Husbandry and Breeding Practices of Indigenous Goats, Pre-Weaning Growth Performance, and Mortality Rate of Kids in Abrehamo District, Benishangul-Gumuz Region, Ethiopia

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Abstract: The present study assessed the husbandry and breeding practices of goats, pre-weaning growth performance, and mortality rate of kids in the Abrehamo district. Data were collected through personal single rapid field survey and detailed structured questionnaire interviews of 164 respondents. Moreover, flock monitoring was conducted by purposively selecting goat flocks of 28 households having 61 pregnant does and 45 kids. The live body weight was measured in the morning before the kids were permitted to suckle their mothers. The result revealed that farmers keep goats as a primary source of cash income, meat production and/or consumption. Goats account for the largest share of the livestock holdings and the tropical livestock unit (TLU) among other species in the study area. Uncontrolled breeding was practiced. Disease, shortages of feed, predators, and poor extension service were the most important goat production constraints in their order of importance. The overall mean birth weight (BW), weaning weight (WW), and average pre-weaning daily gain (PrWDG) of kids were 2.32 ±0.06 kg, 9.07±0.17 kg, and 74.82 g/day, respectively. The BW, WW, and PrWDG were significantly affected ($P<0.05$) by sex, type of birth, and parity of does. Kids born from their first parity dams, twin-born kids, and female-born kids had the lowest survival rate. The study revealed that there is a need to further improve the general husbandry and breeding practices by designing appropriate improvement strategies in order to enhance the productivity of goats.

Keywords: *Breeding practices, Monitoring, Mortality rate, Pre-weaning growth*

Introduction

Goats are one of the most abundant species of animals which are domestic in the world and they are grown in different geographical and climatic conditions which are suitable for goat production (Petrovic *et al*., 2012). Goats are reared entirely in mixed crop-livestock, pastoral, and agro-pastoral production systems, and in a wide range of agro-climates covering hot arid, semiarid, and cold humid highlands parts of Ethiopia. The number of goats is estimated to be 52.5 million heads in the country (CSA, 2020). Goats are important livestock species kept by most households in Ethiopia. They are reared mainly to serve as a source of income generation, benefit as capital accumulation, social well-being, milk, skin, manure, and cultural functions (Grum, 2010; Chenyambuga *et al.,* 2012).

Despite the large number and significant role of goat production both in the national and family economy, poor growth performance, high mortality rate, poor nutrition, low commercial slaughter rate, and lack of appropriate breed and breeding strategies confronted the productivity of smallholder farmers goat production in Ethiopia (Deribe *et al.,* 2014; Solomon *et al.,* 2014). Moreover, indigenous goats in Ethiopia are genetically less productive as compared to temperate breeds (Mohammed *et al.,* 2012). Thus, to efficiently exploit their genetic potential, it is crucial to understand the growth and production performance of breeds in their environment and under smallholder farmer's situations. The most important production trait in small ruminants is growth, because it affects the production contribution of a producer by reducing the sale value of live animal and meat production (Belay and Mengistie, 2013). Among economically important growth traits are birth weight of kids, weaning weight, and growth rate. These traits are affected by feeding practices, climatic factors, and husbandry management under on-farm conditions. Body size, age, sex of kids, protection, and feeding conditions of a breed are commonly known to have an impact on the growth and body weight of an animal (Akta and Dogan, 2014). Genetic and non-genetic are the two grouped factors that could affect the growth performances of goats (Mengistie *et al.,* 2009; Temesgen, 2010). Parity of doe, birth type, and season of birth of kid are considered to be fixed effects/non-genetic factors, which significantly affect the productive performances of goats. To efficiently design sustainable genetic improvement strategies, the relative significance of benefits obtained from small ruminants, and their genetic, husbandry, and breeding management practices need to be assessed and plainly understood (Kosgey and Okeyo, 2007).

The present study dealt with particular emphasis on indigenous goats that local farmers have traditionally kept in the Benishangul-Gumuz Regional State. The major goat-rearing is kept under mixed crop-livestock

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farming systems. Very few research efforts have been conducted to make use of the available genetic resources of the goat population in the study area. Goat production is suitable in the study area, because goats can adapt to survive, produce, and reproduce in semi-arid ecological conditions. Nevertheless, the goats face many different threats such as animals' free movement in the Ethio-Sudan border areas, socio-economic-driven changes in goat-keeper preference, and paramount mortality due to regular drought and disease outbreaks. Identifying the impacts of environmental factors affecting the pre-weaning growth performances and mortality rate of kids in the goat flocks would be useful for the achievement of sustainable genetic improvement and conservation of the breed. To develop a breeding strategy for the improvement and conservation of the breed, more detailed and accurate information on goat husbandry and breeding practices, growth performance, and mortality rate of kids kept under smallholder farmer's conditions need to be available. Therefore, the objective of this research was to assess the existing on-farm goat husbandry and breeding management practices, monitor pre-weaning growth performance, and identify factors affecting the pre-weaning mortality of kids in the study area.

Materials and Methods

Description of the Research Area

The study was conducted in the Abrehamo district in Assosa Zone, western Ethiopia. The district is located in a sub-humid agro-ecological zone of Benishangul-Gumuz Region and it is bordered by Maokomo, Ura, and Bambasi districts in the south, north, and east respectively, and South Sudan in the west (Abrehamo District Office of Agriculture, 2022). The district comprises 41 *kebeles* and it is geographically situated at 9.60° to 10.45° N latitude and 34.20° to 34.58° E longitude. It has rainfall and altitude ranges from 850–1200 mm and 580–1544 m.a.s.l, respectively. The mean annual temperature of the district ranges between 16.75°c and 37.9°c. The livestock population is estimated to be 18,950 cattle, 21,358 goats, 3,011 sheep, 4,070 equines, and 30,499 poultry (Abrehamo District Office of Agriculture, 2022). The production system of the study area is characterized by mixed crop-livestock production.

Sampling Techniques and Data Collection Methods

Before the study site selection, consultative meetings with Benishangul-Gumz agriculture offices and a rapid field survey were made to understand the production system in the region and the distribution of goat breeds in the districts. Based on the rapid field survey and discussion with key informants (farmers' representatives, elders, and livestock experts), Abrehamo district was purposely selected. Three Peasant Associations namely Amba 13, Amba 14, and Nebarkomishga were selected from the district on the basis of goat population, presence of communal grazing areas, relative significance of goats to the income of the communities, and access to market and road for regular visiting. The sample size for the survey study was determined following Yamane (1973) formula with a 95% confidence level. Accordingly, 26, 55, and 83 households from Amba 13, Amba 14, and Nebarkomishga, respectively were selected for interviews. For the survey study, a total of 164 farmers who owned a minimum of one goat and were willing to participate in the study were undertaken using systematic random sampling.

Accordingly, the sampled households in the study district were an unequal proportion of households, which comprises ten households from each of three *kebeles* (i.e., thirty households in total). Sixty pregnant, does with a total of 45 kids (proportionally 15 kids from each of three *kebeles*) owned by the selected households were taken purposively for the monitoring study. A questionnaire was prepared in English and translated to local language, pre-tested, and administered. The structured questionnaire was also designed to collect information on livestock holding, species and herd size composition, flock structure, husbandry and breeding practices, reason for keeping, and production constraints of goats.

Data were collected through a monitoring approach for a period of three months. To identify each experimental animal ear tag numbers were used. The lifetime information of each doe such as date of animal birth, parental detail, type of birth (single, twin, triplet), abortion cases, progeny evidence (sex, birth weight), and health information (vaccinations, treatments) were recorded in a prepared record sheet.

The growth performance traits documented during the study period were birth weight (BW), three months weaning weight (3-MWW), and average daily weight gain (ADWG) of 90 days. Suspended spring balance was used to measure the weights of kids. The successive weights of kids were taken at ten-day intervals. BW of the kids was taken within 24 hours after birth. The live weight of the kids was measured early in the morning before the kids are allowed to suckle their dams. Data recorded includes the growth performance of 45 kids. Kids' sex, single and multiple birth types, and does parity from 1 to 5 were considered as fixed effects. Based on growth traits, the average PrWDG was computed according to Befikadu *et al.* (2022) as follows:

$$\text{Average Daily Gain(ADG)}t3\text{-}t1=(Wt3\text{-}Wt1)/t3\text{-}t1$$

where, ADGt3-t1 is the weight gain between periods t1 and t3; Wt3 and Wt1 are the weight of ages between t3 and t1, respectively; and t3-t1 is the number of days between ages t1 and t3.

Kid mortality rate and survival rate (%) were computed according to Tsedeke (2007) as follows:

$$\text{Kid mortality rate (\%)}=\frac{\text{No.of kids died during monitoring period}}{\text{No of kids born during the study periods}}$$

$$\text{Kid survival rate}=\frac{\text{No.of kids survived during monitoring period}}{\text{No of kids born in a particular study periods}}$$

Data Analysis Methods

Survey data were analyzed using the Statistical Package for the Social Sciences (SPSS, 2013). The selection criteria of farmers' trait preferences ranking were summarized into an index. Indices were calculated as the sum of (3x for rank 1st + 2x for rank 2nd + 1x for rank 3rd) given for a given reason proportional of the sum of (3x for rank 1 + 2x for rank 2 + 1x for rank 3) for all preferences (Kosgey *et al.*, 2004). The data generated from the monitoring study was analyzed using the general linear statistical model (GLM) procedure. Fixed effects evaluated for growth traits were the sex of the kid (male, female); number of 1st, 2nd, 3rd, and 4th parties; single, twin, and triplet birth types; and season of birth (wet, cool, and dry). The influence fixed effects evaluated for the mortality rate of kids were the sex of the kid, party, and birth type. The effects of 2-way interaction were also fitted in the models and were considered at $p<0.05$ in the beginning analysis.

Results and Discussion

Purpose of Keeping Goat

The major reason for the community's keeping of goats was for income generation followed by meat production for home consumption and saving (Table 1). The income generation identified as the primary purpose of keeping goats in the current study is also similar to the results obtained by Solomon *et al.* (2014) and Befikadu *et al.* (2020) in Ethiopia. The higher rank given for income generation is due to the value and the ability to reproduce quicker for replacement of the goat to produce money when needed for regular and urgent desires.

Table 1. Farmers' rankings indexes of the relative importance of goat keeping.

Purpose	Ranks			Index	Rank
	Rank 1	Rank 2	Rank 3		
Income generation	148	13	3	0.491	1
Meat for home consumption	13	60	62	0.206	2
Milk for home consumption	0	0	4	0.004	6
Saving	1	77	32	0.196	3
Manure	2	15	53	0.092	4
Social and cultural functions	0	0	10	0.010	5

Index= Sum of (3 X number of households ranked first + 2 X number of households ranked second + 1 X number of households ranked third) given for a particular purpose, criteria or preference divided by the sum of (3 X number of households ranked first + 2 X number of household ranked second + 1 X number of household ranked third) for all-purpose, criteria or preferences.

Based on group discussions with key informants, the majority of households do not consume goat milk due to a lack of awareness of its nutritional value. In addition, they reported that it is a form of ensuring the better growth performance of kids. In support of this, an earlier study by Solomon (2014) explained that due to cultural taboos majority of households did not consume Gumuz goat milk in the western areas of Benishangul-Gumz Region.

Livestock Holding and Flock Structure

In the present study, the tropical livestock unit (TLU) of goats was higher as compared to other species (Table 2), which indicated that goat production is considered to be a major livestock activity for the farmers in the study areas. A higher number of goats kept in comparison to other livestock species might be indicative of the goat's ability to adapt to the existing harsh environment. This is in agreement with the results of Demissie (2015), who noted that goats are usually considered higher in number in lowland areas, which is associated with the availability of varieties of trees and shrubs. The study of Befikadu *et al.* (2020) showed that the mean goat flock size is higher per household in the western lowlands of Ethiopia. According to group discussions with key informants, goats serve as an urgent source of returns and have short intervals between generations. Moreover, they produce high kids and have a fast growth productive rate as compared to any other livestock species. Besides, they believed that goats are productive more than others due to better adaptive characteristics and resistance to diseases.

The average breeding and young female goats comprise nearly 53% of the total flock size per house goat holdings (Table 3). Breeding does constitute the highest proportion (35.86%) followed by female kids 6-12 months (17.8%) and buck (14.8%). Keeping a higher number of female animals indicates the community's desire to sustain the flock size and to increase income generation. Similarly, Solomon (2014) and Befikadu *et al.* (2020) noted that breeding females (does) consist of 48 % and 57 %, respectively among goats in the Benishangul-Gumz Regional State. Bucks and male kids (6-12 months) have a lower mean number as compared to their female complements. This indicated that the higher percentage of females may be accredited to the common practice of keeping females for reproduction purposes, whereas males are castrated to obtain better market prices at an early age. The smaller proportions of kids could be associated with the seasonal kids born, because due to the occurrences of drought in the area, most of the kidding happens from November and December in subsequent the active breeding during the wet season in June and July months (Befikadu *et al.*, 2020).

Table 2. Mean ± SE livestock species holding in the study area.

Species	Mean ± SE	TLU
Cattle	1.98±3.81	0.20
Sheep	0.39±0.92	0.04
Goat	6.90±4.36	0.69
Equine	0.67±0.84	0.07
Chicken	6.03±4.92	0.60

SE= Standard error; TLU= Tropical livestock unit.

Table 3. Mean number of goats across age structure.

Age classes	Mean number of flock size	Percent
Overall	189.17	100.00
Kid < 6 months	151.00	13.30
Male kid 6-12 months	122.00	10.75
Female kid 6-12 months	202.00	17.80
Does	407.00	35.86
Buck	168.00	14.80
Castrated (wither)	85.00	7.49

Goat Husbandry Practices

Feed resources and feeding practices: The accessibility to abundant and diverse feed resources depends on the seasons. In the study area, natural pasture comprises a broad variety of naturally occurring both annual and perennial grasses, herbaceous, legumes, and browse species during dry and wet periods (Table 4). Similar to the present finding, Yilkal (2015), Onzima *et al.* (2017), and Befikadu *et al.* (2020) described that in Ethiopia natural pasture grazing land was the major feed source for livestock species. The main feed resources during the wet season were natural pasture, maize grain, and food leftover, whereas, crop residues (sorghum and maize stover), natural resources from indigenous browse species, and crop aftermath were the main available feed resources in the dry season. Most of the grazing land areas during the dry season turn into uncovered and the accessibility of browse, shrubs, and bushes is decreasing. This is mostly attributable to the use of unrestrained burning of the rangeland and the browse species leaves are shedding. The communal grazing lands were utilized throughout the year even if there were variations in the level of utilization across months in a year, which demonstrates that feed shortage should be improved in the natural pasture of the areas (Befikadu *et al.,* 2020).

Table 4. Farmers' rankings and derived rank indexes of the relative importance feed resources and their seasonal availability.

Feed sources	Seasons			
	Dry		Wet	
	Index	Rank	Index	Rank
Natural pasture	0.21	2	0.57	1
Crop aftermath	0.16	3	0.05	5
Maize grain/seed	0.13	4	0.14	2
By-products (flour, local brewery by-product, *Atella*)	0.06	6	0.04	6
Private grazing land	0.01	9	0.07	4
Food leftover	0.11	5	0.10	3
Crop residue	0.26	1	0.03	7
Concentrate (wheat bran)	0.02	8	0.00	8
Fruit leftover	0.03	7	0.00	8

The majority (82.6%) of respondents provide supplements with cereals (maize, sorghum), salt, and feeds for their goats during the dry season, especially to the lactating does; adult breeding bucks; and finishing goats to improve milk production for fast growth of kids; maintain their body state for breeding; and to contain better muscular growth and obtain better market price, respectively. This is in agreement with the report of Fikru and Gebeyew (2015) in eastern Ethiopia. The result of the present study showed that after the cropping season, most the herd holders isolated their goats from cattle, sheep, and equine followed by unrestrained herding. Only 5.6% of the respondents herd their goat with sheep, while 3% herd their goat with cattle and equines.

Disease and health management: According to the perception of the interviewers in the study area, the most economically important diseases of goats were pest des petites ruminants (PPR), contagious caprine pleuropneumonia (CCPP), and foot and mouth disease (FMD) (Table 5). Recent studies noted that similar

disease problems were reported by goat keepers in Uganda and Ethiopia (Onzima *et al.,* 2017; Befikadu *et al.,* 2020). Both internal parasites and external parasites have occurred as usual problems in goat production in the area. In this study, respondents indicated that diseases affected the entire age class of goats. Similarly, Onzima *et al.* (2017) indicated that disease was the most important constraint affecting the production of goats in Uganda, in which other diseases and parasite infestation of animals were the common features in the lowland areas. This might be due to the existence of communal grazing land and animal movement (Assen and Aklilu 2015) and the availability of limited information on the incidence of disease outbreaks (Dube, 2015). Therefore, this result suggests the need to develop health interventions to reduce mortality and optimize the productivity of goats. In addition, most farmers find it difficult to identify some of the diseases. Therefore, there is a need to train the community and animal health workers who, despite the shortage of drugs as well as equipment, are supplying a sustainable solution to animal health problems (Befikadu *et al.,* 2019).

Table 5. Economic importance of goat diseases based on the perception of the respondents in the study area.

Diseases and parasites	N	Percent
CCPP (contagious caprine pleuropneumonia)	36	21.95
FMD (foot and mouth disease)	26	15.85
Pasteurellosis	14	8.54
PPR (pest des petites ruminants)	47	28.66
Trypanosomiasis	16	9.76
External parasites	18	10.98
Internal parasites	7	4.27

N= Number of observations.

Most of the interviewees utilize veterinary services from the government (77.4%) and local traders (12.8%) as sources of drugs to treat sick animals, while others sell and slaughter immediately. The majority of respondents described that vaccines were provided before the disease outbreak (47.3%), followed by after the report of disease occurrences (32.7%) and after the death of certain animals (20%). Thus, there is a need to provide training to farmers and extension workers on how to control before and after disease outbreaks occur in the study area.

Breeding Management Practices

As it is described in Table 6, the majority of respondents castrate their goats. The main reason for castration was to enhance the fattening potential and as a way of attaining better sale prices in local markets, which is in agreement with the report of Feki *et al.* (2015) and Hulunim *et al.* (2015). Few respondents in the study area indicated that castrations were practiced to control unwanted mating and improve the behavior of the buck. Therefore, fattening was the most imperative cause for the castration practice. The study by Befikadu *et al.* (2020) indicated that castration practice among communities of the western lowland could be a practice to control unwanted bucks mating and to increase the value of culled bucks. The authors also noted that bucks with better body structures and the potential for fattening are regularly subjected to castration. This designates that better genotype breeding bucks were disposed of serving the breeding females in the flocks. Thus, to avoid this early removal of breeding males, a well-built extension service is needed to maintain better genotypes from their best males for mating functions (Befikadu *et al.*, 2020).

Amongst the interviewees who experienced castration, about 59.2% utilized the traditional castration method using locally available materials such as stone, hammer, and wood. Abebe *et al.* (2013) noted that the traditional method of castration leads to infections due to the wound formed by the castration procedure. The remaining use modern methods such as the Burdizzo with the help of professionals in the veterinary clinic. This suggests that the practice of castration in the study areas might be advantageous to control the incidences of inbreeding and unwanted mating.

The majority of households (93.3%) practiced uncontrolled natural mating systems and only 6.7% of households practiced controlled breeding (Table 6). This is similar to the report of Tekleyohannes *et al.* (2012), Hulunim (2014), and Solomon *et al.* (2014), who indicated a predominance of uncontrolled mating within households' flocks. Uncontrolled mating among small flock sizes with poor and/or the absence of record keeping is anticipated to result in severe inbreeding which directs to reduced growth rates (Saico and Abul, 2007). The key reasons for the absence of controlled mating in the current study might be due to communal grazing areas and a lack of farmers' knowledge about the harmful effects of inbreeding. The average age of castration was 16.16±0.53 months. Goats were weaned on average at the age of 5.14±0.11 months as the kids were separated from their does by smearing the teat of their dams with a dung. A total of 53.7% of goat owners had not practiced weaning (Table 6). According to the focus group discussion, the reason for less practicing of weaning was due to their poor knowledge about the importance of the weaning age of kids. The growth rate is dependent more on weaning than age. This implies that kids born from dams with good mothering ability weaned faster as compared to kids born from does with bad mothering ability.

Table 6. Castration and weaning practice of households in the study area.

Castration and weaning practice	Response of HH (N=164)	
	N	Percent
HH practicing castration	145	88.4
HH not practicing castration	19	11.6
Purpose of castration:		
To control unwanted breeding	40	24.39
Better temperament	13	7.93
Fattening	111	67.68
Castration method:		
Traditional	97	59.15
Modern	67	40.85
Natural mating system:		
Uncontrolled	153	93.3
Controlled	11	6.7
Practicing weaning:		
HH practicing weaning	76	46.34
HH not practicing weaning	88	53.66

HH= Household.

Major Goat Production Constraints

Disease, shortages of feed, and predators were the major constraints that influenced goat production in their order of importance (Table 7). The low efficiency of veterinary services provided by the government could be associated with high burden of disease conditions. Similarly, disease problems and feed shortage were reported as the major production constraints of local goat breeds in the Bale Zone of Oromia and Assosa Zone of Benishangul-Gumuz Region (Solomon, 2014; Belete *et al*., 2015; Befikadu *et al.,* 2020). The great production loss caused by disease could be due to the harsh climatic conditions of the study area, which might aggravate the incidence of disease and lead to scanty nutrition for goats. Furthermore, insufficient farmers' health management, less capable veterinary service, and repeat occurrence of drought may exacerbate the problem. Solomon (2014) reported that the western lowland area has a relatively large communal grazing land and it receives good rain with feed scarcity to be a problem only for a few goat owners. However, the finding of Befikadu *et al.* (2020) noted that poor quality and harvesting management of the communal grazing land; erratic rainfall; fast human population growth; investment expansion for farming land; drought; and shortage of water were the most important causes of feed problems both in terms of quality and abundance. The constraints reported in the present study were also reported by earlier studies (Assen and Aklilu, 2015; Belete *et al*., 2015; Hagos *et al*., 2017).

Table 7. Farmers' rankings and derived rank indexes of the prevailing major production constraints of goats in the study areas.

Constraints	Rank			Index	Rank
	Rank1	Rank2	Rank3		
Disease	97	40	18	0.38	1
Shortages of feed resources	41	82	15	0.20	2
Water shortage	2	10	39	0.07	5
Labor shortage	0	2	5	0.041	6
Drought	2	12	11	0.08	4
Theft	0	4	3	0.01	7
Predators	16	12	34	0.10	3
Lack of market access	0	0	3	0.00	9
Lack of extension service	5	15	35	0.08	4

Growth Performance

The overall average birth weight (BW) was 2.32±0.06 kg (Table 8). The mean BW of the kids obtained in this study is similar with the study of Tesfaye (2009), which showed a range of 2.2 to 2.9 kg body weight under the traditional system. However, it is higher than the reported value of 2.01±0.03 kg for central Highland (Belay and Mengistie, 2013) and 2.19±0.08 kg for Somali (Hulunim, 2014) goats. Male kids were heavier by 0.36 kg at birth weight and 0.66 kg at three months weight than female kids. Befikadu *et al.* (2022) reported greater BW in male than female goats, which is attributed to the effect of male sex hormones which stimulate skeletal physiological function, thus leading to higher in male birth weight. The present result is supported by different studies (Zeleke *et al*., 2017; Befikadu *et al.,* 2022). The birth weight varied significantly ($p<0.05$) between the birth types and sex of kids. The nutrition the dam receives during the pregnancy term might influence the BW of the kids (Otuma and Osakwe, 2008).

The birth weight and WW of kids were affected by the parity dams. Kids born from dams of first parity had significantly lower ($p<0.001$) weights at birth and WW than those in other parities. Whereas, significantly higher BW ($p<0.01$) and WW ($p<0.05$) were recorded in the fourth parity than kids born to does from other parities (Table 8). This could be due to the superior body weight of does and better mothering ability than those does that gave birth for the first, 2nd, 3rd, and 5th time. Moreover, it might also be associated to the weight of the doe at kidding. Single-born kids had significantly higher ($p<0.01$) BW (2.47 ±0.11 kg) than kids born as twin-born (2.28±0.07 kg). This might be ascribed to rivalry for nutrients and space from their dam before birth in the case of twin births. Therefore, it is vital to enhance the feeding and management practices, particularly for those with higher litter sizes at the time of breeding so as to increase birth weight and to attain better WW.

The average WW growth of kids was 9.07±0.17 kg (Table 8), which is higher than for Abergele goat kids (9 kg) (Belay and Mengistie, 2013) and Arab goat kids (8.48±2.13 kg) (Befikadu *et al.,* 2022) under the traditional management system. Kids born from does with second and fifth parity had significantly ($p<0.001$) lower WW with values of 9 ±0.36 kg and 8.6 ±0.34 kg, respectively than kids born in other parities. This might be related to the kid's weight at birth and it might be due to the dams' milk production reduction. With regard to sex, female kids were 1.16 kg/day lower than male kids at weaning weight and recorded lower daily gain than male kids indicating that the sex effect is more favorable for males in body growth and daily weight gain. Similarly, an earlier study by Andries (2013) noted that the weaning weight and pre-weaning average daily gain were affected by the sex of the kids for Kentucky meat goats. The superior birth weight of males might be due to the forceful nature of males at the time of suckling. Also, it is a natural observable fact that male goats have faster growth performance rates and heavier body weights at the maturity stage than female goats (Zeleke, 2007). In previous studies, similar sex effects were reported by Yaekob *et al.* (2015) and Kunbhar *et al.* (2016).

The average pre-weaning daily gain (PrWDG) of goats was 74.82±1.71 g/day (Table 8), and it was significantly affected by parity, sex, and type of birth. As observed in the current study, female kids gained significantly ($p<0.01$) lower pre-weaning weights as compared to male kids.

The superiority of male kids on PrWDG might be the result of their higher birth weights. Similarly, a previous study reported that male kids were heavier than female kids with PrWDG and BW measurements (Befikadu *et al.*, 2022). Different studies also supported the current result (Tesfaye, 2009; Belay and Mengistie, 2013). Generally, the disparities in the PrWDG are closely related to the amount of milk intake differences during the milk feeding time and the nutritional condition of the dam (Selamawit *et al.*, 2015). Birth type was significantly associated ($p<0.01$) with PrWDG, in which multiple-born kids were lower by 11.00 gm/day than single-born kids, which could be due to the reason that kids born in single birth type being the only users of their dam milk (i.e., no competition for dam's milk). In the study by Befikadu *et al.* (2020), it was described that single-born kids gained weight greater than multiple-born kids.

Table 8. Overall Least square means ±SE for the effects of non-genetic factors on growth of kids.

Effects/ levels	BW (kg)	WW (kg)	PrWDG (g)
Overall means	2.32±0.06	9.07±0.17	74.82±1.71
N	45	35	35
CV %	18.53	12.56	14.63
Sex:			
Male	2.53±0.05^{a}	9.44±0.27^{a}	69.48±3.78^{a}
Female	2.17 ±0 .09^{b}	8.78±0.21^{b}	61.10±4.51^{b}
P-value	0.01	0.01	0.01
Parity:			
1st	2.12±0.21^{c}	9.12±0.76^{bc}	76.87±7.41^{a}
2nd	2.32±0.21^{bc}	9.00±0.36^{c}	74.10±3.04^{bc}
3rd	2.31±0.12^{bc}	9.17±0.29^{b}	76.28±2.67^{a}
4th	2.41±0.06^{a}	9.20±0..40^{a}	75.29±4.28^{b}
5th	2.35±0.12^{b}	8.66±0.34^{d}	70.64±2.34^{c}
P-value	0.001	0.001	0.001
Birth type:			
Single	2.47±0.11^{a}	9.95±0.24^{a}	83.14±2.51^{a}
Multiple	2.27±0.07^{b}	8.79±0.19^{b}	72.14±1.88^{b}
P-value	0.01	0.01	0.01

^{abcd} means values within a column group and under the same parameter with different letter are significantly different ($p<0.01$; $p<0.001$); BW= Birth weight; WW= Weaning weight; PrWDG= Pre-weaning daily gain weight; CV= Coefficient of variance; N= Number of observations.

Pre-Weaning Mortality Rate

The mortality rate before weaning of kids was 22.2% (Table 9). The pre-weaning mortality rate result found in this study is lower than kids mortality rate of 25.4% in short-eared Somali goats (Grum, 2010) However, it is higher than the kid mortality of 13.3% for indigenous goats breed in Dale district, Sidama Zone (Endeshaw, 2007). Besides, a study by Dereje *et al.* (2015) indicated that the highest kid losses occurred before weaning age. Poor dam milking ability, poor feeding, and poor management practices are the most common causes for the losses of kids' at pre-weaning period. Thus, the mortality rate could vary among goat flocks due to management practice differences (Awgichew, 2000). The result of the current study showed that parity of does, birth type, and sex significantly ($p<0.05$) affected pre-weaning mortality rates of kids. The highest pre-weaning mortality was recorded in does in their first parity (11.1%) and fifth parity (6.7%). This might be due to the low body weight of kids at birth from dams of 1st and 5th parity and their low capability to nourish ample amount of milk for their kids. Single-born kids had a lower mortality rate than twins, which could be associated to the fact that kids born singly become the sole user of dam milk and have better birth weight than twins. Female (11.5%) kids had a higher mortality rate than male (5.3%) kids. The higher mortality rate in females may be accredited to the lower birth weight of female kids. The main causes of mortality were disease and predators. According to the study of Adama *et al.,* (2011), diseases such as PPR and pasteurellosis were responsible for high mortality rates in small ruminants.

Table 9. Mortality rate of kids during the monitoring periods.

Factors	N	Mortality rate up to 90 days age (%)
Overall	10	22.2
Parity:		
1	4	11.11
2	0	0.00
3	1	2.22
4	1	2.22
5	4	6.67
Type of birth:		
Single	3	4.44
Twin	7	17.78
Sex:		
Male	3	6.67
Female	7	15.55

N= Numbers of respondents.

A higher mortality rate was recorded in multiple-born (11.5%) than in single-born kids (Table 9). Similarly, previous studies have also reported the effects of birth type on pre-weaning survival (Girma *et al.,* 2013; Selamawit *et al.*, 2015; Befikadu *et al.,* 2020). Particularly, Girma *et al.* (2013) and Befikadu *et al.* (2020) described that the lower mortality of single-born kids in pre-weaning survival rate is credited to lower birth weights in twins. The limited nutrient content of feeds and milk consumed by fetuses after birth could be the major factor related to the high rate of after-weaning kids mortality in multiple birth types (Devendra and Burns, 1970). The death of kids before weaning could be the main reason for economic loss to goat keepers. This can be minimized by improving the feeding management of kidding goat flocks. Kids' survival can be ensured by improving the pregnant dam's nutritional conditions and adopting control measures against parasites and other disease conditions in the newly born kids. Particularly, attention to feeding and management practices is necessary in the first few days after the birth of multiple kids.

Conclusion

The present study revealed that goat production is considered to be a major livestock activity as compared to other species, indicating that they are the most economically important livestock in the study areas. However uncontrolled breeding, disease, shortages of feed, and predators were the major constraints influencing the production of goats. The pre-weaning kids growth performances in Assosa district were average. However, they are subjected to comparatively high mortality rates. The non-genetic factors (parity of does, sex, and birth type of kids) mainly affected BW, WW, pre-weaning daily weight gain, and kids' mortality rate. The body weight was lower during dry seasons, which is linked to the reduced feed intake rate resulting from inadequate feed resources and heat stress. The kids' mortality rate was high during the dry season, which might be associated with nutritional stress coupled with disease problems. Therefore, identifying the most relevant constraints of goat production should be the first step in enhancing the growth performance traits of in the study areas. The results of this study suggested the need to strengthen intervention through the conservation of available feed resources for the dry season and designing suitable disease prevention strategies that improve live weight performance and decrease the incidence of goat mortality.

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Conflict of Interests

The authors declare that they have no competing interests.

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