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Characterization of Indigenous Goats Production System in Qellam Wallaga Zone of Oromia Regional State, Western Ethiopia

Gemechu Shuma[1], Ayantu Mekonnen[2]*& Gemeda Duguma[2]
[1]Finance Bureau of Oromia, P.O. Box 669, Addis Ababa, Ethiopia
[2]School of Veterinary Medicine, Wollega University, P. O. Box 395, Nekemte, Ethiopia

Abstract

A study was conducted in Sayo, Gawo Qebe, and Dale Wabara districts of the Qellam Wallaga zone of the Oromia region, involving 152 households. A semi-structured questionnaire and focus group discussions were used to gather data. Mixed-crop livestock is the major production system. The average goat flock size per household was 8.8±5.40 heads. Cash and meat were the main goals of goat farming. Natural pastures, fallow lands, and shrubs are major feed resources of the areas. In the dry season, goats are herded and allowed to roam freely; during the rainy season, they are tethered and herded. All classes of goats, except newborn lambs, are herded together. Rivers and springs are major water sources. 38.2% of goats are kept in family homes, while 56.6% are kept in houses that were built separately. The age of first sexual maturity was 7.6±0.07 months for females and 7.2±0.07 months for males. The average age at first kidding and kidding interval were 11.9±0.09 and 7.7±0.06 months, respectively. Diseases and periodic feed shortage are the two main challenges to goat production. Improving farmers' and development workers' capacity to mitigate issues associated with disease and seasonal feed shortages will be essential in the future.

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*Corresponding Author:

Ayantu Mekonnen

E-mail:

ayantumekonnen@gmail.com

INTRODUCTION

Ethiopia is home to a large number of livestock species, each with unique genetic pools and adaptations to a broader variety of agro-ecologies (Peter et al., 2022). Approximately 70 million cattle, 42 million sheep, 52 million goats, 8 million camels, and 56 million chickens are kept in the nation (CSA, 2022). The livestock sector is an essential part of the country's economy contributing about 19 and 45% of the total and the agricultural Gross Domestic Product (GDP), respectively. The sector also accounts for about 16–19% of total export earnings (CSA, 2022).

Goats are one of the livestock species that significantly contribute to the livelihood of farmers with limited resources (CSA, 2022). In Sub-Saharan Africa, goats are an essential component of livestock husbandry, primarily kept for their milk, meat, wool, manure, and ability to save money or avoid risk (Teweldemedhn et al., 2023). They also serve socioeconomic, cultural, security, investment, and risk mitigation goals, according to Dhaba et al. (2012). Goats serve a variety of social and cultural purposes in tropical and subtropical Africa, depending on the culture, socioeconomics, agro-ecologies, and

geographic (Teweldemedhn et al., 2023). In Ethiopia, of the total 52 million head of goats' population Ethiopia owns, about 70.6% are females and about 29.4% are males (CSA, 2022). About 12% of all livestock products consumed and 48% of farm-level family income are derived from goats. In Ethiopia, goats are accountable for about 25% of the domestic meat consumption and they also provide significant contributions to the national economy by contributing to export trade (CSA, 2022).

Because they are browsers and selective feeders, goats can survive on a limited amount of bushes and shrubs. Goats have a comparative advantage over other species due to their broad feeding habits and short reproductive cycle (Taye et al., 2024). In addition to their quantifiable outputs of several products, goat production is important for diversifying agriculture and livestock production, creating employment opportunities, improving family income, building capital, contributing to human nutrition, and reducing risk like those of the whims of nature (Dhaba et al., 2012). Smallholder farmers prefer goats because they grow quickly, require less capital, and are more tolerant of changing environmental conditions than large ruminants (Taye et al., 2024).

Ethiopian goat productivity is quite poor despite their huge size, wide dispersion, and variety of uses. This is caused by a variety of things, including inadequate diet, a high prevalence of illnesses, a lack of suitable breeding techniques, and a lack of knowledge about the production system (Taye et al., 2024) Improvement programs must be designed in order to boost and maintain the productivity of native goats in order to meet the increasing demand from both domestic and international markets for live goats and related products (Adem, 2018). This is especially true for nations like Ethiopia where extensive systems of husbandry are the most prevalent.

In addition, the development and research initiatives implemented to enhance the effectiveness of Ethiopia's goat types/breeds are not at all satisfactory. Up until now, nearly all of the studies have been conducted on research stations. (Alilo et al., 2018). It is often possible to improve livestock production by carefully evaluating the performance of the animals in their surroundings/their ecological niche and then designing and implementing appropriate breeding strategies. Information on the production system, breed description, breeding objective, and obstacles impeding the performance of the breeds must be gathered before developing any breeding strategies. (Adem, 2018). Consequently, the current study's goals were to describe the production system, identify breeding objectives, opportunities and constraints of goat production in the study areas.

MATERIALS AND METHODS

The investigation was carried out in Qellam Wallaga Zone which is one of the 20 zones of Oromia Regional state, Ethiopia. The administrative town of Qellam Wallaga zone, Dambi Dollo, is located at a distance of 652km from Addis Ababa to the west direction. It extends from 8º10' to 9º21' N latitude and 34º07' to 35º26' E longitude. The altitude of the zone ranges from 500 to 1500 m. a.s.l. With regard to agro-ecological zones, about 0.2% land area of Qellam Wallaga zone

is categorized as highland, 20.35% midland and 79.45% lowland. The annual temperature of this zone ranges from 15 - 25ºC; whereas the mean annual rainfall range from 1200mm to 1600mm. Qellam Wallaga zone's livestock population include cattle, sheep, goats, horse, mules, donkey and chickens that are estimated as 933,197, 455,141, 285,326, 28,787, 27,829, 88,495 and 976,580, respectively (QWLDO, 2019).

Methods for choosing sites and sampling

A quick informal field survey was made to the Qellam Wallaga zone Livestock Development office. During the informal survey discussion was convened with the experts of the zone livestock development office to find out how the targeted goat populations are distributed throughout the study regions. Considering the results of the quick informal field survey and conversation, three districts and eight peasant associations (PA) were selected purposely by considering their representativeness, potential they have with the indigenous goat production. The three districts are Gawo Qebe, Sayo and Dale Wabara. A total of eight associations of peasants (PAs), three PAs each from Gawo Qebe and Sayo districts and two PAs from Dale Wabara were selected. The distribution and density of the goat population were taken into account when choosing PAs. The current study identified 152 households (HHs) with at least two adult does and at least one year of experience in goat husbandry practices. The total number of the households considered for the interview was estimated according to Yamane (1996) with 92% confidence level. After HHs having two or more does with one or more year of experiences in goat production was determined, selection of HHs was done randomly using lotto system. Summary of the sampling details are shown in Table 1. In determining the number of HHs, the following formula was used.

$$n = \frac{N}{1 + N(e)^2}$$

Where, n = sample size, N = total number of households, 1 = probability that the event occurring, and, e = maximum variability or margin of error =8 (0.08)

Table 1

Summary of the sampling details

District	Peasant association (PA)	Sampled HHs for the survey	Series of group discussions held
Sayo	Shogo	11	1
	Yengi	18	1
	Kero Baha	20	1
Gawo Qebe	Joge Walwalo	16	1
	Ilu Gonde	23	1
	Qumbabe	26	1
Dale Wabara	Omo Walensu	18	1
	Foge Kombolcha	20	1
Total		152	8

Data collection

A semi-structured questionnaire, group discussions, and the use of secondary information sources were used to generate the data. The questionnaire was developed based on the research objective and in a way that it can capture all information required. The survey was created in English and then translated into Afan Oromo when it was being administered. Prior to administration, a pre-test was conducted, and the results were used to inform some reorganizations and corrections. Some of the information collected through interview was supported by observation and group discussion. Information gathered through questionnaire included: social and economic characteristics such as gender, age, education level, size of household, ownership of animals, financial benefit of goats, and significant production limitations; reproductive performances such as age at first breeding, kidding interval, breeding practices like mating type, purpose of keeping goats, the selection criteria include factors like the age at which culling and castration are performed, the feed situation, including major feed sources, supplementation, grazing techniques, and water sources, the major goat diseases prevalent in the area, the various treatments employed, and the various livestock species.

Data analysis

The Statistical Package for Social Sciences (SPSS) was used to further analyze the coded data that were gathered from each site. The General Linear Model (GLM) in the Statistical Analysis System (SAS) was used to analyze quantitative data. Before beginning the primary data analysis, preliminary data analysis techniques such as homogeneity testing, normality testing, and outlier screening were used. Indices were also calculated to investigate goat producers' breeding objectives and to rank primary barriers to goat production in the research areas; the reason for raising goats; available feed; diseases; the classes of goats that should be sold first when money is needed; and the criteria for selecting males and females based on the following formula.

Index = Sum of (3 * number of household ranked first + 2 * number of household ranked second + 1 * number of household ranked third) given for an individual reason or criteria divided by the sum of (3 * number of household ranked first + 2 * number of household ranked second + 1 * number of household ranked third) for overall reasons or criteria (Kosgey, 2004)

RESULTS AND DISCUSSIONS

General Households Information

Gender, age category and level of education of targeted HHs are presented in Table2. In this study, the majority of participants considered were male headed households (81.6%) of which about 85.7%, 81.5% and 76.3 in Sayo, Gawo Qebe and Dale Wabara districts, respectively. Proportion of female respondents in Sayo, Gawo Qebe and Dale Wabara districts were 14.3%, 18.5%, 23.7%, respectively. About 45.4% of the households considered in the current study fall within the age class of 31- 40 year, and about 28.3% fall within the age class of 41-50 years. The current result agrees with 33% age class fall within 41-50years reported by Taye et al. (2024) in North Wallo. That means about 73.7% of goat producers in the current study

were considered as an active age group and serve as the primary labor supply for farms. A significant correlation (p>0.05) was not found between age groups and districts.

With regard to marital status, the survey revealed that about 85.5 % of the household heads in the study area were married while about 11.8 % and 2.6% were single and divorced, respectively. The less number of divorced females and males may be pretty true as logically and practically rural people could not live being single shouldering the multifaceted activities to be undertaken by group of people. With regard to education status, the majorities of respondents (69.7%) were illiterate. As livestock technology in the western part of the country is in its infant stage, it might be difficult to associate with livestock technology adoption in the current study. Generally, high level of illiteracy may negatively influence the adoption of new technology. The current study result with regard to the illiteracy of livestock producers is in higher than findings 45% reported by Teweldemedhn et al. (2023).

Table 2

General household information of the study areas

Descriptor	District								X^2	P-value
	Sayo		Gawo Qebe		Dale Wabara		Over all			
	Mean ± SD		Mean ± SD		Mean ± SD		Mean ± SD			
Family size	5.65±1.8		5.71±2.2		6.00±1.9		5.76 ± 2.0			0.69
Sex	N	%	N	%	N	%	N	%	57.32	0.54
Male	42	85.7	53	81.5	29	76.3	124	81.6		
Female	7	14.3	12	18.5	9	23.7	28	18.4		
Marital status									22.84	0.87
Married	42	85.7	55	84.6	33	86.8	130	85.5		
Single	4	8.2	10	15.4	4	10.5	18	11.8		
Divorced	3	6.1	0	0	1	2.6	4	2.6		
Respondent age (yr)									51.50	0.679
<31	8	16.32	8	12.3	5	13.1	21	13.8		
31-40	20	40.8	28	43.1	21	55.3	69	45.4		
41-50	14	28.6	21	32.3	8	21.1	43	28.3		
51-60	7	14.28	8	12.3	4	10.5	19	12.5		
Educational status									39.58	0.549
Illiterate	32	65.3	45	69.2	29	76.3	106	69.7		
Primary	13	26.5	13	20	7	18.4	33	21.7		
Secondary	4	8.2	7	10.8	2	5.3	13	8.6		

SD=standard deviation, N= Number of households, X^2 = Pearson Chi-square

Production system and landholding

In the study areas, the predominant production system is a mixed crop-livestock system. The major crops grown in the study areas include maize, chickpea and sorghum. In addition, crops such as chickpea, haricot bean and ground nut (not common) are also grown in the areas. Some of the main livestock species present in the study districts are goats, sheep, donkeys, and chickens. From

the livestock species goat is more favored in the system because, they have a short kidding interval and have better browsing ability. Goats are also more defensive to predators than sheep and are more productive than sheep under scarcity of feeds. Both fallow and communal grazing lands serve as livestock feed in the areas.

The farmers in the research areas possessed an average of 2.4ha and more or less similar for the districts (Table 3). This average landholding per household as stated in the present investigation was slightly lower than the 2.78ha land holding per household reported by Biratu (2008) at Guduru district. The mean landholding per household at Sayo, Gawo Qebe and Dale Wabara districts were about 2.3, 2.4, and 2.4 hectares, respectively. The corresponding land holding per household of the districts for crop production and grazing lands were 2.0, 1.7 and 1.9 and 0.04, 0.1 and 0.01 hectares, respectively. The current study's findings show that one of the most important and pressing issues in the study districts is a lack of grazing land.

Table 3

Average land holding (ha) per household in the study areas

Descriptor	Districts				P- value
	Sayo	Gawo Qebe	Dale Wabara	Over all	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Total land	2.3(1.2)	2.4(0.9)	2.4(1)	2.4(1.0)	0.981
Crop land	2.0(1.0)	1.7(0.7)	1.9(0.9)	1.9(0.9)	0.259
Fallow land	0.2(0.2)	0.4(0.4)	0.3(0.3)	0.3(0.3)	0.0001
Grazing land	0.04(0.1)	0.1(0.1)	0.01(0.04)	0.07(0.15)	0.0001
Other	0.1(18)	1.1(0.2)	0.2(0.2)	0.1(0.2)	0.077

SD = standard deviation

Livestock holding per household in the study areas

Table 4 displays the types of livestock and the number of livestock per household that were observed in the study districts. Numerous livestock species, including chicken, goats, sheep, donkeys, and cattle, are raised in the study districts. In the research area, the average number of goats per household was 8.8. The mean (SD) of goat flock size per household was 10.4±6.60, 7.3±3.40 and 9.5±5.80 in Sayo, Gawo Qebe and Dale Wabara districts, respectively. Goat flock size was the highest at Sayo and the lowest at Gawo Qebe district, because available feed sources and grazing lands is more abundant at Gawo Qebe district than Sayo district. The current study's average number of goats per household was less than Alubel's (2015) average of 24.9 flocks per household in the districts of Zinquala, Tunqua Abergelle, and Lay Armachiho. The current study's reported flock size per household was also less than Tsigabu's (2015) report of 16.9 in the Nuer zone (Jikawo and Lare districts). This could be due to the reason that in the current study area the production system is mixed crop-

livestock production system so the number of goat flock size is smaller than the rift valleys of the country where vast areas of land used for grazing purposes.

Table 4

Livestock species and livestock holding per household in the study areas

Species	Districts			Overall	P-value
	Sayo	Gawo Qebe	Dale Wabara		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Cattle	3.6 (3.9)	4.7 (3.2)	4.5 (3.3)	4.3 (3.5)	0.227
Goat	10.4 (6.6)	7.3 (3.4)	9.5 (5.8)	8.8 (5.4)	0.006
Sheep	1.7 (2.1)	2.5 (1.9)	1.6 (2.5)	2.0 (2.1)	0.064
Poultry	13.6 (7.4)	10.7(5.4)	15.8 (6.8)	13 (6.7)	0.001
Donkey	0.6 (0.8)	0.7 (0.7)	0.5 (0.6)	0.6 (0.7)	0.208
Mule	0.08 (0.28)	0.1(0.3)	0.08 (0.3)	0.09 (0.3)	0.850
Horse	0.04 (0.2)			0.01 (0.1)	0.120

SD = standard deviation

Goat Flock Structure

Least squares mean (± SE) of flock structure per household are indicated in Table 5. In the current study, there was a significant difference ($p<0.05$) in the number of goats per household. Goat flock size was highest at Sayo district followed by Dale Wabara district; and Gawo Qebe was the least. The overall mean number of breeding females older than one year was 2.2±0.90 per household. In respective order, the mean number of breeding females owned by each household was 2.4±1.10, 2.0±0.70 and 2.4±0.90 at Sayo, Gawo Qebe abd Dale Wabara district, respectively. There was a significant ($p<0.05$) variation found between districts in the number of breeding females (older than one year) per household. The overall proportion of breeding females older than one year was about 25.4% followed by female kids younger than six-month-old. The overall mean for breeding males older than one year was 0.9±1.10 per household in the study areas. Breeding males older than one year constitute about 10.7% of the total flocks in the study areas. Castrates constituted about 1.8% of the flocks in the study districts, indicating that castration is practiced in the study areas. In the current study, the proportion of females above one year of age was the highest, which is in agreement with the report made by Alefe (2014) on Somali goats of Shabelle zone and Belete (2014) on Bale goats in Bale zone. However, the study's overall mean was less than the numbers documented for the Bati, Borena, and Siti regions (Hulunim, 2014). Due to the early sale of bucks for revenue generation, there were few breeding bucks reported in the current study. Generally, the present study revealed that the flock structure of indigenous goat found in the study area was mainly based on maintaining large number of breeding female goats. This might be due to the fact that breeding females are kept for kid production and replacement purposes. Males are commonly sold due to different reasons,

For instance, males are commonly slaughtered during public festivals and holidays (Id Al Maulid, Idal Adaha, Id-Al-Fetter, Easter and Ethiopian New Year), and also commonly sold for income generation as opposed to females which are kept for production purposes.

Table 5

Least squares mean (± SE) flock structure per household in the study areas

Goat types/ classes of goats	Districts			Over all	P-value
	Sayo	Gawo Qebe	Dale Wabara		
Male kids < 6 month	1.5 ± 1.2	1.0±0.9	1.3±1.1	1.3±1.1	0.04
Female kids < 6 month	2.2 ± 1.5	1.4±0.9	2.1±1.4	1.8±1.3	0.004
Male >1year	0.9± 0.7	0.9±0.7	0.8±0.7	0.9±0.7	0.781
Female >1year	2.4±1.1	2.0±0.7	2.4±0.9	2.2±0.9	0.043
Male 6m-1year	1.1±1.2	0.8±0.9	1.0±1.2	0.9±1.1	0.175
Female 6m-1 year	1.9±2.1	1.0±1.2	1.9±1.8	1.5±1.7	0.005
Castrated male	0.2±0.5	0.1±0.4	0.1±0.3	0.2±0.4	0.642

SE= standard Error

Purpose of Keeping Goat

The purposes of goat keeping in the study areas are presented in Table 6. Goats are kept for reasonable reasons that are connected to the long- or short-term needs of farmers. The primary goat production in the study districts income generation which is mainly meant for emergency cases, school fees, and purchase of agricultural inputs and for other household expenses. Meat production and manure are the 2nd and 3rd reasons for goat production in Sayo district, respectively. The 2nd and 3rd reasons for goat production in Gawo Qebe and Dale Wabara districts are meat and milk production, respectively. Analogous to the current reports different researchers (Feki & Berhanu, 2016, Zergaw et al., 2016) were also reported that goat producers in the different parts of Ethiopia primarily rear goats for income generation. With regard to meat production, other scholars (Feki and Berhanu, 2016 ; Zergaw et al., 2016& Tsigabu, 2015) were also reported that goats are produced for meat and milk production (home consumption) and by products such as manure and skin. Generally, breeding objectives for goat production varies with production system or agro-ecologies. For instance, milk is not the reason for goat production in the study districts. However, in the lowland agro-ecologies goats are primarily produced for milk production. In the current study, the index values for purposes of keeping goats are indicated in Table 6.

Table 6

Purposes of keeping goat in the study areas

Purpose of keeping	District											
	Sayo				Gawo Qebe				Dale Wabara			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Income	41	5	3	0.46	49	11	5	0.45	31	6	1	0.46
Meat	8	31	10	0.33	13	43	9	0.34	5	29	4	0.34
Milk	0	1	2	0.014	3	7	13	0.09	2	0	11	0.07
Manure	3	8	39	0.25	1	4	13	0.06	0	3	0	0.03
Skin	1	3	5	0.048	0	0	0	0	0	0	0	0

Feed Resources

Major feed resources commonly used in the study areas both dry and wet seasons are presented in Table 7. Natural pasture, fallow lands, crop residues, shrubs, chat leaves, grain and kitchen left over are some of the common feed resources used in the districts. In all the three districts, natural pasture, follow land and chat leaf leftover were ranked as 1st, 2nd and 3rd feed resources used during wet season, respectively. On the other hand, during dry season natural pasture and shrubs were the most important feed resources ranked as 1st and 2nd in all the three districts, respectively. Fallow land, crop residues and discarded chat leaf (chat leaf left over) were the 3rd ranked feed sources at Sayo, Gawo Qebe and Dale Wabara districts during the dry season, respectively. Goat producers provide supplementary feeds such as kitchen left over and discarded chat leaves to overcome feed shortage during dry season.

Table 7

Feed resources commonly used in the study area

Types of feeds used	Districts											
	Sayo				Gawo Qebe				Dale Wabara			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
During wet season												
Natural pasture	40	6	3	0.46	59	5	1	0.48	31	5	2	0.46
Shrubs	0	0	0	0	0	0	0	0	0	0	0	0
Crop- residues	0	0	0	0	0	0	0	0	0	0	0	0
Fallow land	7	18	21	0.27	6	48	11	0.32	4	27	6	0.32
Concentrate	0	3	11	0.06	0	0	0	0	0	0	0	0
Chat leaf leftover	2	10	8	0.12	0	5	9	0.05	3	8	11	0.16
During dry season												
Natural pasture	36	11	2	0.45	44	13	8	0.43	26	10	2	0.44
Shrubs	12	30	7	0.35	17	39	9	0.35	8	23	7	0.34
Crop- residues	0	0	0	0	3	5	7	0.07	1	2	4	0.05
Fallow land	1	5	12	0.09	1	4	11	0.06	2	6	5	0.1
Concentrate	0	0	0	0	0	0	0	0	0	0	0	0
Chat leaf leftover	0	0	13	0.04	0	6	28	0.1	1	3	11	0.09

Feeding Management

Herding is the most common management practice (71.7%) in wet season followed by tethering (21.7%). About 75.5% and 14.3% of respondents from Sayo, 66.2% and 30.8% from Gawo Qebe and 76.3% and 15.8% from Dale Wabara district indicated that herding and tethering are the most common goat management practices during wet season, respectively. Goats are herded to prevent them from damaging crops and from theft and predators. In the study areas, the majority of goat producers (53.3%) from all the three districts herd their own flock separately. For instance, in Sayo, Gawo Qebe and Dale Wabara districts about 73.5%, Sayo and 76.3% respondents reported that farmers herd their own flocks separately, respectively. Conversely, though, about 38.2% of respondents of the three districts indicated that goats are herded with sheep. Every kind of goat are herded together in the study areas, except newly born kids that are unable to run with flocks (Table 8). This may have negative consequence with regard to inbreeding and unwanted breeding. Inferior and mediocre bucks may have a chance of mating breeding females. The majority of respondents (69.7%) of respondents stated that a goat producers herd their own flock separately. However, about 30.3% of respondents indicated that more than two or more flocks of neighboring households' are herded together. In this case, neighboring households herd the flocks turn by turn based on the number of neighboring households.

Table 8

Feeding management used in the study area

Descriptors	Districts							
	Sayo		Gawo Qebe		Dale Wabara		Over all	
	Number	%	Number	%	Number	%	Number	%
Grazing methods during dry season								
Free grazing	44	98.8	44	67.7	32	84.2	120	78.9
Herding	2	4.1	16	24.6	6	15.8	20	15.8
Tethering	3	6.1	5	7.7	0	0	8	5.3
Grazing methods during wet season								
Free grazing	5	10.2	2	3.1	3	7.9	10	6.6
Herding	37	75.5	43	66.2	29	76.3	109	71.7
Tethering	7	14.3	20	30.8	6	15.8	33	21.7
Ways of herding different classes of goats								
Male and female separated	0	0	0	0	0	0	0	0
Kids are separated	4	8.2	5	13.2	5	13.2	20	13.2
All classes herded together	45	91.8	33	86.8	33	86.8	132	86.8
Herding with other livestock species								
Together with cattle	0	0	0	0	0	0	0	0
Together with sheep	23	46.9	14	36.8	14	36.8	58	38.2
Together with calves	3	6.1	1	2.6	1	2.6	13	8.6
Goat herded separately	23	46.9	23	60.5	23	60.5	81	53.3
Way of herding								
Flock of a HH run as flock	36	73.5	41	63.1	29	76.3	106	69.7
Flocks of HHs run as flock	13	26.5	24	36.9	9	23.7	46	30.3

Water Source and Watering Frequency

Table 9 lists the study districts' principal water sources. Goats in the study areas primarily obtained their water from rivers and springs, in that order. In both the dry and wet seasons, well water, or bore holes, rank third among the study area's water sources (Table 9). In the study areas, approximately 89.5 and 10.5% of respondents said that goats receive daily watering and have unrestricted access to water during the dry season. In wet season, about 58.6% and 41.4% of respondents indicated that goats are watered once a day and had free access to water, respectively. The proportion of animals which had free access to water was higher in wet season compared to the dry season. This may be due to the availability of rain water and seasonal water that may dry out during dry season. In line with the current finding, Abraham et al. (2017) also reported that that the majority of goat owners (82%) watered their animals once in a day.

Table 9

Water source and frequency of watering in dry and wet seasons in the study areas

Water source	Districts							
	Sayo		Gawo Qebe		Dale Wabara		Over all	
	Number	%	Number	%	Number	%	Number	%
Source of water during dry season								
Dam/pond	0	0	2	3.1	0	0	2	1.3
Borehole/water well	1	2	12	18.5	2	5.3	15	9.9
River	44	89.8	41	63.1	33	86.8	118	77.6
Pipe water	0	0	0	0	0	0	0	0
Spring	4	8.2	10	15.4	3	7.9	17	11.2
Source of water during wet season								
Borehole/water well	0	0	8	12.3	3	7.9	11	7.2
River	36	73.5	41	63.1	26	68.4	103	67.8
Spring	13	26.5	15	23.1	9	23.7	37	24.3
Rain water	0	0	1	1.5	0	0	1	0.7
Frequency of water during dry season								
Free access	5	10.2	6	9.2	5	13.2	16	10.5
Once a day	44	89.8	59	90.8	33	86.8	136	89.5
Once in 2 days	0	0	0	0	0	0	0	0
Frequency of water during wet season								
Free access	21	42.9	30	46.2	12	31.6	63	41.4
Once a day	28	57.1	35	53.8	26	68.4	89	58.6
Once in 2 days	0	0	0	0	0	0	0	0

Housing, house types and housing materials

Table 10 lists the goat housing systems used in the research area. According to Tsigabu (2015), a good housing system is necessary to increase productivity, safeguard the flock from disease threats and predators, and facilitate management. Most of the participants (56.6%) stated that they keep their goats in a different house. However, about 38.2% and 5.3% of respondents indicated that they use family house and veranda, respectively. In contrast with the current finding, Alilo et al (2018) reported that about 80.7 % of goat producers in Esera district, of Dawro zone, Southern Ethiopia, shared main family house with their goats. Almost all classes of goats are housed together, except about 11.2% who reported that kids are housed separately. The housing of all goat classes described in this study is consistent with the findings of Mahilet (2012), who found that all goat ages and sexes were kept together at night, with the exception of the newborn kids. Goats are either housed with sheep or housed separately in the study districts (Table 10).

Almost similar housing materials are used in the study districts. About 59.9% and 41.1% of respondents from all districts indicated that grass/bushes and iron sheet are the commonly used roofing materials in the areas, respectively. Almost all respondents (96.1%) of respondents reported that wood is the major construction material used for wall. Furthermore, earthen and wooden floors were common in the current study areas in their respective order.

Table 10

Housing types and housing materials for goats in the study areas

Housing types and housing materials	Districts (%)							
	Sayo		Gawo Qebe		Dale Wabara		Overall	
	Number	%	Number	%	Number	%	Number	%
Types of house								
Share family house	16	32.7	23	35.4	19	50	58	38.2
Separate house	32	65.3	39	60	15	39.5	86	56.6
Varenda	1	2	3	4.6	4	10.5	8	5.3
Roofing materials								
Iron sheet	15	30.6	24	36.9	22	57.9	61	40.1
Grass/bushes	34	69.4	41	63.1	16	42.1	91	59.9
Type of material for wall								
Iron sheet	1	2	3	4.6	2	5.3	6	3.9
Wood	48	98	62	95.4	36	94.7	146	96.1
Floor types								
Mud/earth	39	79.6	56	86.2	32	84.2	127	83.6
Wood	10	20.4	9	13.8	6	15.8	25	16.4
Housing management								
All classes housed together	49	100	50	76.9	36	94.7	135	88.8
Kids housed separately	0	0	15	23.1	2	5.3	17	11.2
Goats/sheep housing management								
Goats housed with sheep	17	34.7	36	55.4	20	52.6	73	48
Goats not housed with sheep	32	65.3	29	44.6	18	47.4	79	52

Major Prevalent Goat Diseases in the Study Areas

Table 11 lists and ranks some of the most common diseases affecting goats in the study areas according to respondents. Healthy animals with normal physiological makeup and function may be able to yield their highest possible yield. Most goat farmers of the study areas did not know the name of the diseases, rather they identified based on the symptoms of the common diseases that affect their animals. Globally, it is believed that being disease-free is a prerequisite for genetic advancements because optimal productivity in a particular production system arises when disease control is established (Tassew, 2014). Some of the most common goat diseases and parasites listed by respondents were: pasturollosis, brucellosis, black leg, anthrax, coenuruses, foot and mouth (FMD), mange mites, bloating and external parasites (ticks). Bloating was ranked as a primary health problem at Sayo district with an index value of 0.36. With index values of 0.42 and 0.39, respectively, pasturollosis and coenuruses were the corresponding health issues at Gawo Qebe and Dale Wabara districts. At Sayo and Dale Wabara districts the 2nd and 3rd ranked animal health problems reported were pasturollosis and brucellosis in their respective order. On the other hand, Brucellosis and foot and mouth diseases (FMD) were the 2nd and 3rd economically important diseases at Gawo Qebe district, respectively.

Table 11

Major goat diseases according to their occurrence ranked by respondents

Diseases	Districts											
	Sayo				Gawo Qebe				Dale Wabera			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Pasteurellosis	10	25	6	0.29	46	11	5	0.42	6	4	29	0.24
Brucellosis	6	5	29	0.19	7	39	13	0.29	5	9	8	0.18
Ticks	3	7	0	0.08	0	1	6	0.02	0	0	3	0.01
Black leg	0	4	1	0.03	2	0	5	0.03	2	1	0	0.04
Anthrax	0	2	3	0.02	1	4	7	0.05	0	0	0	0
Coenuruses	0	3	10	0.05	5	10	3	0.1	25	3	8	0.39
FMD	7	5	9	0.14	9	12	42	0.24	7	2	15	0.18
Bloating	27	9	7	0.36	6	4	8	0.09	1	30	7	0.30
Mange-mite	0	0	2	0.01	0	1	0	0.002	0	4	5	0.06

FMD=Foot and mouth diseases; R1, R2 and R3=Rank from 1 to 3

Marketing and Culling Age

Male goats reach marketing age slightly earlier than female goats, as evidenced by the overall mean marketing ages of 10±0.08 months for males and 10.8±0.09 months for females. There was no discernible difference in marketing age between the districts' male and female populations ($p>0.05$). Furthermore, males are fast grower compared to females and hence reach marketing age early and fetch also higher price than females. Belete (2014) also reported that, in the Bale zone of the Oromia region, male goats

reached marketing age approximately one month earlier than female goats (11.67±0.4 vs. 12.33±0.4 month), which is consistent with the results of the current study. The current study's mean marketing age was also less than Belete's (2014) report. On the other hand, Hulunim (2014) indicated that both male (6.21±0.23 month) and female goats (6.35±0.23 month) of Bati area are marketed at early age as opposed to the market age reported in the current study. Additionally, the author stated that the marketing ages of male and female goats in the Siti area of the Somali regional state and the Borena zone of the Oromia region were 8.35±0.19 and 8.62±0.19 months, and 8.58±0.24 and 8.84±0.22 months, respectively.

In all of the three districts, the first class of goats marketed are growing bucks of six month to one year old followed by growing does of six month to one year of age. Breeding does are the 3rd ranked class of goats marketed in Sayo and Dale Wabara districts. However, in Gawo Qebe district breeding bucks was reported as the 3rd ranked class of goats marketed. Generally, respondents reported that farmers' sell their animals depend on the market price and the amount of money needed for their immediate needs. Belete (2014) stated that the most marketed class of goats to meet short-term financial needs was old bucks and old does, which is in contrast to the findings of the current study.

Marketing/culling of old animals are common in the study areas. Breeding males and females are also culled due to different reasons. The major reason is just to remove poorly performing animals to speed up the improvement of flocks breeding potential. The average age at which farmers in the study areas cull their goats is 4.6 ±0.08 years for male goats and 6 ±0.08 years for female goats. Males are usually culled at younger age than their female counterparts. Livestock producers are naturally reluctant to sale breeding females compared to males and the market demand for male is higher than female. Most of the time females are kept for breeding purposes. The current study's reported culling age is less than Belete's (2014) report of 8.17 years for male goats and 8.5 years for female goats in the Bale zone of the Oromia region (Table 12).

Table 12

Average marketing and culling age of goats in the study area

	Districts				
	Sayo	Gawo Qebe	Dale Wabara	Overall	
	Mean ±SE	Mean ±SE	Mean ±SE	Mean ±SE	P-value
Average marketing age (m)					
Male	9.8 ±0.15	10.2 ±0.12	10.1 ±0.14	10 ±0.08	0.103
Female	10.7 ±0.16	10.9 ±0.15	10.67 ±0.17	10.8 ±0.09	0.584
Average culling age (yr)					
Male	4.6 ±0.12	4.5 ±0.14	4.8 ±0.13	4.6 ±0.08	0.273
Female	5.9 ±0.14	6.1 ±0.13	6.08 ±0.16	6 ±0.08	0.773

SE= standard Error, m= month, yr= year

Fattening of goats in the study areas

On average about 29.6% of respondents (i.e. 20.4%, 43.1% and 18.4% of respondents at Sayo, Gawo Qebe and Dale Wabara districts, respectively) reported that goat fattening is practiced in the study areas (Table 13). Other than the Gawo Qebeb district where about 43.1% of respondents indicated that goat fattening is practiced in the area, only about 18.4 to 20.4% of the goat producers practiced goat fattening at Sayo and Dale Wabara districts. This may indicate that the higher market demand for lean meat as opposed to fat. Belete (2014) also reported that only about 20.8% of goat producers in Bale zone practiced goat fattening. According to Alefe (2014), no goat fattening practices in the Shabelle zone of the Somali regional state. In the current study areas, fattening of goats is traditional and grass based or concentrate based intensive fattening is non-existent. Natural pasture, kitchen leftover and discarded chat leaves (Geraba) were major feed resources used for goat fattening. Accordingly, about 55.9% of respondents indicated that goat fattening is carried out during wet season, mainly due to the availability of feeds.

Only about 15.8% of the respondents indicated that fattening is carried out during dry season. Maize grain mixed with salt is sometimes (irregularly) provided as supplementary feeds. Duration of fattening is mostly from 3- 6 months of age in all the three districts, but still about 10% of the respondents from Sayo and Dale Wabara districts indicated that duration sometimes extended for more than six months, which may warrant capacity building for goat producers on modern fattening practices that lasts only at three months.

Table13

Fattening practices in the study area

	District (N and %)									
	Sayo		Gawo Qebe		Dale Wabara		Over all		X^2	p-value
	N	%	N	%	N	%	N	%		
Practice fattening									20.08	0.007
Yes	10	20.4	28	43.1	7	18.4	45	29.6		
No	39	79.6	37	56.9	31	81.6	107	70.4		
Season of fattening									33.58	0.598
Dry season	10	20.4	8	12.3	6	15.8	24	15.8		
Wet season	39	79.6	37	56.9	22	57.9	85	55.9		
No idea	0	0	20	30.8	10	26.3	43	28.3		
Duration of fattening									15.89	0.874
3-4 month	9	18.4	12	18.5	11	28.9	32	21.1		
4-6 month	27	55.1	36	55.4	13	34.2	76	50		
>6 month	5	10.2	0	0	4	10.5	9	5.9		
No idea	8	16.3	17	16.2	10	26.3	35	23		

Table.13 continues.

Types feed you use to fatten goats									17.05	0.78
Natural pasture	27	55.1	42	64.7	13	44.8	82	55.4		
Grain &home left over	7	14.3	6	9.2	4	10.5	17	11.5		
Natural pasture + home left over	10	20.4	6	9.2	4	10.5	20	13.5		
Natural pasture +geraba	5	10.2	11	16.9	13	34.2	29	19.1		

Castration

Castration is not commonly practiced in the study districts. Approximately 78.3% of participants stated that goat producers do not castrate animals. According to about 72.4 % of the respondents, mean age of castration of goats is one year and above. In disagreement with the current finding, about 71.0% of goat producers from East Hararghe zone, Oromia region carried out goat castration (Mahilet, 2012). Goat producers from Shabelle zone of the Somali regional state also widely practiced goat castration, where about 93.7% of goat producers practice castration (Alefe, 2014). From these it can be argued that goat castration practices are influenced by agro-ecologies and socio-cultural reasons.

Majority of the respondents (75.7%) indicated that goat castration is carried out by Burdizo. In the study areas, goat castration is done by animal health experts at the nearby veterinary clinic. Modern type castration was more widely conducted (81.6%) at Sayo district compared to the other two districts. This is mainly due to the district's location advantage. Sayo district covers in and around the capital town of the Qellam Wallaga zone, Dambi Dollo town. Castration is mostly accompanied with fattening. Castrated goats are fattened being supplemented with roasted maize grain mixed with salt and kitchen left over. The major purposes of castration are to improve body condition of the castrated animals in order fetch premium market price (i.e gain profit) and to make the animals docile (Table14).

Table14

Castration of goats in study area

	District (N and %)						Over all		X^2	p-value
	Sayo		Gawo Qebe		Dale district					
	N	%	N	%	N	%	N	%		
Castration buck									16.32	0.014
Yes	12	4.5	19	29.2	2	5.3	33	21.7		
No	37	75.5	46	70.8	36	94.7	119	78.3		
Reason for castration									35.58	0.781
Improve fattening	23	51	23	35.4	16	42.1	64	42.1		
Control breeding	6	12.2	8	12.3	5	13.2	19	12.5		
Better temperament	4	8.2	22	33.8	3	7.9	29	19.1		
No idea	14	28.6	12	18.5	14	36.8	40	26.3		

Table. 14 Continues.

At what do you castrate									64.47	0.074
>1year	32	65.3	49	75.4	29	76.3	110	72.4		
No idea	17	34.7	16	24.6	9	23.7	42	27.6		
Castration method									27.84	0.510
Modern	40	81.6	47	72.3	28	73.7	115	75.7		
Traditional	0	0	0	0	2	5.3	2	1.3		
No idea	9	18.4	18	27.7	8	21.1	35	23		

N=number, X^2= chi-square

Proffered Traits for Breeding Buck Selection

Some of the most preferred traits for breeding bucks selection are indicated in Table 15. In the study districts, no due attention is given to breeding does selection. Major attention is given mainly to breeding bucks selection. Among the different traits, appearance, coat color and horn were rated as the first, second, and third desired features. in breeding bucks selection at all the three districts. The index values attributed to appearance, coat color and horn at Sayo district were 0.41, 0.27 and 0.16, respectively. The matching index values assigned to the three traits at Gawo Qebe district were 0.36, 0.32 and 0.19 and 0.37, 0.36 and 0.14 at Dale Wabara district, respectively. Dawit (2012) and Tesema et al (2023) also reported that appearance and coat color were the two most important characteristics that were widely preferred in the selection of breeding bucks.

Table 15

Farmers' preferred traits for Buck Breeding in the Research Areas

Selection criteria	District											
	Sayo				Gawo Qebe				Dale Wabara			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Appearance	29	14	6	0.41	26	23	16	0.36	17	13	8	0.37
Coat color	3	27	17	0.27	18	22	25	0.32	12	19	7	0.36
Character	0	0	7	0.02	0	0	0	0	0	0	0	0
Growth rate	4	3	3	0.07	4	7	9	0.09	3	4	9	0.11
Testicular size	0	0	0	0	0	0	0	0	0	0	0	0
Libido	0	0	0	0	0	0	0	0	0	0	0	0
Pedigree	3	2	5	0.06	2	3	7	0.05	1	0	2	0.02
Absence of horn	10	3	11	0.16	15	10	8	0.19	5	2	12	0.14

R1, R2 and R3 = rank 1, 2and 3, respectively. Index= sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) give for each selection criteria for breeding buck divided by sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all selection criteria for breeding buck

Proffered Traits for Selection of Breeding Does

Among the selection criteria taken into consideration, the districts of Sayo, Gawo Qebe, and Dale Wabara identified appearance, color, and twining ability as the first, second, and third criteria for doe selection, respectively, with index values of 0.49, 0.3 and 0.09, 0.48, 0.3 and 0.07, and 0.49,0.34 and 0.06 (Table 16). According to Tsigabu (2015) in the Nuer zone (Jikawe and Lare districts) of the Gambella Regional State of Ethiopia and Belete (2014) in the Bale zone, appearance and coat color were ranked as the first and second criteria for breeding doe selection, respectively, which is consistent with the findings of the current study. According to the current study, the main goal of goat production is cash income, which makes farmers' poor preferences for black goats understandable.

Table16

Selection criterion for breeding does in the study area.

Selection criteria	District											
	Sayo				Gawo Qebe				Dale Wabara			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Appearance	45	4	0	0.49	59	6	0	0.48	36	2	0	0.49
Coat color	4	30	15	0.3	6	47	5	0.3	2	35	1	0.34
Mother ability	0	0	0	0	0	0	0	0	0	0	0	0
Kid survival	0	0	0	0	0	0	0	0	0	0	0	0
Kid growth	0	0	0	0	0	0	0	0	0	1	0	0.01
Short kidding interval	0	5	8	0.06	0	0	0	0	0	0	0	0
Twining ability	0	7	11	0.09	0	9	8	0.07	0	0	13	0.06
Better milk yield	0	0	0	0	0	0	10	0.03	0	0	0	0

Reproductive Performances

Reproductive performance of goats of the study areas is presented in Table 17. P>0.05 indicates no significant difference was observed among the districts with regard to most of the reproductive traits, except age at first kidding and the duration of a bucks' reproductive life. For Sayo, Gawo Qebe, and Dale Wabara districts, the mean age at sexual maturity for males was 7.1±0.13, 7.3±0.10, and 7.2±0.14 months, respectively. For females, the comparable mean age of sexual maturity was 7.6 ±0.11, 7.6 ±0.12, and 7.6 ±0.13 months, respectively. The current study's mean age of sexual maturity for both sexes closely matches Belete's (2014) report of 7.6 to 7.9 months for goats in the Bale zone. In the present study areas, the mean ages at first kidding were 11.9±0.14, 12.1±0.16, and 11.4± 0.18 months for the districts of Saya, Gawo Qebe, and Dale Wabara, respectively. The age at first kidding differed significantly (p<0.05). Compared to the other two districts, Gawo Qebe district had the longest age at first kidding. On the basis of kidding interval (KI), no districts were found to differ significantly (p>0.05).

Kidding interval was 7.7±0.10 months at Sayo, 7.6±0.09 months at Gawo Qebe and 7.8±0.13 months at Dale Wabara. As the current study findings were based on questionnaire interview the values reported for KI might not be accurate. The values obtained for kidding interval might not be practical under extensive conditions where breeding does are not well managed. The KI reported in the current study is lower than the 8.1 months reported by Tatek et al (2004) the 8.85 months reported for goats in the Lay Armachiho district. Extremely long KI of 11.31 months was reported by Belay (2008) for Abergelle goats. The likely reason for the very long KI reported for the Abergelle goats may be reasonable with the dryness of the area that can be translated into the availability feeds. The overall mean number of kids per doe lifetime was 11.2±0.14 in the current study. Mean numbers of kids per doe lifetime were reported as 12.17±0.20 and 13.3±0.24 for Aseko and Lemu Bilbilo districts, respectively. In the current study, the mean reproductive life span bucks was reported as 4.3±0.07 months and district had significant influence on the reproductive life span of bucks. The reproductive life spans for Sayo, Gawo Qebe and Dale Wabara districts were 4.6±0.11, 4.1±0.12 and 4.1±0.12 months, respectively. Under situations where there is no exchange of breeding bucks, retaining breeding bucks for such long time in a flock may have an inbreeding effect. About 75.7%, 17.1 and 7.2% of the respondents indicated that their goats are twin, single and triplet bearers, respectively. According to respondents, about 86.8% of goats in Dale Wabara were multiple bearers (twin or triplets) followed by goats in Sayo (82.9%). In Gawo Qebe about 78.5% was multiple bearers.

Table 17

Least squares mean (±SE) of reproductive performances of goat in the study areas

Reproductive traits	District			Over all	p-value
	Sayo	Gawo Qebe	Dale Wabara		
Age at sexual maturity male (m)	7.1 ±0.13	7.3 ±0.10	7.2 ± 0.14	7.2 ± 0.07	0.334
Age at sexual maturity female (m)	7.5 ± 0.12	7.6 ± 0.11	7.6 ±0.13	7.6 ± 0.07	0.735
Age at first kidding (m)	11.9 ±0.14^{b}	12.1 ±0.16^{a}	11.4±0.18^{b}	11.9±0.09	0.023
Kidding interval (m)	7.7 ± 0.10	7.6± 0.09	7.8 ± 0.13	7.7 ± 0.06	0.391
Average number of kids/ doe life	11.3 ±0.26	11.2 ±0.2	10.9 ±0.26	11.2±0.14	0.587
Reproductive life span of doe (yr)	5.9 ± 0.14	6.1 ± 0.13	5.97±0.18	6.0 ± 0.08	0.551
Reproductive life span of buck (yr)	4.6 ± 0.11^{a}	4.1 ± 0.12^{b}	4.4 ±0.13^{c}	4.3 ± 0.07	0.024

Goat Production Constraints

Some of the major goat production constraints identified in the study areas are presented in Table 18. As reported by respondents feed shortage was the primary constraint flowed by diseases with index values of 0.4, 0.42 and 0.39 and 0.37, 0.39 and 0.37 for Sayo, Gawo Qebe and Dale Wabara districts, respectively. Predator was the 3rd most important constraint in all the three districts. The 1st ranked constraint, feed shortage, was not total feed shortage/deficit but seasonal. The seasonal availability of feeds is mainly a reflection of differences in feed availability between years, caused by variation in total annual precipitation and the distribution of rainfall (Duguma, 2001). Similar obstacles for goat production in particular and livestock production in general in different parts of Ethiopia were reported to include feed scarcity, seasonal fluctuations, poor quality of the available feeds, and prevalence of various diseases and parasites (Abraham et al.,2017; Alilo et al., 2018; Taye et al., 2024)

Table 18

Major goat production constraints in the study area

Constraints	Districts											
	Sayo				Gawo Qebe				Dale wabara			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Labor shortage	0	0	0	0	0	0	0	0	0	0	2	0.01
Feed shortage	25	19	5	0.4	34	29	2	0.42	15	19	5	0.39
Water shortage	0	0	0	0	1	3	11	0.05	0	0	0	0
Disease	21	17	11	0.37	28	30	7	0.39	18	13	5	0.37
Drought occurrence	0	0	0	0	0	0	0	0	0	0	0	0
Market problem	0	2	5	0.04	0	0	8	0.02	0	2	3	0.03
Lack of superior genotype	1	5	15	0.09	0	1	13	0.04	0	1	4	0.03
Predator	2	6	13	0.1	2	2	19	0.07	5	3	17	0.17
Extension service	0	0	0	0	0	0	2	0.01	0	0	0	0

CONCLUSIONS

Goat production is significant because they are easy to manage, only need a small initial investment, have high fertility, a short generation interval, can adapt to harsh environments, and can produce in limited feed resources, which means they can quickly pay for themselves in insurance and return on investment. Goat mainly kept for income generation, meat for home consumption and manure production in the study areas. The most crucial characteristics (objective traits) that goat producers took into account when choosing breeding buck and does were appearance and coat color. In addition, twining ability was the 3rd important objective traits in breeding does section. Therefore, when designing goat breed improvement strategies in the area, these traits should be considered

The primary factors limiting goat production in the study area are seasonal feed scarcity, disease and predators, market accessibility, and lack of superior genotype.

Reducing these factors would enhance goat production. It is crucial to increase capacity in the fields of illness prevention and treatment, feed development, and management.

Generally speaking, the current study suggests that goats are the area's primary source of immediate cash, meat production for domestic consumption, and manure production. They also have the potential to make a larger contribution through improved nutrition, better health care, and genetic advancement.

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DECLARATION

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

Data will be made available on request

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