higher feed expenses.

Conclusion

From the current research work concluded that increasing lablab proportion in maize-based silage up to 40% significantly improves both milk yield and overall profitability for dairy farmers in Ethiopian conditions. Treatment 4 (T4) (60% maize, 40% lablab) achieved the highest dry matter intake (15.82 kg/day) and milk yield (15.1 L/day), representing a 35% increase in milk yield over T1 (100% maize) and showing the highest MRR (6.44). This treatment showed a favorable benefit-cost ratio (2.82). Overall, the second treatment (318.85 Birr/day) offers the highest BCR (2.84)**,** making it the most cost-effective option. However, the last treatment (374.40 Birr/day) yields the highest MRR (6.44) and net income (682.60 Birr/day), suggesting that further investment in feed at this level is highly profitable.

Recommendations

Based on the current findings, it is recommended that Ethiopian dairy farmers, especially those who have enough area for forage crop cultivation, can adopt a 60% maize and 40% lablab silage mixture to maximize milk yield and profitability. Agricultural extension services should provide training on silage preparation, handling, and storage to help maintain feed quality and nutrient retention, which are essential for achieving the observed benefits. Additionally, financial assistance, such as subsidies or loans for lablab cultivation and silage production, could support wider adoption, particularly for resource-limited farmers. Further research exploring other legume-based silages and their impact on different dairy breeds and lactation stages would help refine feeding recommendations, contributing to more tailored and sustainable dairy farming practices in Ethiopia.

Contribution by Authors

All the authors contributed equally to writing the manuscript. The final manuscript was read by all authors and consented to publication.

Conflict of Interests

There is no conflict of interest.

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