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Cost-effectiveness of running beef feedlot using locally available feed resources: a case of Isiolo and Kajiado Counties, Kenya

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Abstract

Feedlot finishing has the potential to stabilize beef supply and increase the quality of marketed beef products. The cost of running such feedlots using local feed resources is not widely documented to support investment. The purpose of this study was to examine the financial advantages of running an alternative feedlot that uses locally available feed resources such as *Prosopis juliflora*, *Balanites aegyptiaca pods*, and *Acacia tortilis* pods found in the Arid and Semi-arid Lands (ASALs) of Kenya. Data for this study were obtained from a controlled experiment conducted at the Kenya Agricultural and Livestock Research Organization (KALRO), Beef Research Institute where 27 beef steers of Zebu, Boran, and Sahiwal crosses were fed on rations formulated with selected local feed resources obtained from Isiolo and Kajiado counties of Kenya. For 90 days, the animal weights were captured weekly, and the costs were recorded daily. Additional market data on costs were obtained from selected key informants in the beef value chain in the Counties of Isiolo and Kajiado. The viability of investing in a feedlot was evaluated using cost-benefit analysis, break-even analysis, and sensitivity analysis. The results showed that overall animal weight gain varied with the type of breed. The improved Boran (Animal 8F51) gained the highest weight followed by Sahiwal (9F65) in the experiment while Zebu gained the lowest. The findings showed that it is financially viable to operate a feedlot using locally available feed resources only if the targeted markets are value-added with better beef prices. Furthermore, sensitivity analysis showed that adjusting prices upwards by KES +6.00 in Isiolo and KES + 58.00 in Kajiado could make beef farmers who have adopted feedlot systems to achieve break-even. In conclusion, for the viability of feedlots that use local feed resources, there is a need to consistently source for value-added markets for better pricing and profitability. Policy-makers therefore need to critically evaluate and promote farmers’ access to these value-added markets.

Keywords: Cost-benefit Analysis, Break-even Analysis, Feedlot, Beef, Local Feed Resources

Introduction

Beef in Kenya is mainly produced under pastoral systems in the Arid and Semi-Arid Lands (ASALS). These pastoral systems rely on seasonal grass and forages for animal production (Creemers & Aranguiz, 2019; Ndiritu, 2020; Nguhiu-Mwangi et al., 2020). Currently, national statistics show both fluctuations and a drop in meat production quantities from 589 thousand metric tons in 2017, to 200.8 thousand metric tons in 2018, 329.2 thousand metric tons in 2019, and 244 thousand metric tons in 2020 (Gale & Dong, 2023). Statistics further show that meat supply quantities per capita per year in 2019 for Kenya were 8.77 Kgs, while for USA, Brazil, Canada, Australia, and South Africa stood at 37.6, 37.1, 26.6, 26.1, and 17.5 respectively (Godfray et al., 2018). Beef production in Kenya and Sub-Saharan Africa is likely to gain importance with increasing population, expanding middle class, and urbanization (Heller, et al., 2020). This expected rise in demand (Gatsby Africa, 2022) necessitates investing in productivity-enhancing technologies such as feedlots. In the ASALs however, most farmers do not finish their beef cattle for the markets but keep the animals until they have gained enough weight to be sold in the market.

Kenya’s meat production does not meet local demand. In the year 2020, for example, cattle imports to Kenya were valued at 5,916,000 US dollars against the exports of only 235, 000 US dollars (Ndiritu, 2020). Indeed, these statistics show the opportunities in beef production and marketing. In Kenya, Mombasa and Nairobi cities are the main markets for meat products while consumption patterns show more preference for raw unprocessed meat (Kenya Meat Commission, 2015). A major participant in Kenya's official beef markets, the Kenya Meat Commission, processes meat and meat products and also buys meat from suppliers who can meet strict set guidelines. KMC's processed meat is mostly exported or marketed to institutional and local markets (Kenya Meat Commission, 2022). In the ASALs, auction markets and butcheries are the most common market outlets for beef. The market for hides for leather processing also presents a potential market for beef farmers.

Therefore, to increase beef production efficiency and connect producers to high-end beef markets, pastoral farmers, who provide the biggest share of Kenya’s beef, need to consider fattening in feedlots (Ndiritu, 2020). Only a few ranchers in Sub-Saharan Africa have used feedlot finishing techniques (Greenwood, 2021). To have efficient and profitable feedlot systems, the diets must have the right combination of high-quality forages and grains (Cowley et al., 2020). Pacheco et al. (2021) showed that in feedlot systems, feasibility could be attained if the steers gain more weight. Maneses et al. (2021) further underscored the importance of feedlots by demonstrating that under feedlot finishing systems, the daily weight increase by steers was about three times higher than that of pasture-grazed steers.

The beef feedlot sector is concentrated more in developed countries such as the United States, Australia, Brazil, Canada, and Indonesia. In these countries where the adoption of improved production has increased, research on feedlot systems focuses on several aspects such as feeding, animal health, and environmental impacts. In feeding, Vichare & Morya (2024) investigated ways in which oilseed could be incorporated into diets while Kim et al. (2019) examined the addition of urea into rations. Badran et al. (2024) studied space allowance per animal while. In animal health, Malafaia, et al. (2016) compared the economic impact of health problems under two feedlot systems in Brazil whereas Urso et al, (2021) reviewed the effect of dust on feedlot health.

Locally available feed resources.

With use of well-formulated cattle diets, profitability in feedlot systems can be reached (Pereira et al., 2019). Uys (2022) notes that relying only on forage-based fattening with low-quality feeds may not be suitable for income-generating cattle. Diet is, therefore, a major factor in steer weight increase; hence its quality and consistency are critical in feedlots. Moreover, various locally identified forages and fodder can be utilized for finishing beef animals. In the ASALs however, due to overutilization of the communal resources, and climate risks, farmers are more vulnerable to climate risks and shocks (Habiba et al., 2016). Kumar et al. (2022), consistency, accessibility, and affordability of these ingredients for commercially recommended feed formulations may also be a challenge for most pastoral producers.

As a way of adaptation, pastoral farmers often rely on naturally and locally growing forages to supplement their beef cattle diets. *Prosopis Juliflora*, *Acacia tortilis*, and *Balanites aegyptiaca* are drought-resistant forages available in the ASALs of Kenya. These Indigenous feed resources have high levels of crude protein (150-249gkg $^{-1}$ DM) which provides enough nutrients for utilization as a supplement to low-quality natural pastures and crop residues (Amole *et al.*,2022; Osuga *et al*, 2006). The metabolizable energy (ME) content of locally available feedstuff from the ASALs ranges from 8.7 MJ/Kg DM in *Acacia tortilis* pods and 14.6 MJ/Kg DM in *Balanites aegyptica* nuts. *Balanites aegyptica* nuts are high in metabolized energy compared to *Prosopis juliflora* pods and *Acacia tortilis* pods. Legume tree forages have high crude protein, organic matter, and mineral content and can also be used as supplements to help offset the effects of low-quality feeds (Idan *et al.,* 2022; Ondiek *et al.,* 2013). The browse forages have high crude protein content, which makes them good protein supplements to poor quality roughages particularly during the dry season (Tao *et al.,* 2022).

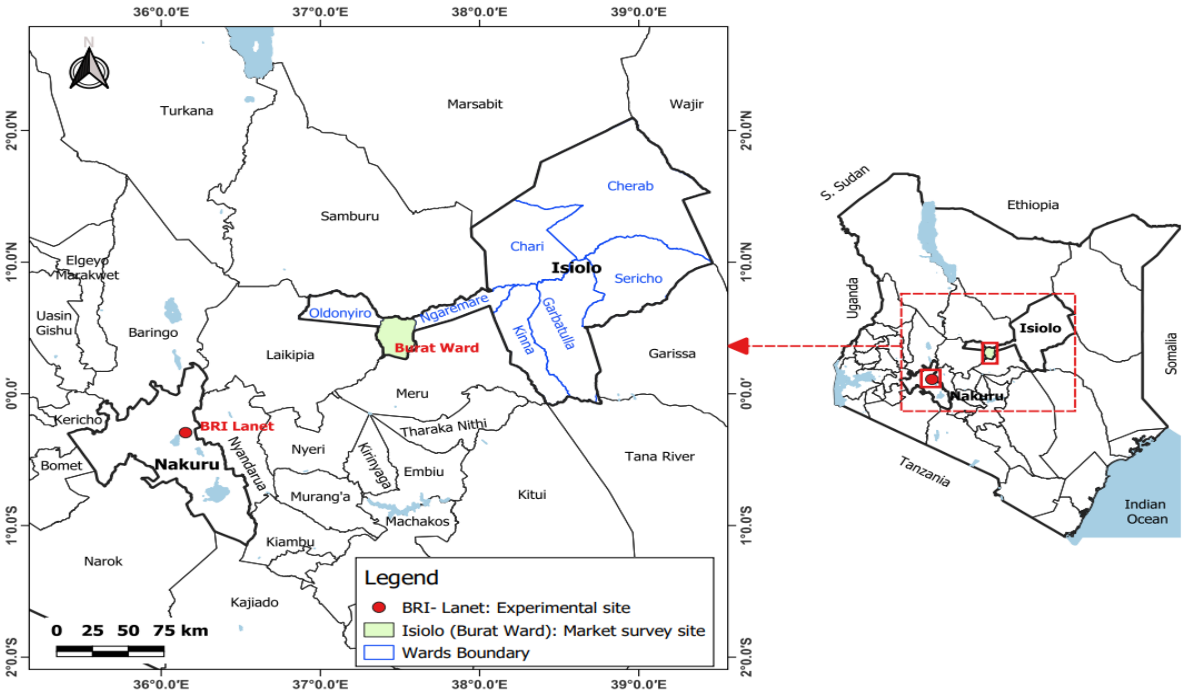
Prosopis Juliflora is a prolific, evergreen, and very adaptable to drought conditions and a rich protein source for the animals. Further, promoting *Prosopis Juliflora* enhances the capacity to utilize the plant and control its unwanted spread (Maundu et al, 2009; Muho and Omar 2020). Similarly, *Balanites aegyptiaca* is also a high-protein feed (Kemboi, 2018) that can easily grow in the ASALs. Additionally, the *Acacia tortilis* tree is an important resource whose leaves and pods contain high protein levels, which can also be utilized during drought periods (Mutai, et al., 2022; Sagala, Gachuiri et al., 2020). The feeding value and quality of *Prosopis juliflora, Acacia tortilis,* and *Balanites aegyptiaca* forages for animal consumption have been evaluated (Derero & Kitaw, 2018; Kemboi, 2018; Mangara, 2018; Mathur et al., 2018; Ondiek et al., 2017 Zampaligré et al., 2013).

The use and adoption of these indigenous forages in feedlot fishing is an option that pastoralists can use but its potential has not been sufficiently explored. Although Pacheco, et al. (2021) classified feedlot technology as high risk with a high probability of economic loss, local feed resources are an option that can be adopted to reduce these risks, especially for pastoral farmers. These local feed resources are critical resources for livestock sustenance in the ASALs and therefore need to be explored and utilized. However, little is known in Kenya about the costs and benefits of finishing beef cattle under a feedlot system using these feed resources. To promote the adoption of feedlot finishing, this study therefore sought to investigate the financial viability of feedlots using local feed resources in Kenya.

Materials and Methods

This study was conducted at the Kenya Agricultural and Livestock Research Organization-Beef Research Institute (KALRO-BRI), Nakuru, Kenya, (0° 18¢W, 36°09¢E) (Kenana et al., 2020). The institute occupies 1,418 hectares of land of which 20% is in Ecological Zone Three and 80% in Ecological Zone Four. The rainfall pattern is bimodal with an annual mean of 800mm and a relative humidity of 83% with temperatures ranging between 10°C and 26°C. Information was obtained from the feedlot experiment with 18 beef steers and control of 9 beef steers of Zebu, Boran, and Sahiwal Cross breeds for 90 days. Two-year-old steers with an initial average body weight of 205±1.3 (mean ± se) were randomly assigned in a randomized complete block design (RCBD) to two (grass and silage-based) feeds, with a control kept under ranching conditions. Each ratio had three breeds assigned to it, and each breed was replicated three times. The breeds were selected based on the preferences of Kenyan beef cattle ranchers. Daily feed intake and weekly weight increase were recorded for each animal. The crude protein (CP) content of the diets was 15.4 g/kg DM in Ration 1(Rhodes-based) and 16 g/kg DM in Ration 2 (Sorghum-based). The metabolizable energy content was 11.06 MJ/kg DM in ration one (Sorghum-based) and 12.3 MJ/kg DM in the ration. The animals were fed twice a day. Additionally, labor costs and veterinary and medicine costs were captured during the experimentation period. The ingredients used for the formulations of rations were also collected from Isiolo and Kajiado Counties Subsequently, a market survey and Key Informant Interviews were also conducted in Isiolo and Kajiado counties to obtain a record of costs and market prices from local beef outlets, feedlots, and local animal feed dealers. A cost-benefit analysis was then conducted to determine the viability of a feedlot.

Map of the study Areas



Source: Google Maps

Results and Discussion

The results presented in the table below show the chemical compositions of the ingredients used in the feedlot experiment. To meet the daily nutritional needs of the animals, commercial feeds were also included in the feed formulation.

Table 1. Chemical composition (g/kg^{-1}DM) of ingredients used in ration formulation

Parameters	Ration1 (Rhodes Based)	Ration 2 (Sorghum Based)	SEM	P
CP(g/kgDM)	15.4^{a}	16^{a}	0.0667	<.0001
ME (MJ/kg DM)	11.06^{a}	12.30^{a}	0.0851	<.0001
ASH (%)	7.26	5.14	0.0033	<.0001
EE (gkg^{-1}DM)	17.16^{a}	15.93^{a}	0.0085	<.0001
DM (%)	89.23^{a}	87.93^{a}	0.0094	<.0001
NDF(g/kgDM)	65^{b}	81^{a}	0.3064	<.0001
ADF(g/kgDM)	41^{b}	47^{a}	0.2357	<.0001

CP=crude protein, ME= Metabolisable energy, EE= Ether extract, DM=dry matter, OM=organic matter, NDF=Neutral detergent fiber, ADF= Acid detergent fiber.

Breed selection for the experiment

The table below shows the selection and distribution of breeds and the initial weights of the steers for the experiment.

Table 2: Description of breeds used in the experiments

Boran		Zebu		Sahiwal Crosses	
	Initial Weight (kg)		**Initial Weight (kg)**		**Initial Weight (kg)**
Confined group					
8F40	227.0	ZB4	162.5	8F107	211.0

8F110	203.0	ZB6	153.5	9F53	201.0
8F87	209.0	ZB1	201.0	8F117	218.0
8F24	207.0	ZB3	175.0	8F18	254.0
8F95	219.0	ZB9	155.5	8F47	249.0
8F51	230.0	ZB2	197.5	9F65	226.0
Control group					
8F49	259.0	ZB7	167.5	8F19	280.0
8F90	269.0	ZB5	157.0	8F11	337.0
8F82	304.0	ZB8	144.0	8F21	301.0

Cost of ingredients

In beef production, providing an alternative to pasture-based systems is crucial for growing cattle, and improved feed efficiency. Adopting a sustainable feedlot system is crucial since the cost of feed continues to play a critical role in determining the financial viability of the livestock sector (Lynch et al., 2022). The study on feeding management strategy (Galyean, & Hales, 2023) indicates that feed represents about 65 to 75% of the total cost of beef production. Furthermore, beef cattle recover less than 20% of the total energy ingested across most diets, indicating a rather inefficient use of feed for livestock production. The source and quality of feeds are equally important aspects that contribute to variable costs and, ultimately, the margins received from the enterprise. To estimate the profitability of the two rations in this experiment, the cost of all inputs used during the experimentation was computed to obtain the average cost per animal under each feeding ration.

Table 3 shows the costs of feed as incurred by the experiment. *Prosopis Juliflora pods, Balanites aegyptica, and Acacia Tortilis* pods were locally available ingredients that were sourced from Isiolo and Kajiado counties. The prices for Sunflower cake, Maize germ, Sorghum Silage, Rhodes Grass hay, and Molasses are estimated from the market price information obtained from Kajiado and Isiolo**.** Other costs included the cost of normal cattle management, which were incurred during the experiment period, which included the cost of Dewormer (Canazole), Tetra cyline, Dexa jet, Epsom Salt, and Labour costs. The results show that ration 1 (Rhodes-based) was slightly cheaper than ration 2 (Sorghum based). On average, feeding one steer using ration one would cost KES 29,780, while in ration two it would cost KES 33,960. The use of current market prices is important because prices are the first indicator of value for the products being sold as well as a show of market competitiveness (Mawazo, Kisangiri, & Jesuk, 2014). Further, prices are an important cost component of ingredients that may encourage or discourage the adoption of any agricultural product (Resources & National Research Council. (2015), and are very critical in an input-intensive system such as a feedlot.

Table 3: Cost of Ingredient used under ration 1 and 2

Diet	**Ration 1 Quantity (Kg)**	**Ration 2 Quantity (Kg)**	**Cost per unit (KES)**	**Total cost Ration 1 (KES)**	**Total cost Ration 2 (KES)**	**Total cost (KES)**
Prosopis Juliflora pods	2382	2583	32	76224	82656	158,880
Balanites aegyptica pods	300	234	80	24000	18720	42,720
Acacia Tortilis pods	172	186	80	13760	14880	28,640
Sunflower cake	1900	2660	40	76000	106400	182,400
Maize germ	515	705	28	14420	19740	34,160
Sorghum Silage	0	3255	10	0	32550	32,550
Rhodes Grass hay	219.5	0	150	32925	0	32,925

Molasses	1100	1100	15	16500	16500	33,000
Total Feed Costs				**253,829**	**291,446**	**545,275**
Other costs (18 animals)	*Amount per animal (ml/g)*					
Dewormer (Canazole)	60			450	450	900
Tetra cyline	40			70	70	140
Dexa jet	40			70	70	140
Epsom Salt	500			100	100	200
Labor costs	90 days		300	13500	13500	27000
				268,019	305,636	573,655
Average cost per animal				**29,780**	**33,960**	**31,870**

Ingredient cost estimation by County

The ingredients that were applied in this research included *Prosopis juliflora*, also known as mesquite, this is a common tree species that is prevalent in arid and semi-arid areas, most in areas such as Kajiado and Isiolo Counties. Despite its invasive nature, it offers significant potential in these areas as a resource for beef production. Moreover, the pods of *Prosopis juliflora* are rich in carbohydrates and proteins and are so important for beef production, making them a viable energy and protein source for livestock (de Lemos et al., 2023). The seeds within the pods also contain essential nutrients that promote milk production and cattle health making them essential feed resources in the ASAL region. Generally, *Prosopis Juliflora and Balanites egyptica* trees occur naturally in the communal lands in the ASALs and resource-poor farmers can benefit from these free resources. However, those farmers who are time-constrained can pay labor costs to get the feed resources that are available just within their locality.

From Figure 1 below, this study shows the cost of Rhodes grass and sunflower cake was higher in Isiolo compared to Kajiado while the cost of obtaining *prosopis pods* was higher in Kajiado than in Isiolo (Makini et al., 2019). This is characterized by the fact that Kajiado County is endowed with highly nutritious soil where farmers have ventured into producing fodder and animal feed ingredients. Similarly, Kajiado County is neighboring Makueni, which is a major livestock production hence the availability of improved livestock feeds at an affordable cost for standard farmers (Kimaru, 2023). Generally, sunflower cake and *Prosopis Juliflora* pods contributed to over 20 percent of the total feed cost for the two Counties while in Isiolo, Rhodes hay grass contributed over 18 percent of the total feed cost. Commercial feeds may provide critical nutrition for increased weight gain in the feedlots. However, this is critical for pastoral farmers, since the commercial feeds are largely inaccessible due to the high costs of transportation and purchasing of these feeds, from production areas to the ASALs hence opting for scavenging to sustain their livestock.

Moreover, the findings in Figure 1 also show the price of maize germ to be significant in computing the overall cost of feed. Research shows that there are options that can be considered to lower this cost, for example, growing own maize. For the ASALs however growing maize may not be the best option since the region is conducive to maize production, but sorghum and millet can offer equal benefits since they survive well in ASALs. In Brazil, for example, da Silva, et al., (2020), showed that feedlots were economically viable to replace maize-based diets with pearl millet. Indeed, with the current research that has focused on promoting these crops in the ASALs, this is one aspect that can be further researched on to further promote feedlot systems in the ASAls using the available cost-effective ingredients.

These results justify the need to implement policies and strategies that encourage on-farm production of these feed ingredients as a way of reducing total costs for feedlot enterprises that adopt the rations used in this study. In the ASALs, the adoption of improved varieties, which are more resistant to drought, could improve feedstock systems. Furthermore, this study also presents an opportunity for the commercialization of these local prolific forage resources in supporting livestock in other ASAL counties that are climate-impacted and don’t have the forage.

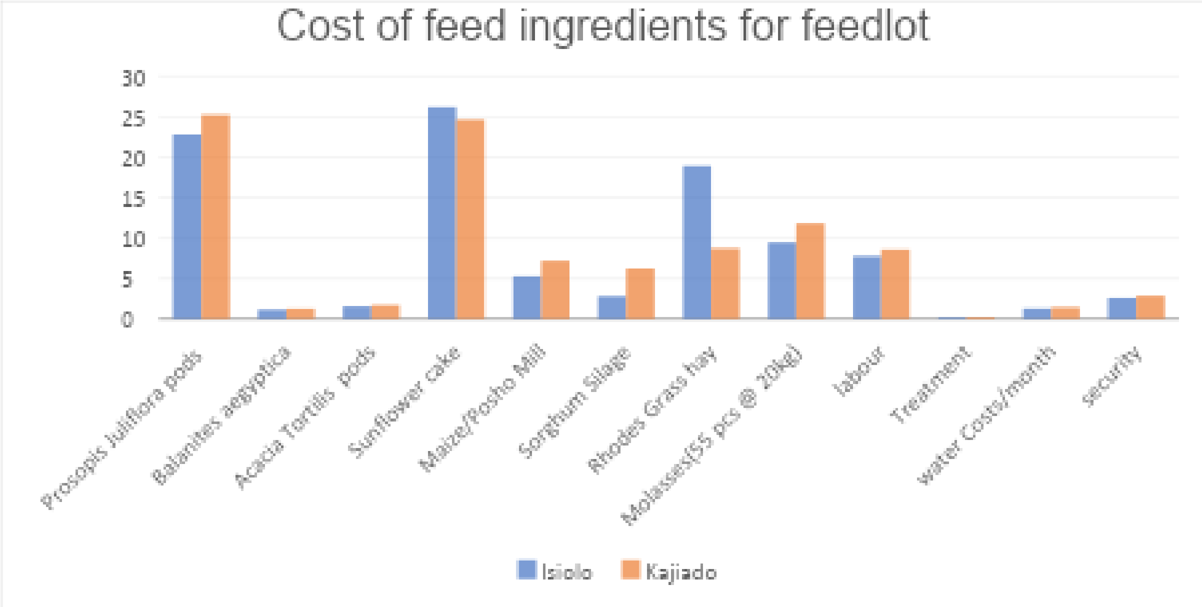


Figure 1: Contribution of ingredients to total cost of feed in the feedlot

Identification and Estimation of Benefits

The weight acquired by the steer is the most essential advantage to the enterprise in a feedlot finishing system. Additionally, the quality of the animals selected for the system is also a significant factor. Furthermore, the mix, quality, and cost of feed materials used in the feedlot all contribute to the overall benefit (cost) that a farmer will receive following the finishing phase. The benefits of feedlot technology were calculated for this study by estimating increased weight gained during the experiment period. Weight was measured at 1-week intervals for 90 days. The total weight gained was calculated by subtracting the final weight from the weight at the start of the experiment. The difference in weight of the steers in this experiment was then used as the benefit gained from the experiment. To identify the costs, the main factors of production in the feedlot system were identified and estimated. These may include the initial cost of the steers, feeds, labor, depreciation, treatments, and salt lick (Gabdo, 2020). For this study, costs were derived from feeding, treatments, and labor costs. Feeding costs constituted the costs of acquiring and constituting the feeding rations. Moreover, economic factors, in this case, play a major role in the feedlot objectives and can be influenced by legislation, the environment, welfare, consumer demands, animal health, and availability of labor, which in turn increase the overall cost (Tabu et al., 2025). In contrast, nutrient utilization reduces the feeding cost, reducing feed wastage and nutrient excretion, and this is improved by precision feeding. Moreover, the utilization of feeding techniques allows the correct amount of feed to be used per cattle with the right composition of nutrients to be provided at the right time to the "right" animals. On a global scale, Liu et al. (2022), beef producers need to venture into tools that will enhance their production to increase to more high-quality products whilst maintaining economic efficiency.

The results as shown in figure 2 below that the overall weight gain varied with the type of breed. Animal 8F51 (Boran) gained the highest weight followed by 9F65 (Sahiwal) under feeding ration 2 while 8F110 (Sahiwal) gained the most weight under ration 1. This clearly shows the importance of selecting the right steers with the greatest potential to increase weights for feedlots. These findings underscore the critical advantages of selecting the appropriate breed and individual steers with the highest genetic and physiological potential for weight gain when optimizing performance in feedlot operations. Different breeds may respond differently to specific feeding regimens. Therefore, careful consideration must be given to matching the feed rations to the breed and genetic potential of the steers to achieve the best outcomes for growth performance and economic returns

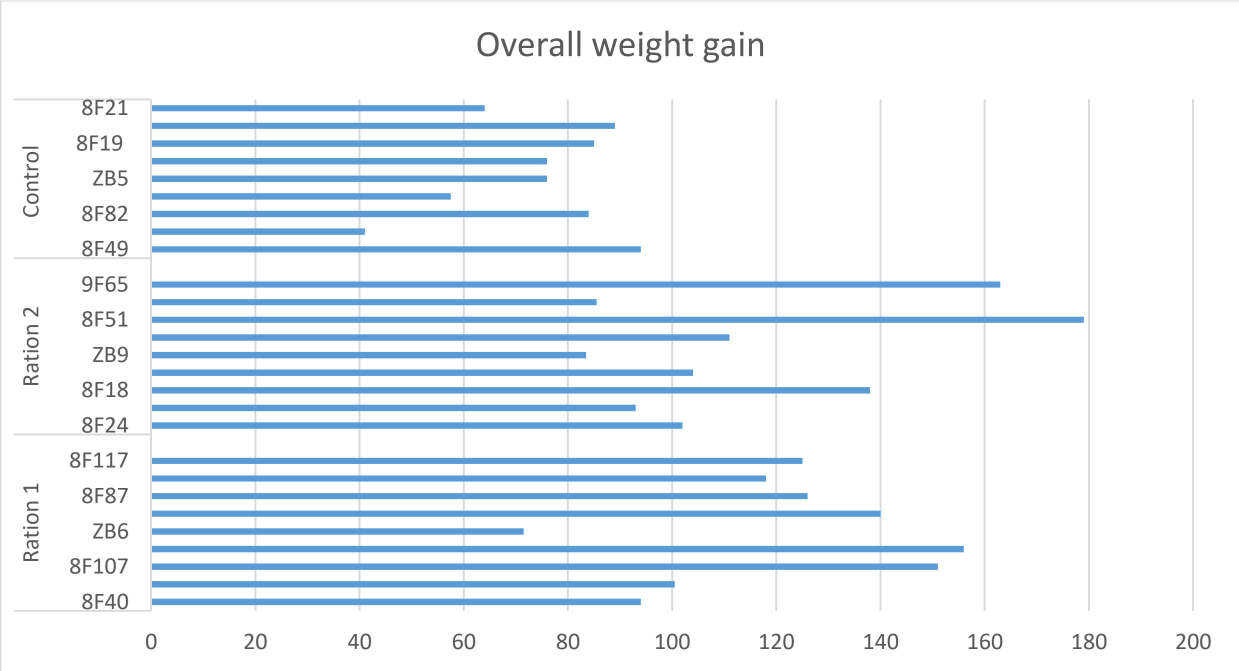


Figure 2: Weight gain for different breeds in the feedlot experiment

Comparison of weight gain between the control and feedlot steers.

Generally, the results as shown in figure 3 below that under the feedlot system, the steers gained more weight when compared to the control. The ability of a feedlot system to generate profits depends on the ability of the steer to gain more weight compared to a steer left to openly graze. The quality of the animals confined in the feedlot for finishing and the ingredients for finishing were the key contributors to the final weight gain (Maciel et al., 2021). This finding highlights the efficiency of the feedlot system in optimizing growth rates through controlled feeding and management practices.

The ability of a feedlot system to generate profits relies heavily on the capacity of steers to gain more weight than those allowed to graze freely. Steers in the feedlot system benefit from a structured feeding regimen that provides a consistent and nutritionally balanced diet, ensuring optimal growth and weight gain (Slayi et al., 2023). In contrast, control steers, which typically rely on natural grazing, may experience fluctuations in nutrient availability due to seasonal variations and forage quality, leading to slower weight gain.

Several factors contribute to the enhanced weight gain observed in feedlot steers. The quality of the animals selected for confinement plays a crucial role, as genetically superior steers with better growth potential tend to perform better under intensive feeding conditions. Ferrinho, (2019), the composition of the finishing diet, which typically includes high-energy grains, protein supplements, and essential vitamins and minerals, significantly influences the overall weight gain. This carefully formulated diet ensures that the steers receive the necessary nutrients to maximize muscle development and fat deposition within a shorter period.

Moreover, environmental factors in the feedlot system, such as reduced physical activity, controlled stress levels, and consistent health management practices, further contribute to improved growth performance (Kahl, 2018). In contrast, free-grazing steers may expend more energy in search of food, which can limit their net weight gain. Therefore, controlled conditions of the feedlot system result in a higher and more predictable weight gain compared to open grazing (Tura et al., 2024). Since the efficiency of this system underscores the economic advantage of feedlot finishing, particularly in commercial beef production, where maximizing weight gain within a given timeframe is essential for profitability hence farmers can predict the market.

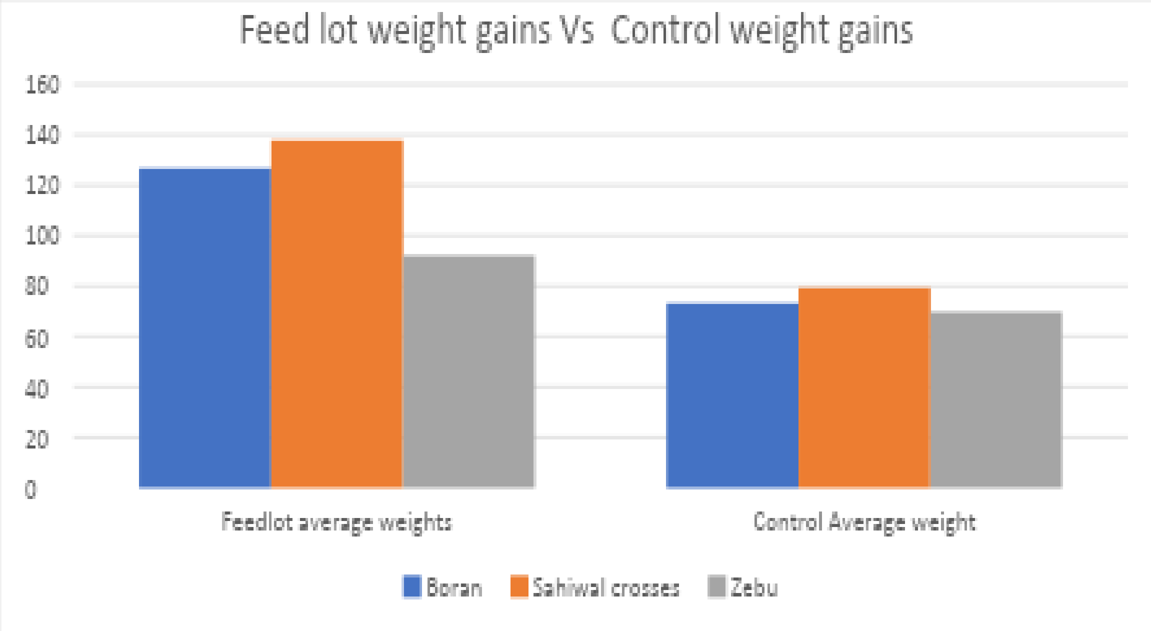


Figure 3: *Comparison of weight gain between the control and feedlot steers*

Breed characteristics

The experiment assessed the economic performance of three cattle breeds Sahiwal, Boran, and Zebu under different feeding and confinement conditions. The selected breeds were subjected to two formulated rations in a confined system, while a control group of the same breeds remained unconfined. The focus of this procedure was to determine how these conditions influenced weight gain and overall economic viability.

As indicated in Figure 4 below, Sahiwal cattle demonstrated superior weight gain compared to Boran and Zebu breeds. This was characterized by the fact that Sahiwal's exhibited better-feed conversion efficiency under the tested feeding regimen (Bedada, 2021). Similarly, several factors may have contributed to this outcome, for instance, genetic potential, adaptability to intensive feeding, and metabolic efficiency. Boran and Zebu, while resilient breeds, exhibited lower weight gains, possibly due to their evolutionary adaptation to extensive grazing systems rather than intensive feeding strategies.

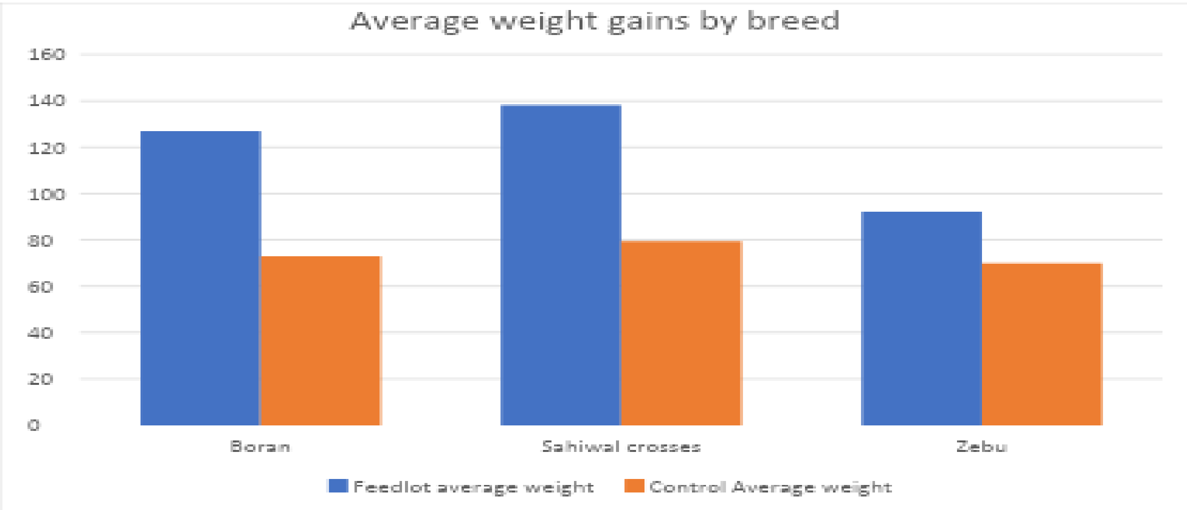


Figure 4: Comparison of weight gain between cattle breeds under experiment

The superiority of Sahiwal's growth performance can be attributed to the breed's enhanced feed conversion efficiency, which allows them to effectively utilize nutrients more compared to other breeds under the tested feeding regimen (Shashank et al., 2023). Sahiwal demonstrated a more efficient conversion of feed into body mass compared to Boran and Zebu cattle due to their genetic adaptability and metabolic advantages.The findings indicate that differences in growth performance have important economic implications. For instance, Sahiwal's, with their higher weight gain, may offer a more profitable option for farmers using confined feeding systems. However, adaptability of Boran and Zebu in less intensive systems could make them suitable for low-input production settings where feed are a constraint. Therefore, this study aimed to compare the economic performance of selected three breeds of cattle, confined and fed, using two formulated rations. This is then compared with the same type of breed under an unconfined system which was the control.

Market comparison of Cost-benefit analysis for beef sold at a local auction and value-added markets
Markets play a crucial role in the modernization of agricultural value chains by influencing both production efficiency and profitability. Through push-pull mechanisms, markets drive the adoption of improved farming practices and create incentives for value addition (USAID, 2020; Mainville & Narayan, 2017). The characteristics of these markets, such as pricing structures and market access, directly impact the livelihoods of beef farmers. In regions where livestock farming is a primary economic activity, market dynamics determine whether production systems, such as feedlot finishing, can be profitable. Understanding the cost-benefit implications of different market types is therefore essential for decision-making by farmers and policymakers.

While some locally available feed ingredients had relatively stable prices, key components such as Molasses, Sorghum Silage, and Rhodes Grass used in the experiment exhibited considerable cost variations, making them major contributors to the overall ration expenses. These feed components are essential for finishing cattle under a feedlot system, which aims to enhance weight gain and improve meat quality. However, the price fluctuations of these feeds could add financial pressure on farmers, particularly those relying on feedlot systems as opposed to traditional grazing methods.

Local auction markets remain the dominant market outlet for beef farmers in these counties. A notable characteristic of these auction markets is the lack of price differentiation based on cattle breeds. Unlike structured value-added markets, where meat quality, marbling, and breed-specific attributes influence pricing, local auctions treat all beef equally, leading to uniform pricing. The survey found that the average price per kilogram of live weight was KES 202.00 in Kajiado and KES 290.00 in Isiolo. The price disparity between these two Counties may be attributed to factors such as market demand, transport logistics, and variations in bargaining power among farmers. However, in both cases, the pricing structure at auctions does not favor farmers investing in high-cost finishing systems.

The economic evaluations for both counties indicate that finishing cattle under a feedlot system is not profitable if the targeted market is a local auction. While feedlot systems offer benefits such as faster growth rates and better carcass quality, their high input costs outweigh the revenue generated from auction sales (Guelker, 2024). Given that auction prices do not reflect quality improvements from intensive feeding, farmers are unable to recover their production costs. This challenge is further compounded by fluctuating feed costs, which vary between counties and represent a significant portion of the total expenditure.

Given these findings, farmers who rely solely on local auction markets may need to reconsider their production strategies. One potential approach is market diversification, where farmers seek access to value-added markets such as butcheries, supermarkets, and export-oriented meat processors that offer premium prices for high-quality beef. Additionally, adopting low-cost grazing strategies may be more sustainable for farmers targeting auction sales, as it minimizes input costs while maintaining reasonable market returns. According to Trotter, (2020), policy interventions, such as improving transport infrastructure, increasing price transparency, and facilitating direct farmer-market linkages, could also enhance market efficiencies and provide better financial outcomes for producers.
As shown in the table below, economic evaluations for both Kajiado and Isiolo show that it was not profitable to finish cattle under a feedlot system, if the targeted markets are local auction markets. While the cost for the local ingredients may not vary between the counties, the costs for Molasses, Sorghum silage, and Rhodes grass varied and represented a huge percentage of the ration costs.

Table 4: Cost-benefit analysis of beef sold in local and value-added markets

	Value-added Market			**Local Market**		
	Ration	Ration 2	Total	Ration 1	Ration 2	Total

	1					
Weight gain (Kgs)	1,082	1,059	2,141	1082	1059	2,141
Price per Kg in Kajiado	450	450	450are	202	202	202
Benefits Dressed (KES)	277,533	271,633.5	549,166.5			
Benefits-Offal (KES)	93,052	91,074	184,126			
Total benefits (KES)	370,585	362,707.5	733,292.5	218,564	213,918	432,482
Feed cost (KES)	261,547	284,456	546,003	261,547	284,456	546,003
Benefits less Cost (KES)	109,038	78,251.5	187,289.5	(42,983)	(70,538)	(113,521)
Less operational cost (KES)			20613			20,613
Net Benefit (KES)			166,676.5			(134,134)
Price per Kg in Isiolo (KES)	500	500	500	290		290
Benefit- Dressed (KES)	308,370	301,815	610185			
Benefit-offal (KES)	93,052	91,074	184126			
Total benefit (KES)	401,422	392,889	794311	313780	307,110	620,890
Feed Cost (KES)	342,054	271,826	613880	342054	271,826	613,880
Benefits less Costs (KES)	59,368	121,063	180431	(28274)	35,284	7,010
Less operational cost (KES)			20613			20,613
Net Benefit (KES)			159818			(13,603)

Aside from the auction markets, market surveys showed that beef producers also sold to prime markets where the animals were slaughtered and dressed. For this study, it is estimated that from the weight of a live animal, 57 percent will form the meat while 43 percent will form the offals.

Beef meat is estimated to be KES 450 per kilogram in Kajiado and KES 500/Kg in Isiolo while offals are sold at KES 200 per Kg in the two markets. The overall weight gain from the feedlot experiment was then apportioned using the same technique to estimate the total benefit for the value-added markets. As presented in the table above, it is indeed financially viable to operate a feedlot if the targeted markets are value-added. For both Isiolo and Kajiado, the benefits were positive. This finding implies that for feedlot systems to take off, markets play a huge role.

Break-even analysis

An approximation of break-even analysis is presented in figure 5 below. An increase in the current price of beef per kilo of KES 290.00 by a small margin to KES 296.30 (0.02 percent) in Isiolo will make the feedlots break even. The difference in break-even points between the two counties could be because the cost of feed in Isiolo was found to be higher as compared to Kajiado. Similarly, in Kajiado, an increase in the current price of KES 202.00 to 260.70 (28. 71 percent) will allow the feedlots to break even. These findings show the importance of securing better markets for beef farmers. This is important to enable development partners to support pastoralists in securing a better market environment that can enable beef farming to achieve profits.

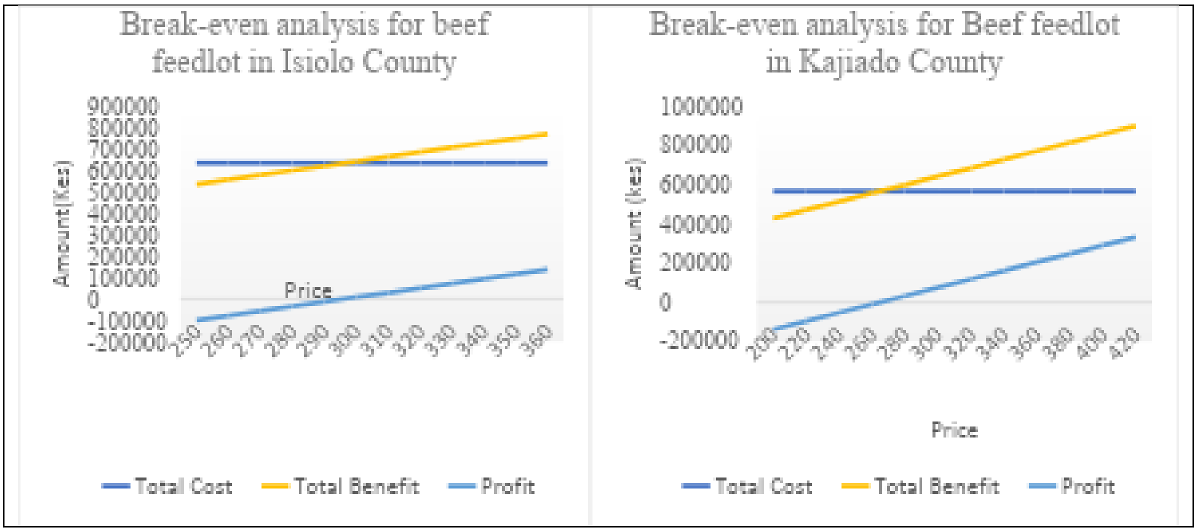


Figure 5: Graph showing Break-even analysis for Kajiado and Isiolo Counties

Conclusion

The source and quality of feeds are critical components in determining variable costs and corporate margins. To analyze the profitability of the two rations in this experiment, the cost of all inputs used during the experiment must be calculated to determine the average cost per animal under each feeding ration. Furthermore, commercial feeds provide vital nutrition for higher weight gain in feedlots. However, this is crucial for pastoral farmers because commercial feeds are mainly inaccessible due to the high expenses of transportation and purchasing feeds from producing areas to ASALs, forcing them to rely on scavenging to feed their livestock. As a result, these findings highlight the need to implement policies and tactics that promote on-farm production of key feed ingredients as a means of lowering total costs for feedlot companies that employ the rations studied. The adoption of drought-resistant cultivars in ASALs is recommended to enhance feedstock systems. Furthermore, this opens the possibility of commercializing these abundant local forage supplies to support pastoralists in other ASAL counties who lack pasture due to climate change. Demonstrating the importance of creating better markets for beef farmers, development partners may assist pastoralists in securing a better market environment that allows cattle farming to be profitable.

Recommendation for Future Research

While feedlot systems are recommended for boosting productivity and profitability, several concerns must be considered in decision-making that could not be explored in the scope of this study. First, the impact of climate change on the steers and the impact of expanded feedlots on climate change and greenhouse gas emissions need to be quantified. The effect on heat stress in pastured beef cattle is less severe than in feedlot cattle due to decreased animal mobility and radiating heat from dirt or concrete under feedlots. The effect of harvesting the local feed resources on environmental conservation is also important. Promoting the seeding of tree crops is required to preserve biodiversity in the ASALs. Climate risk mitigation measures must therefore be included in any feedlot analysis for long-term sustainability. Second, with the increasing demand for human food, it is critical to comprehend the impact of feeding rations on human food availability. For faster weight gain in feedlots in many industrialized countries, feed formulations tend to emphasize higher grain intake while decreasing forage diet composition. In the long run, this leads to larger emissions and negative economic returns. In the setting of this study, where persistent food poverty is a major concern, the usage of locally selected feed resources does not compete directly with human food, hence offering more benefits.

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Data Availability Statement

The authors certify that the data used in this article was collected for the study and can be availed by the corresponding authors upon request.

Informed Consent Statement

This study was conducted according to the guidelines of the Declaration

Competing Interest

The authors declare that they have no conflict of interest.

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