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A study on the productivity and mortality rates of native and blended goats in Dodoma, Tanzania

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Abstract

The focus of breeding animals such as goats has been to increase productivity and other benefits from domestic animals. A breeding programme for producing blended goats is ongoing in Mpwapwa, Dodoma, Tanzania. However, few studies have been conducted to understand the performance of the produced breed (blended goat) in comparison with local indigenous goats. This study assessed the performance of blended and local indigenous goats in terms of milk and meat productivity while taking into consideration birth type, mortality rate, diseases causing mortality, and management system used. Primary and secondary data collection methods were used in this study. The weight, length, and girth of 2-year-old kids were measured in the morning and evening, and milk production in a lactating doe was recorded. Secondary data on the weight, length, and girth of inborn between 2010 and 2020. The results showed significantly higher productivity for blended goats than for indigenous goats in terms of meat and milk production ($P < 0.005$). The mortality rate of indigenous goats was not significantly higher than that of blended goats ($P > 0.05$). Diseases significantly influence goat mortality. Breed, management system, and milking time had a significant impact on goat productivity. For instance, morning milking produced significantly more milk than evening milking ($P < 0.05$). It is conclusive that the blended goat performs better than the indigenous goats in terms of milk and meat productivity. We recommend and encourage the adoption of blended goats by farmers who want to maximize goat production while considering other factors such as milking time, disease intervention, and management system used.

Keywords: Productivity of goat, Mortality, Milk and meat production, Dodoma

Introduction

Dodoma is ranked fifth out of the twenty-one regions of Tanzania's mainland in terms of goat rearing. In terms of livestock retained, goat output is the second biggest in the region (NBS 2006). Reports have shown that the growth rate of goat populations has varied over the years. For example, between 1995 and 2003, the goat populations grew at a rate of 0.15% per year. This upward trend predicts a population increase of 8 years, from 788,145 in 1995 to 797,481 in 2003. The number of goats decreased from 788,145 in 1995 to 621,405 in 1999, representing a − 5.8% annual reduction. Between 1999 and 2003, the goat population grew at a 6.4% annual pace (NBS 2006). Mpwapwa is third in goat output (123,282 goats, 15.5%), whereas Dodoma Rural district (284,299 goats, 35.6% of all goats in the region) and Kondoa (226,010 goats, 28.3%) were first and second, respectively (NBS 2006; Shirima 2005). Indigenous goat breeds account for 99% of the population in Dodoma, while cross-bred goats account for 1%, regardless of socio-economic benefits. Other animals kept by local communities in Dodoma are cattle, sheep, and chickens (Chota et al. 2021; NBS 2006; Ngongolo and Chota 2021; Ngongolo et al. 2021).

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The Gogo people dominate the known ethnic groups interested in goat keeping in Dodoma, while other ethnic groups such as the Sukuma, Sandawe, and Maasai are less visible. Although some efforts have been made to introduce mixed goats, ethnic groups have been recognized for domesticating indigenous goats known as small East African goats. There are several strains of small East African goats (SEA) in Dodoma, including Pare, Gogo, Sukuma, Sonjo, and Boer goats. Pare and Sukuma goats were larger than Pare and Gogo goats. SEA goat breed strains are diverse populations with a wide range of morphological characteristics (Nguluma et al. 2016; Komwihangilo et al. 2012). Ujiji, Lindi, Maasai, Pwani, and Tanga are goat strains found in Tanzania (Nguluma et al. 2022). The ethnic groups in the region view blended goat keeping favourably because it can generate meat, live sales, milk, and manure, despite the fact that supplies from the breeding centre (Mpwapwa breeding facility) are low. Improved meat and dairy goats, for example, account for 0.2% and 0.8% of the total, respectively (NBS 2006). Mixed goats boost income, nutritional value, and employment prospects in communities, thus raising awareness among livestock caretakers (Mruttu et al. 2016). Further research on the performance of mixed goats in Mpwapwa, Dodoma, in terms of milk production and meat quantity is required.

High goat production requires improving the breed, which can adapt to the local environment while providing a high-quality yield. Blended goat rearing is a means of increasing production yield and income among communities in local environmental settings (Nguluma et al. 2022). Blended goats are mixtures of three breeds of goats, namely Boer, Kamorai, and Indigenous goats, with a composition of 55% Kamorai from Pakistan, 30% Buha from South Africa, and 15% Indigenous from East Africa (Nguluma et al. 2022). Other studies in several countries have found that enhanced breeds have the potential to boost goat productivity. Additionally, these studies show that the success of a breeding programme to improve the goat breed requires the participation of communities targeted at incorporating indigenous goats to reduce the alterations that occur during cross-breeding operations. For example, Kosgey et al. (2006) found that socio-economic and ecological aspects must be considered to ensure the effectiveness of breeding programmes. Native breeds, holistic production systems, and incorporation of traditional behaviours must also be observed during cross-breeding (Kosgey et al. 2006). Furthermore, findings from Kenya revealed that a community-based breeding programme was successful, resulting in a goat population growth of 5500 in 7 years. This enhanced farmers' livelihoods and food security as a result of daily milk consumption, increased income from the sale of live goats and goat products, and improved crop yields as a result of the availability of rich goat manure (Peacock et al. 2011). However, there is a greater demand for enhanced goats than farmers' ability to supply (Peacock et al. 2011).

Furthermore, Mbuku et al. (2015) found that the breeding systems are critical for goat improvement. A three-breed terminal system improved on straight reds by 10 kg (64%) every doe mated per year. A multi-breed composite may be the cross-breeding system of choice in a low-input livestock production system (Mbuku et al. 2015). Another study has shown that the long-term viability of cross-breeding is frequently jeopardized by poor adaptation to the local environment or a lack of logistical support (Leroy et al. 2016). Factors that contribute to long-term sustainability include continuous access to a suitable breeding stock, the ability of enhanced animals to develop their genetic potential (e.g. through proper inputs), and integration into a reliable market chain. Acceptability of small-scale farmers' stakeholders (Leroy et al. 2016). Despite the abundance of knowledge on improved goat breeds in other countries, there is still a need to learn more about the performance of these blended goats (improved goats) in Tanzania, notably in Dodoma.

Emerging hybrid goats are believed to produce high quantities of meat and milk because of the contribution of the breeds involved in the crossing. For instance, the Kamorai breed is used to produce large amounts of milk, the Boer breed helps produce large amounts of meat, and indigenous breeds are environmentally resistant (Mruttu et al. 2016). According to Mruttu et al. (2016), blended goats kept at TALIRI Mpwapwa had desirable characteristics such as good mothering ability and high prolificacy and growth rates, which are important in increasing the productivity of goats. This is in agreement with other studies that showed that cross-breeding has great potential to improve the quality and quantity of livestock production, such as milk and meat products (Galukande et al. 2013; Shirima, Msangi and Kavana 2003; Shirima 2001). The growing population in Dodoma necessitates a greater effort to find a breed that can produce more benefits in a shorter period of time. In Dodoma, a blended goat is an option for increasing goat products and providing benefits to people. In a study conducted in Dodoma, it was discovered that blended breeds brought more advantages to communities than local breeds (Shirima 2005; Shirima and Msechu 2003). Blended goats provided the following benefits: increased employment opportunities, income, and nutrition for recipients;

a shift in economic development; and improved crop output due to goat dung (Stone et al. 2020). The raising of mixed goats also boosted literacy rates in the community by sending more students to secondary schools, and per capita milk and meat intake increased to 156 L and 4.57 kg, respectively (Shirima 2005; Shirima and Msechu 2003). Although previous findings showed that goats produce an average of 0.92 L of milk per day (Stone et al. 2020), more studies are required to understand the contribution of blended goats in milk production for socio-economic development in Tanzania. Furthermore, opinions and socio-economic considerations of the breeders for the sustainability of the programme are vital.

Little is known about the production potential of blended goats in Mpwapwa, Dodoma, in terms of milk production, body weight, or mortality rate. The focus of blended goats is to obtain a breed with high production while being able to survive in harsh environments through resistance to diseases and adapting to local climatic conditions (Boettcher et al. 2015). In this study, we assessed the performance of blended goats in terms of weight, length, and milk production. In addition, we examined mortality rates. All of these variables were assessed based on the different management practices of local livestock keepers in the study areas.

Methods

Study area

This study was conducted in the Mpwapwa District of the Dodoma region in four villages: Idilo, Igovu, Mjini, and Mazoe nje (Fig. 1). The Dodoma regional headquarters is 120 km from Mpwapwa District, which is 120 km from Dodoma. The district has a dry savanna climate characterized by an average temperature of 27 °C. It has a short rainy season from December to April, ranging between 600 and 700 mm per annum. This district was selected because it is dominated by the production of local and blended goats by the Tanzania Livestock Research Institute.

Vegetation

The natural plains of Dodoma are characterized by wooded areas, open grasslands, and little or no tree or brush cover. Dodoma ground cover consists of forested grasslands and thickets of bushes (URT 2014). During the dry season, the bush is leafless and dry, but comes to life during the rainy, when the entire countryside turns vivid green (Kayombo, et al. 2020). The remainder of the territory is covered by woodlands, with the highest concentrations in hills (URT 2014). Dry savanna shrub-thicket areas with scattered trees and grassland patches interrupted by trees and shrubs comprise the vegetation. Common plant species include *Bussea massaiensis*, *Commiphora coerulea*, *C. ugogensis*, *C. africana*, *Acacia tortilis*, *A. senegal*, *Maerua decumbens*, *Combretum apiculatum*, *Grewia forbesii*, *Brachystegia spiciformis*, *Sclerocarrya birrea*, *Julbernardia globiflora*, *Delonix elata*, *Markhamia acuminate*, *Euphorbia candelabrum*, and *Terminalia sericea* as indigenous taxa, mixed with exotics such as *Peltophorum pterocarpum* and *Tamarindus indica* (Kayombo et al. 2020).

Study design and sampling procedure

A cross-sectional study design was used to collect secondary data. Secondary data were obtained from records kept at the Tanzania Livestock Research Institute, district livestock officers, and livestock keepers. Secondary data include reports and documents stored at the centre over the previous 10 years (2010–2020). Records from the secondary data and documents were extracted for each year. The number of kids born per goat (doe) was determined using the secondary data: birth type (single child or twin) and growth performance (weight, length, and size). The information was mainly dependent on that collected by the TARILI from their farms. This was done to avoid ambiguity in the objective that could be created if the data included goats kept by local communities.

Sample size

Productivity animal experiment: quantity of milk produced per day per goat

To understand the potential of blended goats in milk production, five blended goats and five local breeds were randomly selected from farmers, specifically among the lactating does for milk production assessment. These goats were monitored for 3 weeks (21 days) where milking was performed twice a day in the morning (6:00 pm–7:00 pm) and evening (6:00 pm–7:00 pm). This made a total of 420 samples. The sample size was calculated with a 95% confidence level, a standard deviation of 0.5, and a confidence interval (margin of error) of 5% (Kibuacha 2021). A sample size of 384.16 was required.

Productivity animal experiment: meat productivity in terms of weight and length

Goats were randomly selected by the researchers with the assistance of a livestock keeper from the four villages. At least 40 goats were recruited from each village for this study. Equal numbers of blended and locally bred goats were used in this study. There were 170 goats in the goat breed category (blended, $n = 85$; local, $n = 85$). The weight and length of the selected goats were measured using a weight balance and tape, respectively.

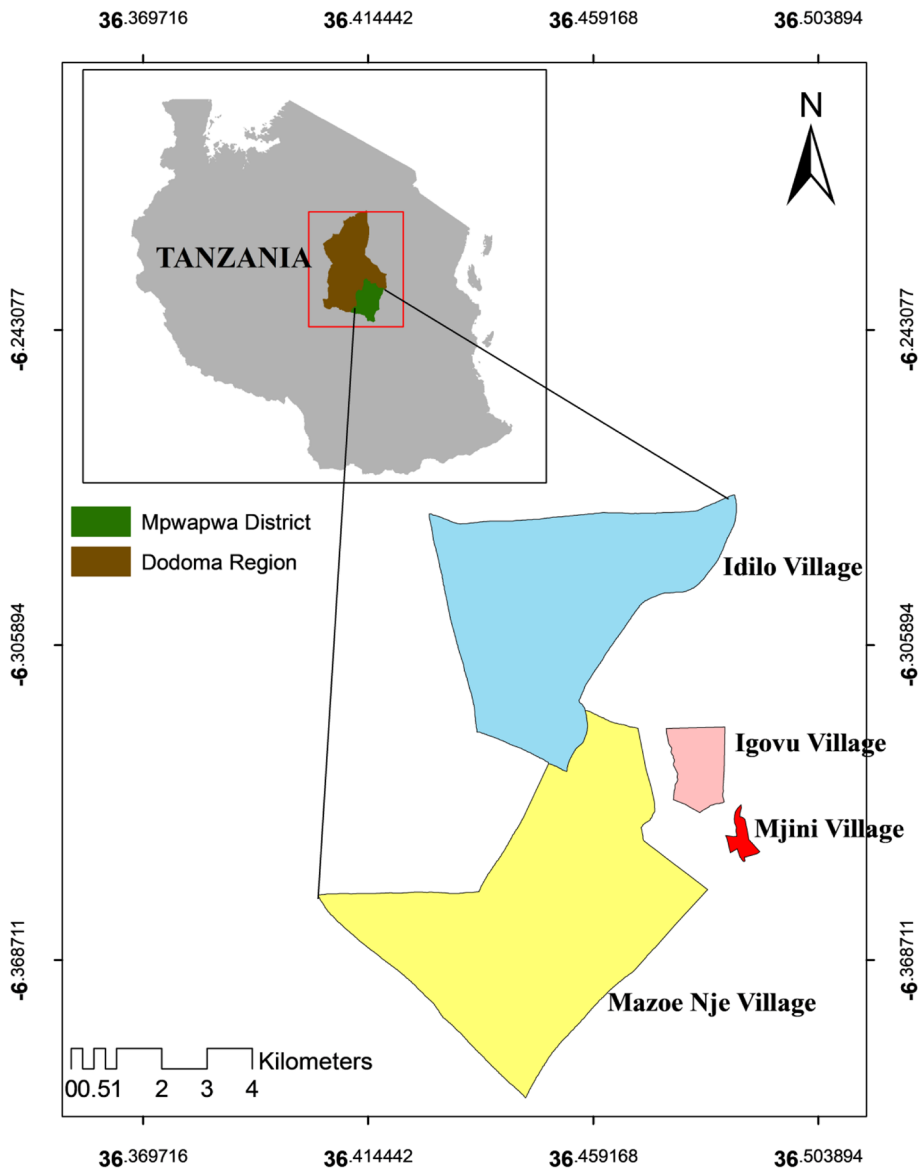


Fig. 1 The four study villages in the Mpwapwa District, Dodoma

Number of individuals born and mortality rate of kids from 2010 to 2020

A longitudinal survey was applied for sampling goats to determine the individuals born and the mortality rate for 10 years from 2010 to 2020. Records kept for 10 years from 2010 to 2020 were collected from TALIRI and livestock district officers because they are properly kept. It was determined to collect 730 samples. The sample size was determined at a 95% confidence level, a standard deviation of 0.5, and a confidence interval (margin of error) of 5% (Kibuacha 2021). In this regard, a total of 384.16 sample size. Also, the average population of blended goats in Mpwapwa is 5500 (Mruttu et al. 2016), which demanded a sample size of 384 at a confidence interval (margin of error) of 5%.

Data collection process

Productivity in terms of milk produced by goats: the quantity of milk collected from each goat was measured in litres to determine the quantity produced per milking session. In addition, other factors such as diseases encountered by farmers, management practices, and grazing systems (zero grazing and free range) were also recorded during data collection.

Productivity in terms of meat produced by goats in terms of weight and length of the goat was measured for each selected goat. Apart from the length, the measurement of girth was also taken into consideration. Other information recorded for the selected goats included sex, age, management practices, diseases, and other associated factors.

Furthermore, data to understand the number of individuals born and the mortality rate of kids from 2010 to 2020 was collected. The number of kids born and those who died in each year were recorded. In addition, the cause of death, such as diseases for kids that died, weight, birth type (single, twin, or triplets), sex, and girth, was recorded.

Data analysis

Differences in growth performance, mortality rate, milk production rate, and calving type (single or twin) between local and blended goats were analysed using the Mann-Whitney *U* test. A non-parametric statistical test was used because the data were not normally distributed with a kurtosis of less than 0.49. The influence of different factors, such as disease and management, on goat productivity was determined using a generalized linear model (GLM). Specifically, linear regression models were used to find a linear relationship between weight as a continuous variable and the predictors (diseases, management, and birth type). That is, lm (dependent variable (weight in Kg) ~ response variable (predictor valuable), data). The analysis model used for productivity in terms of meat (weight) was $Y_{ijklmo} = \times\beta + m_i + B_j + D_k + Bt_l + H_m + G_n + e_{ijklm}$.

where Y_{ijklmo} = live weight of *n*th goat (KG), β = the general mean, m_i = fixed effect of management system ($i = 1, 2$), B_j = fixed effect of breed of goats ($j = 1, 2$), D_k = fixed effect of diseases of goats ($k = 1, 2,3,4$), Bt_l = fixed effect of birth type of goats ($j = 1, 2, 3$), H_m = fixed effect of height of goat ($m = 1, 2, 3 \ldots n$th), G_n = fixed effect of girth of goat ($n = 1, 2, 3 \ldots n$th), and e_{ijklm} = the random residue effect.

The analysis model used for productivity in terms of milk production was $Y_{ijk} = \times\alpha + b_i + n_j + D_k + e_{ijk}$.

whereas Y_{ijk} = amount of milk produced for *n*th goat in millilitres, α = the general mean, b_i = fixed effect of breed of goats ($i = 1, 2$), n_j = fixed effect of the number of kids born per *n*th year ($j = 1, 2,3 \ldots 10$th), D_k = fixed effect of the cause of death in goats (diseases) ($j = 1, 2, 3, 4$), and e_{ijk} = the random residue effect.

Results

Goat productivity performance in terms of growth under different breeds, sex, and disease conditions

Based on primary data, of the 170 sampled goats aged 2 and 2.5 months, 50% ($n = 85$) were female and 50% ($n = 85$) were male. Of these, 42.85% ($n = 73$) were blended goats and 57.14% ($n = 97$) were indigenous goats. The athematic means for girth, height, and weight for the sample kids were mean = 33.66 ± 0.38 cm,

Table 1 The performance of goats in terms of growth under different breeds, sex, and disease encounters

Categories	Classification	Girth (mean ± S. E cm)	Height (mean ± S. E cm)	Weight (mean ± S.E kg)
Sex	Male ($n = 60$)	34.30 ± 0.5	30.00 ± 0.74	3.50 ± 0.18
	Female (90)	32.80 ± 0.55	28.60 ± 0.84	3.10 ± 0.20
	Mann-Whitney	887.5	1075	1050
	P-value	0.01	0.23	0.17
Breed of goat	Blended goat ($n = 70$)	36.00 ± 0.52	34.17 ± 0.51	4.40 ± 0.18
	Indigenous goat ($n = 80$)	30.70 ± 0.34	25.00 ± 0.47	2.22 ± 0.08
	Mann-Whitney	1088	1154	1160
	P-value	< 0.0001	< 0.0001	< 0.0001
Disease encounter	Yes ($n = 50$)	30.20 ± 0.64	24.60 ± 1.02	2.26 ± 0.19
	No ($n = 100$)	34.67 ± 0.38	30.87 ± 0.56	3.65 ± 0.14
	Mann-Whitney	1562.5	1512.5	1500
	P-value	< 0.001	< 0.001	< 0.001
Birth type	Single ($n = 60$)	31.09 ± 0.49	24.59 ± 0.42	2.74 ± 0.09
	Twins ($n = 87$)	30.31 ± 0.51	24.68 ± 0.37	2.62 ± 0.07
	Triplets ($n = 03$)	34.67 ± 0.67	28.33 ± 0.33	3.33 ± 0.33
	Kruskal-Wallis	4.31	4.97	4.67
	P-value	0.12	0.08	0.10

Table 2 The association of weight with the disease's occurrence, birth type, sex, and breed of goats

s/n	Variables	Classification	Coefficient estimate	Standard error	*Z*-value	*P*-value
1	Sex	Intercept (female)	1.01	0.07	13.94	**<2e−16**
		Male	−0.03	0.09	−0.317	**0.75**
2	Breed of goat	Intercept (blended)	1.11	0.06	17.39	**<2e−16**
		Indigenous	−0.26	0.10	−2.50	0.01
3	Birth type	Intercept (single)	1.02	0.07	14.17	<2e−16
		Twin	−0.05	0.10	−0.53	0.59
		Triple	0.19	0.32	0.57	0.57
4	Height	Intercept	0.27	0.36	0.76	0.45
		Height (cm)	0.03	0.01	2.03	**0.04**
5	Girth	Intercept	0.49	0.36	1.37	0.17
		Girth (cm)	0.02	0.01	1.41	0.16

Table 3 Number of kids born and mortality in the 10-year interval (2010–2020)

Breed	Year	Number of kids born per year	Number of kids died per year	*% of kids died per year*
Indigenous goat	2010	20	7	35
Indigenous goat	2011	33	10	30
Indigenous goat	2012	17	5	29
Indigenous goat	2013	40	14	35
Indigenous goat	2014	14	5	36
Indigenous goat	2015	51	11	22
Indigenous goat	2016	30	6	20
Indigenous goat	2017	29	6	21
Indigenous goat	2018	37	6	16
Indigenous goat	2019	42	3	7
Indigenous goat	2020	32	8	25
Total		345	81	23.47
Blended goat	2010	30	5	17
Blended goat	2011	42	11	26
Blended goat	2012	24	6	25
Blended goat	2013	50	8	16
Blended goat	2014	15	2	13
Blended goat	2015	62	12	19
Blended goat	2016	30	6	20
Blended goat	2017	41	8	20
Blended goat	2018	32	4	13
Blended goat	2019	20	7	35
Blended goat	2020	39	6	15
		385	75	19.48

mean = 29.33 ± 0.56 cm, and mean = 3.31 ± 0.13 kg, respectively. Comparing the two sex categories, it was observed that the variation in the girth was significant. In the case of breeds, disease encounters showed significant variation in girth, height, and weight (Table 1). Pneumonia is the most common disease-threatening condition in goats. The weights of goats were significantly associated with the sex and height of the animal (Table 2).

Number of individuals born and mortality rate of kids from 2010 to 2020

From secondary data, a total of 730 goats were born at the interval of 10 years (2010–2020). Of these, 47.26% ($n = 345$) were indigenous goats and 52.74% ($n = 385$) were blended goats. In addition, 156 goats died in this time interval of 10 years, of which 51.92% ($n = 81$) were indigenous goats and 48.08% ($n = 75$) were blended goats. The death rate varied insignificantly between the two goat breeds across the sampled years (Mann-Whitney U test statistic = 62.00, $P = 0.8$). For instance, indigenous goats experienced high death rates in 2014 (36%) and 2010 (35%), whereas blended goats experienced high death rates in 2019 (35%) (Table 3). The major cause of death was pneumonia (64.10%) ($n = 100$), followed by diarrhoea (22.44%) ($n = 35$), hair balls (8.33%) ($n = 13$), and foot-and-mouth disease (5.13%) ($n = 8$). Overall, the number of kids dying due to these diseases varied insignificantly between the blended and indigenous goats (Mann-Whitney U test statistic = 9.00, $P = 0.7$) (Fig. 2). The death rate of kids was positively associated with diseases, such as diarrhoea, breed of goats, particularly in blended goats, and the number of kids born in that particular year (Table 4).

Milk productivity of blended and indigenous goats

The average amount of milk produced per day by goats was 37,436.82 mL, $n = 420$. The average daily milk production per goat was significantly higher in the morning

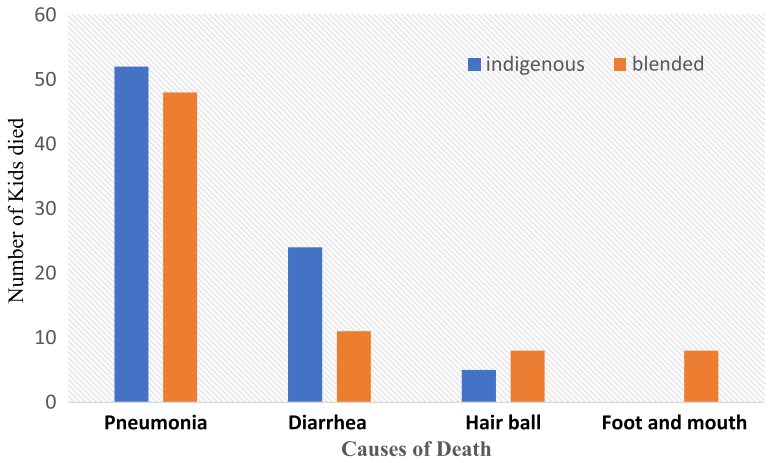
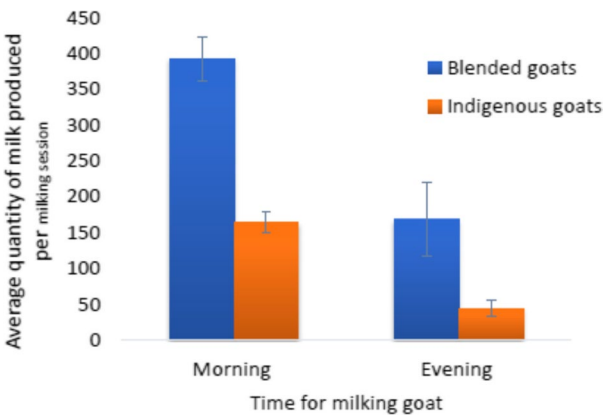


Fig. 2 Causes of death in goats (indigenous and blended goats)

Table 4 Association between the mortality rate with the breed of goat, number of individuals born, and causes of death

s/n	Variables	Classification	Coefficient estimate	Standard error	*Z*-value	*P*-value
1	Breed	Intercept	1.13	0.35	3.25	**0.001**
		Indigenous	0.16	0.17	0.93	**0.35**
2	Number of goats born	Born	0.02	0.01	3.24	**0.001**
3	Cause of death	FMD	−0.27	0.42	−0.64	0.52
		Hair ball	0.13	0.36	0.35	0.72
		Pneumonia	−0.15	0.21	−0.74	0.46

(mean = 278.00 ± 23.48, $n = 210$) than in the evening (mean = 106.00 ± 16.76 mils, $n = 210$) (Mann-Whitney U test statistic = 393.50, $P < 0.0001$). In a comparison between the blended goat and the local indigenous goat, the blended goat performed significantly higher (mean = 540.00 ± 51.32 mL, $n = 210$) than the indigenous goat (mean = 208.00 ± 24.64 mils, $n = 210$) (Mann-Whitney U test statistic = 508.00, $P < 0.0001$). The minimum amounts of milk produced by blending were 300 mL and 100 mL for indigenous goats; both breeds were kept in the same grazing system (free-range system). In addition, the maximum amounts of milk produced by blending were 1500 mL and 500 mL by indigenous goats, both of which were kept under the same grazing system (zero-grazing system). Approximately 60% of the sampled goats were kept in a zero-grazing system, and 40% were kept in a free-range system. The average milk production under free range in the morning and evening was mean = 202.00 ± 24.99 mL and mean = 62.50 ± 24.57 mL, respectively. Those produced from goats subjected to zero grazing have mean = 328.00 ± 32.58 mL in the morning and mean = 135.00 ± 21.33 mL in the afternoon. The difference between the milk produced by goats under free range and those under zero grazing was statistically significant (Mann-Whitney U test statistic = 145.00, $P = 0.002$).



Association of milk production with goat breeding, milking time, and management system

Goat breeds have been shown to influence milk production. Breeding programmes that resulted in blended goats had positive effects on milk production. The

Table 5 Association of milk production with the breed of goat, milking time, and management system

s/n	Variables	Classification	Coefficient estimate	Standard error	*Z*-value	*P*-value
1		Intercept	5.344e+00	2.063e−02	259.00	<2e−16***
2	Breed of goat	Indigenous	−5.097e−01	2.014e−02	−25.31	<2e−16***
3	Milking time	Morning	9.012e−04	5.890e−05	15.30	<2e−16***
4		Evening	1.533e−03	7.941e−05	19.30	<2e−16***
5	Management system	Zero grazing	3.993e−01	1.835e−02	21.76	<2e−16***

Note: For the goat breed and management system, the intercept represents the blended goat and free-range systems, respectively

findings of this study showed that blended goats had a higher milk yield than indigenous goats did (Table 5). Apart from the effect of the goat breed on milk production, the milking time employed and the management system have significant effects on milk production. For instance, a significantly greater positive increase in milk yield was observed in the morning than that in the evening (Table 5).

Discussion

Generally, the blended goat performed higher than the indigenous goat in terms of milk production, weight, and length in spite of local people in semi-arid areas of Tanzania preferring more of the small East African breed (Chenyambuga and Lekule 2014). Although the performance of goats depended on the breed, other factors such as the management system used by the farmer were also observed to have an impact on the productivity of goats in terms of milk. Goat performance is affected not only by breed but also by management systems such as feeding and nutrition (Yusuf et al. 2014).

Productivity performance of goats in terms of growth under different breeds, sex, and disease encounters

Male goats, specifically blended goats, performed better than the indigenous goats in terms of girth. In addition, the blended goats showed significantly higher performance in terms of length and weight than the indigenous goats. In this study, it was clear that variation in performance was associated with the breed, diseases affecting goats, sex, and birth type. For instance, goats that encounter disease exhibit significantly lower performance in terms of length, girth, and weight. These findings are consistent with those of previous studies. For instance, a study in Sirinka, Ethiopia, showed that the growth performance of goats is determined by different factors, including breed and birth type of goats, with high performance being seen in improved breeds (Deribe et al., 2015). A similar finding was observed in Uganda, where an improved goat breed showed more promising results than indigenous goats in terms of productivity (Ssewannyana et al. 2004). Regarding the effect of diseases, another report showed that infection in goats causes a reduction in meat product quality (Karthik and Prabhu 2021). Other studies have indicated that if a breeding programme is accompanied by community participation, a stronger breeding system, inclusion of native goats, and long-term assistance, the programme can improve small livestock keepers' livelihoods. This can be accomplished by breeding improved breeds with high yields, resulting in improved food security, increased income, and job creation (Leroy et al. 2016; Mbuku et al. 2015; Peacock et al. 2011).

Number of individuals born and mortality rate of kids from 2010 to 2020

Although the mortality rate of the goats was insignificant between the two breeds, the death toll was associated with the occurrence of disease in these goats. The surface diseases in the study areas were diarrhoea, hair balls (trichobezoar), and foot-and-mouth diseases which are positively associated with goat mortality. According to another study by Luginbuhl and Anderson (2015), coccidiosis is the most common cause of diarrhoea in confined goats aged 3 to 5 months. Foot-and-mouth disease (FMD) is an infectious disease that primarily affects cattle, buffaloes, sheep, goats, and pigs (Muthukrishnan et al. 2020). Diseases are among the major causes of goat mortality. For instance, in Eastern Cape, South Africa, the study reported that, among other causes of mortality, diseases contributed to too many of the kids that died among the farmers. Other causes of disease in goats are endo-parasites and ecto-parasites, starvation, extreme weather conditions, abortion, theft, diarrhoea, accidents, and wounds, which are perceived as causes of goat mortality (Slayi et al. 2014).

Milk productivity of blended and indigenous goats

Milk production in the blended goats was higher than that in indigenous goats. In addition, milking in the morning yielded more milk than milking in the evening did. The difference in production can be due to genetic variation in the two breeds of goats and other factors

such as disease encounter, nutrition provision, digestibility and conversion variation, and lactation time of milk. Other reports have shown that variations in production among goats can be explained by breed and nutrient content. For instance, a report in the USA showed that milk production by goats varied between breeds because of genetic variation (Saun et al. 2008). In addition to genetic variation, it was also observed that higher milk production was reported in the last 3–4 weeks of lactation, suggesting that the time of lactation influences milk production considering other factors such as the nutritive value of feed provided to goats (Saun et al. 2008). In this study, it was clear that other factors such as the time of milking (morning or evening) and the management system significantly influenced milk production in goats. For instance, milk production in goats declined in the evening compared with that in the morning.

Conclusion and recommendation

The productivity of the blended goat in terms of meat (length, width, and weight) and milk production was better than that of indigenous local breed goats. In addition, diseases have been reported to be a major cause of mortality. Mortality was associated with the breed of goats and management practices, while productivity in terms of weight was associated with sex, breed of goat (positive for blended goats), and height of the animal. Milk production was observed to be higher in blended goats kept in free-range systems for morning milking. We recommend that farmers opt for the production of blended goats if they focus on increasing goat productivity in terms of meat and milk production. However, for milk production, keeping blended goats should consider the management system, milking time, and disease control intervention. Furthermore, more studies need to be conducted on the adaptability and ability of the two breeds of goats to resist diseases and to understand how local farmers perceive and adapt to the raising of blended goats in Tanzania.

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Authors' contributions
K.N analysed the data through statistical analysis, edited the manuscript, and formatted it according to the guidelines, while N.M analysed, organized the data for analysis, and formatted the manuscript. The authors read and approved the final manuscript.

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Available upon request.

Declarations

Ethics approval and consent to participate
The University of Dodoma provided ethical clearance for this work, with the reference number MA.84/261/02.

Consent for publication
The consent for publishing was obtained from the University of Dodoma and among the participating authors.

Competing interests
The authors declare that they have no competing interests.

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