American Journal of Economics and Business Innovation (AJEBI)

ISSN: 2831-5588 (ONLINE), 2832-4862 (PRINT)

VOLUME 3 ISSUE 2 (2024)

PUBLISHED BY

E-PALLI PUBLISHERS, DELAWARE, USA

American Journal of Economics and Business Innovation (AJEBI)

Volume 3 Issue 2, Year 2024
ISSN: 2831-5588 (Online), 2832-4862 (Print)
DOI: https://doi.org/10.54536/ajebi.v3i2.2940
https://journals.e-palli.com/home/index.php/ajebi

Beef Finishing on Range Grass and Legume Supplementation: The Unexploited Profitability Option in Arid and Semi-Arid Lands of Kenya

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Article Information

Received: June 07, 2024
Accepted: July 09, 2024
Published: July 12, 2024

Keywords
ASALs, Grass, Kenya, Legume, Profitability

ABSTRACT

The availability of economical and easily accessible feeds that are high in both quantity and quality is a crucial factor in sustainable livestock production. The study aimed to determine the profitability of finishing sheep by supplementing them with protein-rich leguminous feeds. In a completely randomized experimental design, a group of 18 mass-selected dorper yearling sheep, aged 17-19 months and an average body weight of 20.5±2.9Kgs, were assigned into 6 diet experimental units of 3 animals each. Analysis of variance and economic viability analyses showed Bush rye+Desmodium and African fox tail+Lucerne diets as the leading, with net weight gains of 3.0±0.7Kgs and 2.8±0.5Kgs and profitable returns of Ksh 65,979.00 and Ksh 30,906.00 respectively for 100 units' sheep establishment at the prevailing market live body weight price of Ksh 400/ kg. The selection of a cost-effective legume and the right breed and genetics of the animal were an essential consideration for enhanced enterprise profitability.

INTRODUCTION

The livestock sector contributes a substantial 30% of the value of goods sold at the farm gates (Lutta *et al.*, 2023), 50% of the agricultural sector's GDP, and about 25% of Kenya's GDP (Nyariki & Amwata, 2019). The Arid and Semi-Arid Lands (ASAL) occupy 89% of Kenya's landmass, spread in 29 counties and host a significant 70% of the livestock species kept across the country (Ministry of Devolution and the ASALS, 2019). ASAL region is characterized with low agricultural productivity leaving livestock production as the only suitable alternative means of livelihood for nearly 45.5% of the population (FAO, 2016). The experienced prolonged droughts and sporadic rainfall have left the ASALs degraded leading to reduced pasture quantity as well as nutritional quality majorly impacting on crude protein (Bista *et al.*, 2018). This has dire effects on milk production, growth potential and reduction in animal body condition score (BCS) and induced seasonal weight losses (SWL) and further decline in reproductive capacity of the animals (Chaidanya *et al.*, 2015) posing a huge livelihood risk to the people in the ASALs. Legumes are a good source of proteins contributing up to 20% crude protein and reasonable amounts of energy (Olalekaan & Bosede, 2010). Njarui *et al.*, (2003) categorized legume on their adaptability to the climate and soils of the semi-arid eastern Kenya. This study, aimed to evaluate the economic profitability of finishing sheep using grass and legume in the ASALs of Kenya, a technique that boosts livestock productivity in Kajiado County.

MATERIALS AND METHODS

Study Site

The Study was done in Kajiado county, Kipeto area, an ASAL region characterized with black cotton soils and rocky terrain (Kipeto Energy, 2012). The Area lies at an altitude of 1950 meter above sea level and experiences average temperatures 21-25oC with an average annual rainfall of between 500-750 mm (MoALF, 2018).

Animal Selection and Feeding

The study used 18 yearling dorper sheep aged 17-19 months and weighing 20.5±2.9kgs. The animals were randomly clustered in groups of three and allocated to respective six diet experimental units for a period of 90 days excluding acclimatization period of 14 days. A grass and legume rations comprising of African foxtail or Bush-rye grasses and either Lucerne or Desmodium legumes were used as test diets comprising of; African fox tail (AF), African fox tail+Desmodium (AF+Des), African fox tail+Lucerne (AF+Luc), Bush rye (Br), Bush rye+Desmodium (Br+Des) and Bush rye+Lucerne (Br+Luc). Water and feed were offered to the animals individually (per animal) ad-libitum in a grass to legume ration of 3:1 for the latter (Bosworth & Cannella, 2007). The animals were dewormed before the experiment. The animals were weighed at the beginning and progressively on a daily basis by a research scientist and daily weight gain and feed intake data recorded in an excel data template.

Data Analysis

Cost of Feed and Animal Feed Intake

The average variable cost of unit feed production (AVCf) was calculated as the quotient of the aggregate total variable costs incurred along the crop lifespan in seasons (n) over the aggregate estimated seasonal yields. This is due to the changing costs and marginal rate of productivity over the seasons due to the perennial nature

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of the crops.

$AVCf=(\sum_{(i=1)}^{n}$ Seasonal cost$)/(\sum_{(i=1)}^{n}$ Seasonal yield) (1)

The animal daily intake (DI), was calculated as the difference between the average daily feed offered and the average daily refusal.

$DI=(\sum_{(i=1)}^{n}$ (Feed offered-Refusal)/(Period days) (2)

The total feed cost for finishing the animal was therefore determined as;

Sheep feed cost= (0.75AVCf Grass+0.25AVCf Legume) *DI*Period days (3)

Animal Performance and Proximate Composition of The Test Diets

The average daily weight gain (NWG) was determined as the difference between the final and initial/previous live body weight (LBWi-LBW0). A two-way statistical analysis of variance (ANOVA) statistics was used to compare the NWG means and test for significance difference between the treatments and LSD significance difference post hoc test used to separate significant differences ($P<0.05$) using SPSS software version 22. The results were presented in tables.

The animal daily dry matter intake (DDMI) % value of LBW was also determined as follows;

% value=DDMI/(Avrg LBW)*100 (4)

Where, DDMI= DI* % Dry matter

Additionally, feed proximate laboratory analyses were done and presented.

Economic Analyses

The gross margin (GM) analysis was used to examine the profitability of sheep finishing. The GM was computed as difference between the total revenue (TR) and total variable cost (TVC) incurred within the finishing period. This formula was defined as;

GM=TR-TVC (5)

The physical values for TR and TVC variables were computed as follows as used by Mulei *et al.* (2024);

$GM= NWG_i Y . LWP-\sum_{(j=1)}^{n} X_j C_j$ (6)

Where, $NWG_i Y . LWP$ represent the total revenue, NWG is the net weight gain in kilogram (kg) per sheep and LWP is the live weight price per kg.

While, $\sum_{(j=1)}^{n} X_j C_j$ is the total cost of n variable inputs, X_j is the units of j^{th} variable input, C_j is the cost of input utilized per unit and $\sum$ is the summation. The TVC include the cost of feed on a 3:1 grass and legume ratio, labor and 10% of TVC miscellaneous.

RESULTS AND DISCUSSION

Cost of Feed Production and Animal Feed Intake

Table 1: Unit cost of feed production

Type	Crop	Seasonality	AVCf_Kg	AVCf_15Kg bale	Market price*
Grass	AF	Perennial	6.3	94.0	250
Grass	Br	Perennial	5.1	77.0	250
Legume	Des	Perennial	4.9	72.8	500
Legume	Luc	Bi annual	13.3	198.8	500

*Source: Experimental trial results, *Author livestock feed market survey, 2023 (Ksh).*

Livestock feeds play a crucial role in the cost of livestock production. The type, quality and availability of feeds can significantly influence the overall expenses incurred by livestock producers. Perennial crops generally exhibited a lower unit production cost, primarily attributed to one-time production costs incurred only in the initial season and exempted in subsequent seasons. The overall cost of cultivating the feeds, however, was generally more affordable than purchasing from the market. On-farm feed production led to a 70.5% feed opportunity cost, thereby minimizing overall production expenses and maximizing profits (table 1). Utilizing a combination of feeds with lower cost, compared to commercial feed, presents an alternative strategy to reduce both feed and production expenses (Klahan *et al.*, 2023). Additionally, the quality of the feed is assured.

Animal Performance and Proximate Composition of The Test Diets

The animal performance was influenced by feed nutritive

Table 2: Animal performance and diet nutrient content

Diet	NWG (kg)	DDMI (kg)	ME (MJ/kg DM)	CP (g/kg DM)	ADL (g/kg)
AF	0.8 ± 0.2^{a}	0.73	8.2^{a}	43.8^{ab}	122.5^{ab}
AF+Des	2.3 ± 0.5^{b}	0.68	8.2^{a}	70.9^{a}	73.7^{a}
AF+Luc	2.8 ± 0.5^{b}	0.84	8.5^{b}	120.7^{b}	97.0^{b}
Br	1.8 ± 0.3^{ab}	0.78	7.7^{c}	54.9^{ac}	82.2^{ac}
Br+Des	3.0 ± 0.7^{b}	0.81	9.1^{ab}	117.9^{c}	68.4^{c}
Br+Luc	2.3 ± 0.1^{b}	0.71	7.8^{c}	81.2^{bc}	115.0^{bc}
Sig (P=0.05)	**	* (0.76±0.08)	**	**	**

*Source: Experimental trial results. **The mean difference is significant at the 0.05 level, *Not significant. Column means with different letter superscript are significantly different.*

value, particularly Metabolizable Energy (ME) and Crude Protein (CP) where, the proximate analysis showed a significant difference between the two categories of diets. Bush rye+Desmodium and African fox tail+Lucerne diets showed the highest performance with a NWG of 3.0±0.7Kgs and 2.8±0.5Kgs respectively. While, African fox tail and bush rye basal diets showed the least performance. There was a significant difference between the grass basal and grass+legume category diets performances (table 2). Enhancing the dietary levels of ME (metabolizable energy) and CP (crude protein) resulted in improved digestibility and growth rates for cattle that were fed low-quality grasses (Thang, 2010). A minimum of 7% (70g/kg DM) dietary crude protein is required for maintenance in sheep (Kenana *et al.*, 2020). The average animal DDMI, was 0.76±0.08Kgs, 2.7% of the animal LBW. The results were consistent with Mayulu & Suhardi (2016), who found that a local sheep weighing 14.69+0.82Kg, fed on formulated complete feed resulted average DDMI of 712g/day, 2.2% of LBW.

Economic Analyses

Bush rye+Desmodium and African fox tail+Lucerne diets showed the best profitable returns. However, though there was no significant difference in NWG between the two diets, the latter showed a noteworthy higher BEQ (table 3) and lower GM (table 4) due to the substantially higher cost of the legume production. This is influenced by lower biomass productivity potential of Lucerne in the ASAL (Manyeki *et al.*, 2023). African fox tail grass and bush rye basal diets performed the lowest and subsequently relatively higher BEQ. This indicated that the diets required higher units to operate under an efficient scale. Cost of feed production translated to an estimated average of 73.6% of the total cost of production. The greatest expense in a feedlot production system is associated with the costs related to feeding (Sitorski, 2019).

Bush rye+Desmodium and African fox tail+Desmodium diets showed a positive and highest returns respectively, with a BCR of 2.2 and 1.5 and ROI of 1.2 and 0.5 respectively (table 4). This indicated that, there was a positive return on revenue and profit for every shilling invested as cost.

Table 3: Break even quantity (BEQ)

Diet	Sheep feed cost	Labor costs	Other costs	Revenue	BEQ	BCR (>1)	Viability
AF	482.6	10,500	10%	320.0	1,000.0	0.6	NV
AF+Des	450.4	10,500	10%	920.0	28.0	1.0	Viable
AF+Luc	643.4	10,500	10%	1,120.0	29.0	1.0	Viable
Br	390.7	10,500	10%	720.0	40.0	1.0	Viable
Br+Des	386.1	10,500	10%	1,200.0	15.0	1.0	Viable
Br+Luc	579.1	10,500	10%	920.0	41.0	1.0	Viable

Source: Author calculated. Market LBW price of Ksh 400/kg (Author livestock market survey, 2023). NV= Not Viable.

Table 4: A profitability case at 100 units

Diet	TVC	TR	GM	BCR (>1)	ROI	Rank	Viability
AF	48,260.0	32,000.0	-32,636.0	0.5	-0.5	6	NV
AF+Des	45,040.0	92,000.0	30,906.0	1.5	0.5	2	Viable
AF+Luc	64,340.0	112,000.0	29,676.0	1.4	0.4	3	Viable
Br	39,070.0	72,000.0	17,473.0	1.3	0.3	4	Viable
Br+Des	38,610.0	120,000.0	65,979.0	2.2	1.2	1	Viable
Br+Luc	57,910.0	92,000.0	16,749.0	1.2	0.2	5	Viable

Source: Author calculated.

CONCLUSION

Producing feed on the farm proved to be more cost-effective than purchasing from the market, leading to increased profitability for farmers. Careful selection of cost-effective legumes was a crucial factor for the enterprise. Furthermore, the breed and genetics of the animals play a significant role in influencing feed efficiency, carcass merit, and economic benefits. Hence, it is essential to choose the appropriate breeds whether acquiring the animal or raising it on the farm.

Acknowledgment

We express our gratitude to the Kenya Agricultural and Livestock Research Organization- Arid and Range Lands Research Institute (KALRO-ARLRI) and SNV, for the partnered project implementation support. While, the European Union (EU) and the Embassy of the Kingdom of Netherlands (EKN) for providing the necessary funding support for the project.

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