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Introduction and Capacity Building on an Innovative and Improved Small-Scale Concentrated Feed for Goat Fattening in Ellele Woreda, SRS, in Ethiopia

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About Article

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ABSTRACT

Feed and water inadequacies in both quality and quantity are recognized as significant production obstacles throughout the value chain. The production of feed adequately meets requirements solely during years of favorable conditions; however, deficits can reach 35% during normal years and escalate to 70% during adverse years. The technologies and knowledge that have been developed to date have predominantly been restricted to on-station experimentation and have lacked participatory evaluation, thereby impeding the transfer of technology or knowledge within this Ellele kebele, Ellele woreda. The objective of the project was to introduce goat fattening technologies specifically for yearling breeds of the long-eared Somali goat, aimed at achieving the requisite market weight of 30 kg, while simultaneously equipping the community with practical training regarding these goat fattening methodologies. The study encompassed 10 goats per pastoralist, culminating in a total of one hundred goats being included in the analysis, which were then randomly allocated to two treatment groups through a lottery system: a control group and a finishing group. The feed formulation utilized for the experimental goats consisted of Wheat bran (49.5%), Noug cake (49.5%), and common salt (1%). The responses of the goats to the feed supplementation indicated that the average initial body weight was 17 kg, whereas the average final body weight was recorded at 23.00 kg, resulting in an average total weight gain of 8.14 kg in terms of goats' fattening performance. Moreover, the implementation of supplementary scaling-up initiatives for this technology is anticipated to encourage private investors to acknowledge the latent opportunities present within the region.

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1. INTRODUCTION

In Ethiopia, the agricultural sector plays a crucial role in the economy, with livestock farming being a significant component. Goat fattening, in particular, presents an opportunity for small-scale farmers to enhance their income and improve food security. The introduction of innovative and improved small-scale concentrated feed is essential for optimizing goat fattening practices, which can lead to increased productivity and profitability. However, traditional feeding practices often limit the growth potential and overall productivity of goats (Hailemeskel & Defar, 2020).

The livestock population of Ethiopia is currently estimated at 57.83 million cattle, 28.89 million sheep, 60.51 million poultry, and 29.7 million goats, excluding nomadic areas (CSA, 2016). The export market demands goats weighing up to 25 to 30 kg at yearling age while most indigenous shoaat breeds are commonly slaughtered around yearling age when their body weights are 18-20 kg (Tesema *et al.*, 2021; USAID, 2023). Moreover, abattoirs' report indicated that the market has been constrained by a lack of consistent and uniform supply of the required weight at younger ages. This report discusses the challenges of feed and water scarcity in agriculture, emphasizing that feed production often meets requirements only in exceptionally good years. It highlights that deficits can reach 35% in normal years and 70% in bad years, significantly impacting livestock productivity (FAO, 2021). Therefore, developing feeding packages that support the existing traditional production, and the emerging private producers and exporters is the timely intervention for increased production and productivity to meet the demand for meat and live animal export market.

To improve this scenario, various research activities have been undertaken in different parts of the country. Various attempts have been made during the last couple of decades to develop technology and generate information to avert these problems and improve production and productivity. The evaluation of feeding options for Indigenous blackhead Somali sheep and goats to achieve export market weight reveals significant insights into their growth. Recent studies indicate that specific feeding strategies and technology can enhance weight gain and improve meat quality, which is crucial for meeting export standards. A study on black-goat fattening feed demonstrated that a balanced diet including energy and protein sources, along with vitamins and minerals, significantly improves growth rates and the overall health of goats (Ping *et al.*, 2015).

Research on sheep and goats from different origins in Ethiopia highlighted that feeding duration directly affects carcass quality, with longer feeding periods leading to better meat characteristics (Abebe *et al.*, 2010). In contrast, while enhancing feeding options is beneficial, it is essential to consider the economic implications and sustainability of such practices in traditional farming systems. Balancing growth with cost-effectiveness remains a challenge for producers aiming for export markets.

However, a significant portion of the technologies and knowledge developed thus far has been limited to on-station experimentation and has lacked participatory evaluation to facilitate the transfer of technology or knowledge in the region, particularly in Ellele woreda. Therefore, the principal aim of

this project was to offer training and enhance the capacity of individuals who have effectively implemented advanced goat fattening techniques in the Ellele 02 kebele, situated in the Ellele woreda.

2. LITERATURE REVIEW

2.1. Overview of goat fattening practices in Ethiopia

Raising small ruminants is a significant part of household life in underdeveloped nations. This is because tiny ruminants offer the simplest and most convenient source of credit available to fulfill urgent financial and social responsibilities (Oluwatayo & Oluwatayo, 2012).

In Sub-Saharan Africa, goats are an essential component of livestock husbandry. They are primarily raised for their milk, meat, wool, manure, and immediate cash sources. They also serve a variety of social and cultural purposes that differ depending on the culture, socioeconomics, agroecology, and geographic location in tropical and sub-tropical Africa (Gobena, 2016).

Goats in Ethiopia are suited for smallholder farmers and pastoralists because of their adaptability to a variety of agroclimatic settings, selective feeding habits, quick reproduction, and minimal capital expenditure (Assefa *et al.*, 2011). Ethiopian goat farming is run by smallholder farmers and is classified as a low-input production method. Nearly every goat in the nation can be produced using this approach (Gizaw *et al.*, 2008). Agro-pastoral and mixed pastoral farming systems are the two main production systems used in Ethiopia to raise sheep and goats (Gobena, 2016).

Small flock sizes, communally shared grazing, uncontrolled mating, lack of recording, low productivity per animal, comparatively limited use of improved technology, and the use of on-farm by-products rather than purchased inputs are some traits shared by extensive systems of production (Abebe, 2008).

2.2. Challenges and opportunities in goat fattening within pastoral communities

Goat fattening within Ethiopia's pastoral communities faces numerous challenges, though it also presents promising opportunities. Primary challenges include recurring feed shortages particularly during droughts the prevalence of diseases, inadequate veterinary services, and harsh climatic conditions that negatively impact goat health and growth (Abegaz, 2014; Yemane *et al.*, 2020). These issues are compounded by limited access to profitable markets and the complexities associated with resource management (Seid, 2017; Wendimu *et al.*, 2018). However, there are substantial opportunities for enhancing goat-fattening practices.

One such opportunity lies in genomic selection, which can significantly improve growth rates and overall performance in goat populations (Ibtisham *et al.*, 2017). Castration, when managed effectively, also helps in directing bucks' energy toward growth by reducing reproductive drives, thereby aiding in fattening efforts (Alemu, 2015; Hagos *et al.*, 2016). Additionally, drawing upon indigenous knowledge and established local practices can optimize fattening strategies by aligning them with the specific needs and resilience of local goat populations (Manzi *et al.*, 2011). Phenotypic characterization further supports these efforts, as it allows for targeted selection



based on desirable morphological traits suited for fattening (Tade *et al.*, 2021).

Another essential strategy involves the identification and effective utilization of high-quality fodder resources, which can address nutritional gaps and enhance growth rates (Belay & Negesse, 2019). By addressing these identified challenges and strategically harnessing available opportunities, goat-fattening practices within pastoral communities can be substantially improved, benefiting both the livelihoods of farmers and the resilience of the local goat populations.

2.3. Nutritional requirements and feed innovation for goat fattening

The nutritional requirements for yearling goats, particularly Somali breeds, are critical for effective fattening and achieving target weights. Concentrated feeds play a significant role in meeting these needs, while innovations in small-scale feed production can enhance productivity and profitability. The following sections delve into these aspects.

2.3.1. Nutritional needs of yearling goats

Energy and protein requirements can vary based on breed and growth stage, with Somali breeds needing tailored formulations to maximize growth rates (Lu, 2024). Essential minerals like calcium and phosphorus, along with vitamins, are crucial for bone development and overall health (Wen *et al.*, 2012).

2.3.2. Importance of concentrated feed

Effective concentrated feed formulations include ingredients like maize, soybean meal, and cottonseed meal, which provide necessary nutrients (Jia, 2012). Properly formulated feeds can lead to daily weight gains of up to 120g, significantly enhancing fattening efficiency (Wen *et al.*, 2012).

2.3.3. Innovations in feed production

Innovations allow for cost-effective feed production, reducing reliance on expensive commercial feeds (Matovu, & Alçiçek, 2023). The incorporation of prebiotics and probiotics is gaining attention, potentially improving feed efficiency and animal health (“(Matovu, & Alçiçek, 2023). While concentrated feeds and innovations in feed production are beneficial, there is a need for ongoing research to refine nutritional guidelines and ensure they meet the specific needs of different goat breeds, particularly in varying environmental conditions.

2.4. Community-based capacity building in livestock management

Community-based capacity building plays a crucial role in enhancing sustainable livestock management practices through training and knowledge transfer. This approach not only empowers local communities but also significantly impacts the adoption rates of improved fattening techniques.

2.4.1. Role of training and knowledge transfer

Programs like those in Northern Kenya and Ethiopia have demonstrated that structured training can lead to the adoption of innovative livestock management practices, such as disease prevention and breed improvement (Coppock *et al.*,

2011; Ojango *et al.*, 2023). Engaging community members in participatory education fosters a deeper understanding of sustainable practices, leading to increased confidence and willingness to adopt new techniques (Budiyoko *et al.*, 2024; Coppock *et al.*, 2011).

2.4.2. Impacts of training on adoption rates

In the case of the Core Innovation Groups in Kenya, members adopted multiple technologies concurrently, indicating a strong correlation between training and practice adoption (Ojango *et al.*, 2023). Training in silage production in Indonesia resulted in enhanced livestock feed management, showcasing how targeted knowledge transfer can improve livestock productivity (Budiyoko *et al.*, 2024). Conversely, while community-based capacity building has shown positive outcomes, challenges such as climate variability and resource limitations can hinder the full realization of these benefits, necessitating ongoing support and adaptation strategies.

3. METHODOLOGY

The project took place in Ellele 02 Kebele, Ellele district of Shabelle zone, Somali Region, Ethiopia from April 2022 to April 2023. Ellele 02 Kebele is home to a pastoral community whose livelihoods depend directly on livestock rearing. However, they face challenges due to unreliable rainfall, even during the rainy seasons, and frequent prolonged droughts.

The primary livestock species in the area are camels, goats, and sheep (referred to as shoats). Cattle and shoats are particularly significant in the region as wealth is largely determined by livestock ownership, especially camels and shoats. Despite the potential and opportunities in the area, there is currently no commendable output in livestock production.

3.1. Training and awareness creation

The main approach used to raise awareness about the technological options being demonstrated among the pastoralists was through training. The goal was to enhance the knowledge and skills of the pastoralists, DAs, and the district livestock bureau experts. The training and capacity-building activities were conducted by a multi-disciplinary team comprising animal production and extension researchers from SORPARI.

3.2. Implementation process

This study uses a participatory approach to assess the effectiveness of concentrate-based goat fattening technology for meeting market weight demand at the on-farm level. To start, a PAPREG (Pastoral Agro Pastoral Research Extension Groups) was established/selected based on interest, willingness to adopt the technology, and the potential to serve as a model for pastoralists in the study area. The selected pastoralists were then randomly divided into control and finishing groups through a lottery draw. Each pastoralist was requested to bring 10 goats to the demonstration site, resulting in one hundred goats being included in the study. Upon arrival at the site, the goats were treated for internal and external parasites. The feed formulation for the experiment consisted of Wheat bran (49.5%), Noug cake (49.5%), and common salt (1%).



The animals in the experiment were gradually introduced to feed over a period of ten days. The finishing group of goats received supplementary feed for 120 days, while the control groups were only fed through grazing. Throughout the experiment, all the animals were allowed to graze freely for a day, and the supplementary feed was given in the evening. At the beginning and end of the experiment, the prices were estimated by a panel of three local live goat dealers, and the average estimate was used for economic analysis. The animals' live weight was measured at ten-day intervals after overnight fasting, and the mean daily live weight gain was calculated by

analyzing the relationship between live weight and days of feeding.

3.3. Field day and visit

After fattening their sheep with concentrated feed, field days and visits were arranged for PAPREG members, neighbor farmers, DAs, and experts from the livestock office to learn about the preparation and management of concentrated feed, as well as the advantages and disadvantages of the technologies. This information is shown in Table 1 below.

Table 1. Participants of the field day

S/N	Several PAPREG and Non-PAPREG members participated in the field day	Male	Female	Total
1	PAPREG members	5	5	10
2	Other agro-pastoralist	5	5	10
3	DAs and experts	3	1	4
4	Woreda and kebele administrators	10	2	12
Total				36

3.4. Data collection and analysis

During the research, data was systematically gathered from the goats that were fed with concentrated feed. Subsequently, the attitudes of the PAPREGS (Participatory Rural Appraisal and Extension Group) towards the aforementioned technologies were meticulously compiled and analyzed utilizing descriptive statistical methods.

4. RESULTS AND DISCUSSION

4.1. Responses of the goat to the feed supplementation

Based on the data presented in Table 1, it is evident that the experimental goats in the pastoralist exhibited notable changes in their live body weights. The overall mean initial live body weights, final live body weights, total weight gains, and daily weight gains were recorded as 17.00 kgs, 23.00 kgs, 8.14 kgs, and 65.25 kgs of live body weight, respectively. Importantly, a statistically significant ($P < 0.05$) increase in live body weights was observed after the experiment, indicating a substantial and higher weight gain in the experimental goats.

Table 2. LSM \pm SE of goat-fattening performance

Variables	Mean \pm SE
IBW (kg)	17.00 \pm 0.45
FBW (kg)	23.00 \pm 0.36
TWG (kg)	8.14 \pm 0.34
ADG (gm)	65.25 \pm 0.006

IBW (Initial Body Weight), FBW (Final Body Weight), TWG (Total Weight Gain), ADG (Average Daily Gain)

4.2. Partial cost analysis for goat fattening

Table 3 presents a comparative cost analysis of goat fattening

practices, with a focus on supplemented and non-supplemented groups. Key parameters considered include average initial price, average selling price, total feed cost, total variable cost, total return, net income, and marginal rate of return (MRR). Supplemented goats exhibited a marginally elevated initial expenditure of 1050.4 Ethiopian birr (ETB) in contrast to non-supplemented goats, which registered a cost of 1024.8 ETB. The market prices for supplemented goats were markedly elevated at 4868.6 ETB as opposed to 2260.2 ETB for their non-supplemented counterparts. Supplemented goats incurred a considerable feed expenditure amounting to 2160 ETB, whereas non-supplemented goats did not report any feed-related costs. The aggregate variable costs associated with supplemented goats were significantly greater at 3210.4 ETB in comparison to 1235.5 ETB for non-supplemented goats, predominantly attributed to the heightened feed expenditures. Supplemented goats yielded substantially higher total returns of 3818.2 ETB in contrast to 1235.5 ETB for non-supplemented goats. Notwithstanding the elevated variable costs, supplemented goats realized a considerably higher net income of 607.8 ETB compared to 210.6 ETB for non-supplemented goats. Furthermore, supplemented goats demonstrated an increased marginal rate of return of 0.16 relative to non-supplemented goats, signifying that for each additional unit invested in variable costs, they produced a superior return on investment. The cost analysis in Table 3 shows that although supplementation incurs higher initial and variable costs, it ultimately results in significantly improved economic returns. Goats that are supplemented fetch higher selling prices, resulting in higher total returns and net income. The higher marginal rate of return further confirms the profitability of the supplementation strategy.



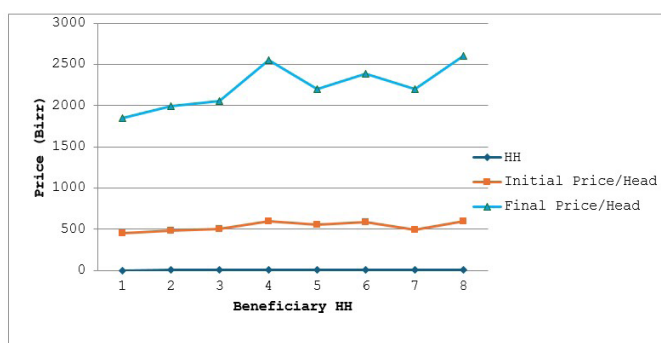
Table 3. Partial cost analysis for goat fattening

Parameters	Supplemented	Non-supplemented
Average initial price	1050.4	1024.8
Average selling price	4868.6	2260.2
Total feed cost (ETB)	2160	-
Total variable cost (tvc)	3210.4	-
Total return (TR)	3818.2	1235.5
Net income (NI)	607.8	210.6
MRR	0.16	-

ETB = Ethiopian birr; NI = change in net income; ΔTR = change in total return; ΔTVC = change in total variable cost; MRR = marginal rate of return.

4.3. Economic returns after selling fattened sheep & goats

Figure 1 presents a graphical representation of the economic returns from selling fattened sheep and goats, focusing on the variation across different beneficiary households (HH). The figure includes three lines: HH: Represents the economic returns for each household. Initial Price/Head: Indicates the initial price paid for each goat (approximately 500 Birr). Final Price/Head: Shows the final selling price for each fattened animal, ranging from approximately 1500 to 2500 Birr. The “HH” line demonstrates significant variation in economic returns across different households, ranging from approximately 1000 to 3000 Birr. This suggests that factors such as animal quality, management practices, and market conditions can influence the profitability of fattening goats. The “Initial Price/Head” line remains relatively stable at around 500 Birr, indicating that households generally paid similar prices for their animals at the beginning of the fattening period. The “Final Price/Head” line shows a general upward trend, suggesting that the value of fattened animals increases as they are prepared for sale. However, there is still some variation in final prices among households, ranging from approximately 1500 to 2500 Birr. Finally, the variability in returns among households underscores the importance of individual factors and market dynamics. Understanding these factors can help policymakers and practitioners develop strategies to improve the livelihoods of livestock farmers and promote sustainable livestock production.

**Figure 1.** Economic returns after selling fattened sheep & goats

4.4. Perceptions of the papreg members towards the technology

Table 4 presents the perceptions of PAPREG members and non-PAPREG members regarding the advantages and disadvantages of a particular feed technology. The data is based on a survey of 36 respondents, with 10 members from PAPREG and 26 non-PAPREG members.

4.4.1. Advantages

A majority of both PAPREG and non-PAPREG members perceived increased income profitability as a significant advantage of the feed technology. PAPREG members reported a slightly higher percentage (50% vs. 38.46%), with 5 out of 10 respondents identifying it as an advantage. A substantial proportion of respondents from both groups reported higher weight gain in animals using the technology. Non-PAPREG members reported a slightly higher percentage (30.76% vs. 30%), with 8 out of 26 respondents identifying it as an advantage. A smaller percentage of respondents, particularly among non-PAPREG members, noted a shortening of the fattening period as an advantage. Only 2 out of 10 PAPREG members and 8 out of 26 non-PAPREG members reported this benefit.

4.4.2. Disadvantages

The most frequently cited disadvantage was the high cost associated with the feed technology, with a significant majority of respondents from both groups expressing concerns. PAPREG members reported a slightly higher percentage (50% vs. 42.30%), with 5 out of 10 respondents identifying it as a disadvantage. A substantial number of respondents, especially non-PAPREG members, reported difficulties in obtaining necessary inputs for the technology. Non-PAPREG members were more likely to report this issue (34.61% vs. 40%), with 9 out of 26 respondents identifying it as a disadvantage. A smaller proportion of respondents, primarily non-PAPREG members, indicated a lack of awareness and skills among members regarding the use of the technology. Only 1 out of 10 PAPREG members and 6 out of 26 non-PAPREG members reported this as a disadvantage.

4.4.3. Comparison between Groups

While both groups perceived income profitability as an advantage, PAPREG members reported a slightly higher percentage (50% vs. 38.46%). Non-PAPREG members reported a slightly higher percentage of observing higher weight gain in their animals (30.76% vs. 30%). Non-PAPREG members were more likely to perceive a shorter fattening period as an advantage (30.76% vs. 20%). Both groups identified high cost and shortage of inputs as major disadvantages, with PAPREG members reporting slightly higher percentages for both. Finally, the data presented in Table 4 suggests that the feed technology is perceived positively by both PAPREG and non-PAPREG members, with income profitability and higher weight gain being the most commonly cited advantages. However, the high cost and potential shortage of inputs represent significant challenges that need to be addressed to ensure widespread adoption of the technology. Further research and policy interventions may be necessary to mitigate these barriers and maximize the benefits of the feed technology.



Table 4. Perceptions of the PAPREG members towards the technology

Advantages of the feed Technology	PAPREG members (10)	Non-PAPREG members (26)	Overall (36)
Income profitability	5(50%)	10(38.46%)	15(41.66%)
Higher weight gain of the animals	3(30%)	8(30.76%)	11(30.5%)
Shortening of the fattening period	2(20%)	8(30.76%)	10(27.77%)
Disadvantages of the feed technology			
high cost	5(50%)	11(42.30%)	16(44.44%)
Shortage of inputs	4(40%)	9(34.6%)	13(36.11%)
Low awareness and skill of the members	1(10%)	6(23.07%)	7(19.44%)

4.5. Pastoralists' focus group discussions on feeding technologies

One Focus Group Discussion was conducted with 10 pastoralists at Ellele 02 Kebele. The discussion focused on how the pastoralists utilized feeding technology and the role it played in improving their livelihoods. The pastoralists mentioned that they previously faced challenges when trying to fatten or finish small ruminants for sale due to feed scarcity in their area. They also had limited knowledge and skills in utilizing improved feeds and feeding management, which hampered their fattening practices. However, after adopting feeding technological options, they experienced improvements in knowledge, skills, and economic/livelihood outcomes. The net returns obtained from sales of the fattened goats were higher compared to their previous practices. The following graph illustrates the net returns obtained from small ruminant sales after the experiment.

5. CONCLUSIONS

The goat fattening system prevalent in the region is predominantly traditional in nature. There seems to be a conspicuous absence of comprehensive production and management technology packages tailored for goat fattening within this locale. The fragmented research initiatives undertaken by various research institutions exhibit a lack of applicability and do not adequately correlate with the realities on the ground; moreover, they fall short of addressing the multifaceted challenges confronting the goat-fattening system. Nevertheless, the participants of the PAPREGs project acquired substantial theoretical and practical knowledge and skills through the formulation and administration of concentrated feed for goat fattening. A salient lesson gleaned by the beneficiaries from the project was that enhancing goat productivity via concentrated feed served as a motivational impetus for other pastoralists in the surrounding area. To render the goat-fattening system both productive and sustainable, it is imperative to implement interventions encompassing research, policy formulation, and practical execution. This initiative should commence with the identification of priority areas and delineation of the requisite actions that must be undertaken. Consequently, this technological approach aimed at rapid weight gain should be disseminated to other pastoralists in the study region as well as to analogous agroecological zones and/or production systems within the region. Furthermore, the undertaking of

additional scaling-up initiatives for this technology would likely incentivize private investors to recognize the potential opportunities within the region.

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