Scientific Research Publishing

Open Journal of Animal Sciences, 2025, 15(3), 259-268
https://www.scirp.org/journal/ojas
ISSN Online: 2161-7627
ISSN Print: 2161-7597

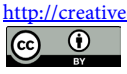
Participatory Demonstration of Concentrate-Based Fattening Technology of Black-Head Somali Sheep in Danod District, Dollo Zone, Somali Region

Mahamed Hassen*, Aden Omer

Livestock and Rangeland Research Directorate, Somali Region Livestock and Agricultural Research Institute (SoRLARI), Jigjiga, Ethiopia
Email: *raabi6947@gmail.com

How to cite this paper: Hassen, M. and Omer, A. (2025) Concentrate-Based Fattening Technology of Black-Head Somali Sheep in Danod District, Dollo Zone, Somali Region. *Open Journal of Animal Sciences*, **15**, 259-268.
https://doi.org/10.4236/ojas.2025.153018

Received: May 20, 2025
Accepted: June 23, 2025
Published: June 26, 2025



Abstract

A cross-sectional study was carried out to participatory demonstration of concentrate-based fattening technology of Black Head Somali Sheep in Danod District of Dollo Zone, Somali Region. Twenty five (25) PAPAREGs have been selected based on interest, willingness to accept technology and become model for pastoralists/agro-pastoralists in the study area. Beneficiary agro-pastoralists, DAs and livestock experts were given trainings on improved small ruminant fattening techniques and feeding management of the experimental animals as awareness creation and capacity building. The experimental selected animals were prepared for supplementary feeding technological option made of ration constituting of 100% natural grass hay, 50% WB: 50% NC, 75% WB: 25% NC and 25% WB: 75% NC For T1, T2 T3 and T4 respectively. The proportions were offered to the experimental animals which have been already assigned randomly. Experimental feed was introduced to BHS at 0.3 kg/head/day with gradual increment within 14 days period. Initial live body weights have been measured and recorded prior to the experiment and weight gains were monitored through fortnight live body weight measurement and recording for a period of 90 days. Data was analyzed using Microsoft ware Excel 2007 and procedure of SAS. There has been a significantly ($P < 0.05$) difference in mean live body weights after the experiment. The Average Daily Gains (ADG) of sheep supplemented were higher than those not supplemented. ADG for sheep supplemented with concentration for treatment T2, T3 and T4 were 0.08, 0.06 and 0.10 kg/day, respectively. While, sheep in the control treatment yielded lowest daily gain 0.05 kg/day. The highest weight gain per animals were received for the T4 fed with 25% WB and 75% NC. Accordingly, the economic benefits agro-pas-

toralists obtained after selling their finished Blackhead Somali sheep were very high. Therefore, the 75% NC with 25% WB feeding technological options is recommended for scale up at larger scale.

Keywords

Demonstration, Participatory, Fattening, Technologies, Blackhead Somali Sheep

1. Introduction

Ethiopia has over 39.89 million heads of sheep [1]. However, sheep productivity is very low. The average carcass yield of sheep is 10 kg per animal which is below the East African (11 kg) and the world (12 kg) average [2]. In Ethiopia, the current per capita consumption of meat is 13.9 kg/year, being lower than the African and the world per capita averages, which are 27 kg/year and 100 kg/year, respectively [3].

Animal fattening is an opportunity for employment and is a means of income generation for the poor, especially the landless and widowed women [4]. Sheep fattening is an efficient income-generating option for small-scale farmers and is a source of family employment. Ethiopian female exhibited better skills in sheep husbandry compared to male households [5]. However, they are unable to realize substantial benefits due to their low level of business experience, access to technology and participation in local markets. Females are confronted by a heavy domestic workload and subsequently face time constraints as well as limited access to resources, such as land, credit and production inputs.

Sheep fattening is one of the options that rural youth and women confronted with the mentioned challenges can use to improve their incomes. As fattening technologies require less land and increase productivity as well as income, demonstration of such agricultural technologies is important. Studies also indicate that rams fattening is a relatively easy and profitable system of animal rearing to reduce poverty, unemployment and generate income for the rural people [6]. In line with this idea, growth performance evaluation experiment was done at Babase kebele of Danod district using different dietary rations on Blackhead Somali sheep in the process of developing sheep fattening technologies. Hence, this study is designed to demonstrate the concentrate-based rams fattening in Babase Kebele of Danod district.

2. Method and Materials

2.1. Description of the Study Area

This research was carried out from April 2023 to April 2024 in the Dollo zone, particularly in Danod Woreda. Dollo zone is one of the eleven zones in the Somali region of Ethiopia. Dollo is bordered on the southwest by the Korehei zone, on

the northwest by the Jarar zone, and on the northeast and southeast by Somalia. Doolo zone has two agro-ecological zones, namely, warm arid lowland and hot arid lowland plains. Warder is the main and administrative center of the zone, and it has a latitude and longitude of 6˚58′N 45˚21′E with an elevation of 541 meters above sea level. It has an annual average temperature of 28˚C. Warder is 537 km far from Jigijiga and 1131 km from Addis Ababa. Based on the 2007 census conducted by the Central Statistical Agency of Ethiopia (CSA), this zone has a total population of 306,488, of whom 175,624 are men and 130,864 are women. According to the [7] report, the estimated population of small ruminants in the zone consists of 791,174 sheep and 647,253 goats. Small ruminants are the primary livestock in the area. Additionally, the majority of the community comprises pastoralists who heavily rely on these livestock resources for their livelihood and economic activities.

2.2. Establishment of PAPREGs

For this project, members of Pastoral and Agro-pastoral Research Groups (PAPREGs) were selected based on their availability, potential for small ruminant fattening, interest in the activity, and willingness to work collaboratively, as well as considerations of gender and age diversity. From the 25 PAPREG members, 10 model pastoralists who demonstrated strong commitment and willing to provide goats for the project were chosen through a participatory discussion involving all PAPREG members and the project team. The intervention was implemented in the farms of these selected individuals. Throughout the intervention period, all PAPREG members were actively participated in the project activities. In addition to, the 10 pastoralists, two extension workers and two experts from the district agricultural bureau provided training on the techniques and appropriate levels of feeding using improved feeds for sheep fattening.

2.3. Training of PAPREGs

A training manual on small-scale goat fattening and management practices, translated into the local language, was developed and distributed to all participants for future reference. In addition, a three-day training session was conducted for the PAPREGs at the Kebele level of the Pastoral Training Center (PTC). The training covered a comprehensive range of topics, including an introduction to sheep fattening, essential aspects of sheep nutrition, various types of concentrate feeds, ration formulation, and effective feeding strategies. It also addressed health management, growth monitoring, record keeping, and economic considerations. Additionally, participants engaged in practical demonstrations and gained insights into marketing, selling, sustainability, and the environmental impact of sheep fattening practices.

2.4. Experimental Animals and Management

Twenty-four yearling Blackhead Somali sheep with relatively similar body weight were selected and identified using ear tags. The animals were isolated and quaran-

tined for 21 days. The rams were treated against internal and external parasites before commencement of the feeding. Then all Blackhead Somali sheep were transferred to their individual pens and offered the basal diet and supplemented with experimental feeds for fifteen days to adapt to the feed prior to the beginning of the actual experiment. After the period of adaptation, the initial body weights before the first day experiment were measured.

2.5. Feeds and Feeding Managements

Hay was used as a basal diet throughout the experimental period, and wheat bran was purchased from the locally available markets. Hay was chopped, weighed, and offered to the experimental animals ad libitum. Noug cake (NC) and wheat bran was purchased from the Sufi Livestock Feed Processing factory. After the feed is prepared completely, the supplemented feed was prepared using 100% natural grass hay and three different mixtures: 50% wheat bran (WB): 50% noug cake (NC), 75% WB: 25% NC, and 25% WB: 75% NC. These supplements were offered to the experimental animals, which had already been randomly assigned to their respective groups. Hay, mineral supplements, and clean water were provided ad libitum throughout the study. The feed supplements were offered twice daily at 08:00 and 16:00 hours for 180 days. The ration provided was assumed to be adequate for the entire duration of the experiment.

2.6. Chemical Composition of Experimental Feeds

Table 1 indicates the chemical composition and total digestible nutrients of the wheat bran and Noug cake used in the ration.

Table 1. Chemical composition of feed ingredients.

Feed type	Chemical composition					
	DM	Ash	NDF	ADF	ADL	CP
Wheat bran	91.1	4.3	40.9	17.6	4.2	16.9
Noug cake	92.9	7.7	36.3	31.2	11.3	34.2
Rhodes grass hay	91.5	11.7	70.3	52.1	17.3	6.3

Note: DM = Dry matter, NDF = Nutrient Detergent Fiber, ADF = Acid Detergent Fiber, CP = Crude Fiber, ADL = Acid Detergent Lignin.

2.7. Experimental Design and Treatment

The experimental design was completely randomized block design (RCBD) with four treatments and six replications. The sheep were blocked based on their initial BW into six blocks and animals within each block were randomly assigned to one of the four dietary treatments. Total animal used were 24. Experimental feeds were grass hay, wheat bran (WB) and noug cake (NC). The proportion of supplementary feed on dry matter basis was indicated as follows:

T1: Ad libitum grass hay + 0-gram supplement (0% WB + 0% NC)

T2: Ad libitum grass hay + 300-gram supplement (50% WB + 50% NC)
T3: Ad libitum grass hay + 300-gram supplement (25% WB + 75% NC)
T4: Ad libitum grass hay + 300-gram supplement (75% WB + 25% NC)

2.8. Measurements and Observations

2.8.1. Live Weight Changes

At the beginning of the experiment, the initial body weights of the Blackhead Somali sheep were measured by taking two consecutive measurements in the morning before feeding. Subsequently, live weight measurements were taken at 14-day intervals, consistently at 8:00 AM. The average daily weight gain (ADG) was calculated by subtracting the final body weight and initial body weight and divided by the total number of days in the feeding trial. The formula applied was:

ADG = (Final Weight – Initial Weight)/Duration of Feeding Period.

2.8.2. Partial Budget Analysis

A partial budget analysis was carried out based on the method proposed by [8] to evaluate the economic feasibility of supplementing goat diets with wheat bran, sesame seed cake, and their combinations at different levels. To determine the profitability of the supplementation strategies, data were collected on the purchase and selling prices, as well as the total quantity and cost of the supplemental feeds. Expenses that remained consistent across all treatment groups, such as veterinary services, were excluded from the analysis.

At the end of the trial, the total return (TR) for each treatment group was determined by calculating the difference in the market value of the goats before and after the experiment. Goat prices were estimated at the beginning and the end of the trial using an average value derived from two experienced local livestock traders selected for each treatment group. Net return (NR) was obtained by deducting the total variable cost (TVC) which includes all expenses that varied due to the feeding interventions from the gross return (GR), as expressed by the formula:

$$NR = GR - TVC$$

The change in net return (ΔNR) was computed by subtracting the change in total variable cost (ΔTVC) from the change in gross return (ΔGR), using the equation:

$$\Delta NR = \Delta GR - \Delta TVC$$

The marginal rate of return (MRR) was used to assess the economic efficiency of the investment. It indicates the amount of additional net return gained for each additional unit of variable cost incurred, and was calculated as:

$$MRR = \Delta NR - \Delta TVC$$

2.9. Data Analysis

Collected data was coded and entered in Microsoft Excel 2007 and checked for any errors. Data on economic parameters were analyzed using descriptive statis-

tics. Data on all live weights and economic parameters were analyzed using the Statistical Analysis System [9].

3. Result and Discussion

3.1. Body Weight Gain

The mean final live weight gain, body weight gain and daily body weight gain of sheep fed at different levels of concentrate mixtures among treatments are presented in Table 2. The Final Weights Gain (FWG) of Blackhead Somali sheep on treatment T2, T3 and T4 was 21, 18.75 and 22.16 respectively, which is significantly higher than the gains attained by those experimental sheep under the control group; which was 17.6 kg. An increasing trend of weight gain was recorded with increasing substitution of nugseed cake supplementation. This finding is in line with the results of [10] who reported concentrate supplementation improved daily body weight gain.

The Average Daily Gains (ADG) of Blackhead Somali sheep supplemented was higher than those not supplemented. The average daily gain (ADG) of Blackhead Somali sheep supplemented with concentrate was 0.08 kg/day, 0.06 kg/day, and 0.10 kg/day for treatment groups T2, T3, and T4, respectively. While Blackhead Somali sheep in the control treatment yielded the lowest daily gain of 0.05 kg/ day. The highest weight gain per animal was received for the T4 fed with 25% WB and 75% NC. This might be due to the high palatability of the diet resulting in increased feed intake and a better supply of microbial nitrogen and readily available nitrogen, which enables proper rumen function and efficient utilization of nutrients (Figure 1).

Similarly, [11] emphasized that sheep fed on maize stover and supplemented with graded levels of desmodium hay showed improved total feed intake, digestibility, rumen fermentation and microbial nitrogen supply, which lead to improved nitrogen balance and body weight gain of the animals.

Table 2. Body weight change and daily body weight of Black head Somali sheep fed grass hay as basal diet with different level of concentrate mixture.

Parameters	Treatments				*P*-value
	T1	T2	T3	T4	
	Mean ± SE.	Mean ± SE.	Mean ± SE.	Mean ± SE.	
IBW (kg)	12.75 ± 0.30	13.70 ± 0.43	13.25 ± 0.38	13.16 ± 0.45	0.4
FBW (kg)	17.66 ± 0.57	21 ± 0.46	18.75 ± 1.02	22.16 ± 0.58	0.006
BWG (kg)	4.9 ± 0.35	7.35 ± 0.73	5.5 ± 0.81	9 ± 0.40	0.005
ADG (kg)	0.05 ± 0.003	0.08 ± 0.008	0.06 ± 0.009	0.10 ± 0.004	0.004

Note: P < 0.05—there is a significance difference between treatments SE = Standard Error, IBW = (Initial body weight), FBW (Final body weight), BWG (Body weight gain), ADG = (Average daily gain), Kg = kilogram, T1 = (control group), T2 = (50% Wheat bran + 50% Nug seedcake), T3 = (25% Nug seedcake + 75% Whearbran), T4 = (75% Nugseedcake + 25% Wheatbran).

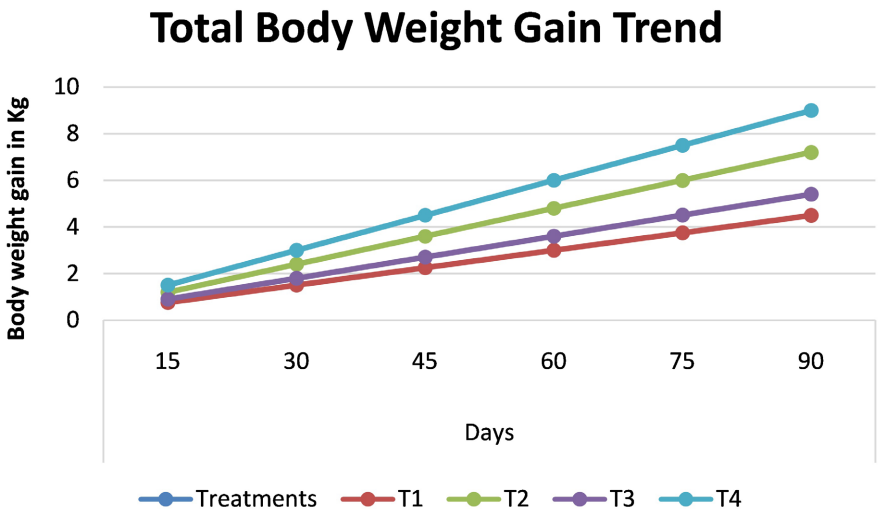


Figure 1. Trend of total weight gain of Black head Somali sheep over fattening period.

3.2. Partial Budget Analysis

The partial budget analysis was conducted to determine the economic benefits of substitution of wheat bran with nug seed cake for Black-Head Somali sheep fed native grass (Figure 2, Table 3). The analysis considered major costs and returns per head of Black-Head Somali sheep. The control group had the lowest net return (758.4ETB) as compared to the highest contrast found in Blackhead Somali sheep supplied with T4 (3,265.7 ETB) whereas the other treatments' profits were intermediate. The net return from each treatment was 758.4, 2610.1, 1506.8, and 13625.7 ETB/head for T1, T2, T3, and T4, respectively. Sheep supplemented with T4 had a higher margin rate of return, followed by sheep placed in T2 and then sheep placed in T3. The marginal rate of return (MRR) for T2, T3, and T4 was 66.34, 64.43, and 69.00, respectively. Therefore, this indicates that sheep supplemented with T2, T3 and T4 increased benefits for each additional unit of 1 birr per sheep cost increment, which results additional 66.34, 64.43, and 69.00ETB, respectively.

Total variable costs were in the order of T1 < T3 < T2 < T4. Hence, T4 has a higher net return, which is economically feasible with the least total variable cost as compared with the other treatments. In other words, income per head was highest in substitution nug seed cake (75%) with wheat bran (25%) than in other treatments. Therefore, substitution of nug seed cake with wheat bran up to 100% is a more profitable and economically optimum combination.

Table 3. Partial budget analysis of experimental feeds.

Parameters	Treatments			
	T1	T2	T3	T4
Purchase price of sheep (ETB/head)	1291.1	1258.1	1350	1400
Wheat bran cost (ETB/head)	-	337.5	506.25	168.75

Continued

Noug seed cake cost (ETB/head)	-	742.5	371.25	1,113.75
Medication + labor cost (ETB/head)	453.3	453.3	453.3	453.3
Selling price of sheep (ETB/head)	1675	5483.3	4225	6383.3
TVC (ETB/head)	458.3	1436.6	1359.1	1558.8
TR (ETB/head)	1216.7	4046.7	2865.9	4824.5
NR (ETB/head)	758.4	2610.1	1506.8	3265.7
NR	-	2830	1649.1	3607.8
ΔTVC	-	952.8	875.8	1075.5
MRR% (ETB/head)	-	66.34	64.43	69.00

Note: T = Treatment, ETB = Ethiopian birr, T1 = (control group), T2 = (50% Wheat bran+ 50% Nug seedcake), T3 = (25% Nug seedcake+75% Whearbran), T4 = (75% Nugseedcake + 25% Wheatbran), TVC (Total Variable Cost), TR (Total Revenue), NR (Net Revenue), ΔNR (Change Net Revenue), ΔTVC (Change Total Variable Cost), MRR (Marginal Revenue Rate).

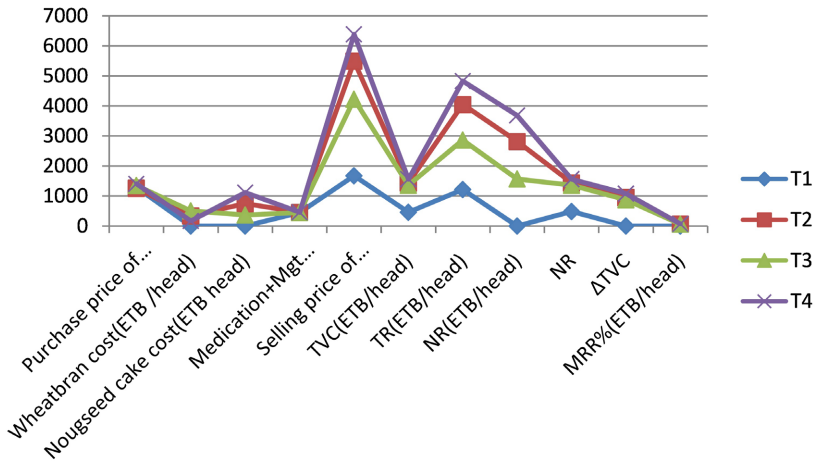


Figure 2. Partial budget analysis among treatments.

3.3. Limitation of the Research in the Area

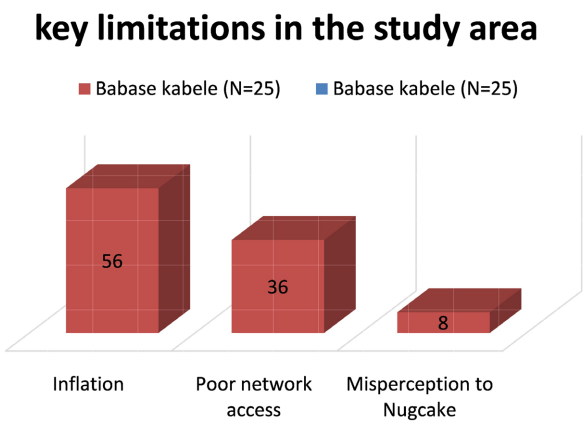


Figure 3. Limitation in the study area.

Major limitations associated with fattening practices were summarized in the following (Figure 3). According to the PAPREGs, the primary limitations undermining fattening activities included high inflation rates (56%), poor network access (36%), and misconceptions about the use of nug cake (8%). These challenges may be attributed to the high cost of commercial feed and the significant proportion of illiterate pastoralists in the region, which further hampers the adoption of improved fattening practices.

4. Conclusion and Recommendations

Supplementation of Blackhead Somali sheep with a concentrate mixture comprising 75% noug cake and 25% wheat bran significantly enhanced their growth performance. Blackhead Somali sheep receiving this supplementation achieved an average weight gain of 22.16 kg over 90 days, indicating improved feed conversion efficiency and overall productivity. This outcome underscores the effectiveness of strategic supplementation using locally available agro-industrial by-products in promoting sustainable livestock production. Therefore, the PAPREGS should take this proportion in order to attain market weight which could be profitable**.**

Acknowledgements

The authors would like to acknowledge Somali region Livestock and agricultural research institute (SoRLARI) and LLRP for their logistic and financial support respectively.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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