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Study of morpho-biometric traits, productive and reproductive performance of Kandri goats

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Abstract

A field study was conducted in the native tract of Kandri goats, covering Bharatpur, Dausa, and Karauli districts of Rajasthan in 2024. A total of 64 villages and 362 goat keepers were randomly selected based on Kandri goat population density. Data related to morpho-biometric traits, productive and reproductive performance were collected across various age group animals. The Kandri goat is typically large in body size and has creamy white coat colour with black patches on face, head, neck, ears, abdomen and legs. The ears were long, pendulous and folded with 29.80 ± 0.45 cm. Horns are in medium size (17.64 ± 0.99 cm), straight with directed backward. The average tail length in both sexes was recorded 21.03 ± 0.47 cm. Body weight of male Kandri goats ranged from 3.64 ± 0.02 kg at birth to 87.18 ± 0.63 kg at 18 months, while in females it ranged from 3.46 ± 0.02 kg to 63.52 ± 0.17 kg. The average chest girth, body length, and height at the withers were 67.65 ± 0.60 cm, 64.18 ± 0.58 cm and 64.38 ± 0.58 cm in males and 63.70 ± 0.12 cm, 60.61 ± 0.21 cm and 62.28 ± 0.22 cm in females, respectively. The average milk yield was 988.57 ± 1.88 gm per day, containing $3.30 \pm 0.01\%$ fat and $8.19 \pm 0.03\%$ SNF (solids-not-fat). The average lactation period was recorded as 281.42 ± 0.27 days. Males were first used for mating at an average age of 421.24 ± 3.09 days, while in females, the first mating occurred at 385.34 ± 1.45 days, following the onset of first oestrus in females at 327.95 ± 2.14 days. However, the oestrus cycle duration in female was recorded 20.51 ± 0.05 days. The first kidding was observed at 546.48 ± 1.70 days, with an average kidding interval of 362.58 ± 0.77 days. The average litter size for Kandri goats was 1.99 ± 0.01 and the lifetime number of kidding was recorded as 8.99 ± 0.08 .

Keywords: Kandri goat, Morpho-biometric characters, productive performance, reproductive performance

Introduction

Livestock plays an integral role in India's socio-economic fabric, contributing significantly to agricultural GDP and serving as a primary livelihood source for millions (Chandel, 2025) ^[1]. Among livestock, goats hold a unique position due to their adaptability, economic efficiency and the wide range of products they provide, such as milk, meat, skin, hides and manure (Nair *et al.*, 2021) ^[2]. India ranks as one of the world's largest producers of goat milk and meat, underscoring the critical role in ensuring nutritional security and rural income.

Rajasthan, with its vast arid and semi-arid regions, supports a diverse range of indigenous goat breeds adapted to challenging climatic conditions (Meena *et al.*, 2023) ^[3]. Goats serve as a lifeline for resource-poor farmers, offering sustenance through milk and meat production and contributing to soil fertility via manure (Kumar *et al.*, 2021) ^[4]. The Kandri goat is a prime example of a dual-purpose breed that thrives in Rajasthan's unique ecological conditions. Its distinct morphometric and productive characteristics make it a valuable genetic resource not only for India but also as a potential contributor to global livestock improvement programs. Despite the importance of conserving goat breeds with unique characteristics, planned conservation programs in tropical regions are often neglected. It's emphasized that preserving indigenous goat breeds in their native habitats is essential for maintaining genetic diversity and ensuring future resilience in goat farming (Routh, 2024) ^[5].

This study delves into the characteristics of the Kandri goat, emphasizing its role in sustainable

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agriculture and rural livelihoods. The Kadari goat, with an estimated population of around 50000 to 60000, faces several threats that necessitate urgent conservation. Key issues include genetic dilution from crossbreeding, a shortage of purebred males and shifting farmer preferences toward other breeds due to better market returns and lack of awareness. Farmers also struggle with limited veterinary support, poor access to organized breeding programs, and shrinking grazing lands. These challenges, combined with the loss of traditional knowledge and rising input costs, threaten both the breed's survival and the livelihoods of rural communities. Focused conservation efforts and farmer support are essential to safeguard this valuable indigenous resource. By documenting its attributes, this paper seeks to support conservation efforts and highlight the breed's potential for genetic improvement.

Materials and Methods

A survey was conducted to document the morpho-biometric characteristics, productive and reproductive performance of the Kandri goat in its native tract. The study was pre-planned and data were collected from the native tract of the Kandri goat located between 26°55'–27°45'N latitude and 76°55'–77°45'E longitude, encompassing Bharatpur, Dausa, Karauli and adjacent districts of Rajasthan. The total area of distribution is approximately 1,000 km². Field survey was conducted from January 2024 to December 2024, involving 12,596 animals. A total of 64 villages were randomly selected across three tehsils from Bharatpur, one tehsil from Dausa and two tehsils from Karauli district, based on the Kandri goat population (Table 1). A stratified random sampling method was used to select 362 goat keepers for the study. A structured interview schedule was developed to systematically collect data on external body characteristics, body weight, biometry, productive and reproductive performance, and lactation length. The study aims to provide a comprehensive understanding of the phenotypic, production and reproduction parameters of the Kandri goat, contributing to its characterization and potential conservation strategies. Data related to external body characteristics were recorded through visual observation, while body weight measurements were obtained for animals across various age groups (at birth, 3, 6, 12, 15 and 18 months) using an electronic weighing scale. Biometric measurements were taken using a measuring tape (Fig. 1). Raw milk samples (500 mL) from each goat were collected and analyzed in duplicate using an automatic milk analyzer (Lactoscan, SM Electronic & Trading) to determine milk composition. Lactation length was monitored through visual observation until the daily milk yield declined to 200 mL/day. Respondents were intentionally selected to represent diverse socio-economic segments, ensuring comprehensive data collection. The collected data were analyzed using SPSS software. Differences in morpho-biometric traits were tested using ANOVA and independent t-tests. Probability values $p < 0.001$ were considered significant. All data given are means $\pm$ standard error of mean (SEM).

Results and Discussion

Natural habitat and distribution of Kandri goats

The Kandri goat native habitat is primarily confined to the Bayana and Bhusawar tehsils of Bharatpur district, with its distribution extending into neighbouring districts such as Dausa and Karauli in the eastern region of Rajasthan, India (Fig. 2). The geographic coordinates of the Kandri goat breeding tract range between 26°55'–27°45' E latitude and

76°55'–77°45' N longitude, covering an estimated area of approximately 1,000 km². The majority of farmers reported that they have been raising this population from over 50 to 60 years.

This region is characterized by a flood-prone eastern plain climate with hot summers and moderate winters. The terrain consists of expansive plains interspersed with low hills, and the goats are well adapted to this environment. The average annual rainfall of the region is 500 to 700 mm, distributed unevenly over the entire area. They depend primarily on natural vegetation and are managed under an extensive grazing system that utilizes common property resources, including community pastures and scrublands.

According to the 20th Livestock Census (2019), Rajasthan hosts a total goat population of 20.84 million, accounting for approximately 31.02% of India's total goat population, which is 148.88 million (Nirmala *et al.*, 2023) ^[6]. Among the districts of interest, the recorded goat populations were 168, 158 in Bharatpur, 311, 068 in Dausa, and 340, 529 in Karauli (GoI, 2022) ^[7]. Despite Rajasthan substantial goat population, the Kandri goat constitutes a minor fraction.

Field surveys and preliminary assessments estimate the Kandri goat population at approximately 50,000–60,000, representing a relatively small proportion of the regional goat population. This limited distribution highlights the need for targeted conservation and breeding strategies to ensure the sustainability and genetic preservation of the Kandri goat.

Morphometric characters

The Kandri goat is a dual-purpose breed predominantly found in the districts of Bharatpur, Dausa, Karauli and nearby regions of Rajasthan. These goats are generally large in size with long legs. One of the most striking features of the Kandri goat is a creamy whitecoat colour with black patches on head, face, ear, chest, abdomen and legs (Fig. 3). Long, pendulous with folded ears (29.80 $\pm$ 0.45 cm) (Fig. 3). Face is large and convex (Roman nose) and males had a small tuft of hairs (Fig.3). The udder is medium-sized with well-proportioned teats. Straight with directed backward medium size horns (17.64 $\pm$ 0.99 cm) (Fig. 3). The tail was recorded medium in length (21.03 $\pm$ 0.47 cm) and the colour of hoofs are primarily light black to brown. These characteristics make them easily identifiable among local goat breeds.

Body weight

The average body weights of Kandri goats across various age groups are presented in (Table 2 and Figure 4). In males, the recorded body weights at birth, 3, 6, 12, 15, and 18 months were 3.64 $\pm$ 0.02, 23.44 $\pm$ 0.12, 31.35 $\pm$ 0.21, 42.99 $\pm$ 0.47, 52.76 $\pm$ 0.54, and 87.18 $\pm$ 0.63 kg, respectively. In females, the corresponding body weights were 3.46 $\pm$ 0.02, 22.18 $\pm$ 0.09, 29.82 $\pm$ 0.13, 41.90 $\pm$ 0.18, 42.89 $\pm$ 0.17, and 63.52 $\pm$ 0.17 kg. The mean body weight increased significantly ($p < 0.001$) from birth to adulthood. Additionally, the results align with previous studies, including those by Gupta *et al.* (2021) and Bhateshwar *et al.* (2023a) ^[8, 9], regarding increase in body weight with age in goats.

Biometry measurements

The chest girth, body length and height at withers in Kandri goats are present in (Table 3). In males, these measurements were 67.65 $\pm$ 0.60 cm, 64.18 $\pm$ 0.58 cm and 64.38 $\pm$ 0.58 cm, respectively. In females, the corresponding measurements were 63.70 $\pm$ 0.12 cm, 60.61 $\pm$ 0.21 cm, and 62.28 $\pm$ 0.22 cm. The biometric parameters, including chest girth, body length,

and height at withers, showed a significant ($p < 0.001$) increase from birth to 18 months of age. These findings align with earlier reports by Rakib *et al.* (2022) and Bhateshwar *et al.* (2023b) ^[10, 11], which were found increases chest girth, body length and height at withers in goats under field condition.

Milk yield, lactation length and raw milk composition

Kandri goat is renowned for its milk production potential, as shown in (Table 4). The average daily milk yield was 988.57 ± 1.88 g/day, ranging from 500 to 1500 g. The total lactation milk yield was recorded at 282.31 ± 0.21 kg. During the survey, the average lactation length was noted as 281.42 ± 0.27 days, with a range of 250 to 300 days. Additionally, the milk of Kandri goats was found to be rich in fat ($3.30 \pm 0.01\%$) and solids-not-fat (SNF) content ($8.19 \pm 0.03\%$). These results agree with previous studies (Bhateshwar *et al.*, 2023a Hristov *et al.*, 2020 and Adamu, 2021) ^[9, 12, 13], which highlight the importance of nutrition and management practices in optimizing milk production. Proper dietary interventions and strategic feeding management can significantly enhance lactation performance.

Reproductive performance

The reproductive performance of Kandri goats described in

(Table 5). The age of first mating was recorded as 421.24 ± 3.09 days for males and 385.34 ± 1.45 days for females. In females, the age at first oestrus and the duration of the oestrus cycle were observed to be 327.95 ± 2.14 days and 20.51 ± 0.05 days, respectively. The age at first kidding was 546.48 ± 1.70 days, with an average kidding interval of 362.58 ± 0.77 days. The average litter size in Kandri goats was 1.99 ± 0.01 , and the lifetime number of kiddings was recorded as 8.99 ± 0.08 . Kandri goats deserve structured conservation due to their outstanding adaptability, strong disease resistance, and efficient reproductive traits. They thrive in harsh, arid conditions, show high kidding rates with frequent twinning, and have early sexual maturity and strong maternal instincts. These qualities make them vital for sustainable rural livelihoods. Without conservation, this hardy genetic resource is at risk of dilution and loss, highlighting the urgent need for focused conservation efforts. The results of this study align with previous findings reported by Bhateshwar *et al.* (2022), Bhateshwar *et al.* (2023a), and Bhateshwar *et al.* (2023b) and Fatet *et al.* (2011) ^[9, 11, 14, 15], which also examined reproductive traits in goats. Several reproductive parameters, including conception rate, kidding interval, litter size, and age at first kidding, are influenced by genetic and environmental factors, nutritional status, and management practices.

Table 1: Name of district, tehsil, village, number of farmers and number of goats covered under survey

Name of District	Name of Tehsil	Name of Village	No. of Farmers	Total Goat
1. Bharatpur	1. Bayana	Jarwar	6	230
		Jhatola	9	340
		Karwari	3	90
		Baori	5	210
		Dhurairi	10	375
		Thana Dang	5	170
		Raseri	5	220
		Shergarh	10	375
		Samogar	6	225
		Kapoor Malooka	7	300
		Gazipur	5	115
		Bagren	6	230
		Dhadren	10	470
	2. Bhusawar	Suhari	10	390
		Targawan	5	201
		Kotki	2	80
		Naya Gaon Khalsa	5	210
		Dayapur	5	150
		Itamada	4	170
		Mahtoli	2	110
		Sendhli	3	100
	3. Weir	Jahaj	10	460
		Sita	10	395
		Hathauri	15	570
		Ballabhgarh	5	130
		Govindpura	5	190
		Ghatri	7	205
		Dayapur	3	65
		Halena	5	125
		Hingota	3	60
	Total	30	186	6961
2. Dausa	1. Mahwa	Amarpur	10	440
		Balaheri	5	170
		Kherla Bujurg	10	300
		Peelwa	7	165
		Maujpur	8	180
	Total	5	40	1255
3. Karauli	1. Hindaun	Kodiya	3	40
		Hindaun	10	360

		Khera	7	270
		Ghonsla	5	80
		Mahoo Ibrahimpur	4	80
		Kutakpur	5	160
		Kalwar Meena	3	40
		Chinayata	2	80
		Nagla Meena	5	170
		Suroth	3	70
		Dhindhora	10	290
		Jagar	4	160
		Alawara	3	120
		Milkipura	5	180
	2. Karauli	Daleelpur	7	290
		Mardai Khurd	5	200
		Beejalpur	4	130
		Paitoli	5	150
		Gaondiyapura	3	90
		Pareeta	2	70
		Manch	4	140
		Akolpura	5	180
		Atewa	5	140
		Rampur	4	120
		Gunesra	5	140
		Raghuvanshi	5	200
		Barh Gulal	5	130
		Jagatpura	4	120
		Bholoopura	5	180
		Total	29	136
		Grant Total	64	362
				4380
				12596

Table 2: Body weight (kg) of Kandri goat at different age groups

Weight at	Male			Female		
	(Mean±SE)	Range	N	(Mean±SE)	Range	N
Birth	3.64±0.02	3-4	857	3.46±0.02	3-4	908
3 months	23.44±0.12	21-28	455	22.18±0.09	20-26	1035
6 months	31.35±0.21	22-38	400	29.82±0.13	20-38	1063
12 months	42.99±0.47	40-60	93	41.90±0.18	50-55	1153
15 months	52.76±0.54	50-55	118	42.89±0.17	32-62	1535
18 months	87.18±0.63	70-97	266	63.52±0.17	50-90	4713

Table 3: Biometry measurements (cm) of Kandri goat

Body Measurement	Male			Female		
	(Mean±SE)	Range	N	(Mean±SE)	Range	N
Chest-girth	67.65±0.60	20-102	2189	63.70±0.12	17-102	10407
Body length	64.18±0.58	15-96	2189	60.61±0.21	15-96	10407
Height at withers	64.38±0.58	17-102	2189	62.28±0.22	15-96	10407

Table 4: Dairy performance of Kandri goat

Parameters	(Mean±SE)	Range	N
Daily milk yield (gm)	988.57±1.88	500-1500	248
Total lactation milk yield (kg)	282.31±0.21	260-300	4713
Lactation length (days)	281.42±0.27	250-300	4713
Fat%	3.30±0.01	2.3-4.1	6248
SNF%	8.19±0.03	3.1-9.4	6248

Table 5: Reproductive performance of Kandri goat

Parameters	(Mean±SE)	Range	N
Age at first mating in males (days)	421.24±3.09	290-510	477
Age at first mating in females (days)	385.34±1.45	290-510	1535
Age at first Oestrus (days)	327.95±2.14	210-510	1153
Oestrus cycle duration(days)	20.51±0.05	17-24	980
Age at first kidding (days)	546.48±1.70	390-660	1535
Kidding interval (days)	362.58±0.77	290-450	4713
Service period (days)	48.84±0.13	30-60	6954
Litter size	1.99±0.01	1-3	6201
Lifetime numbers of kiddings	8.99±0.08	7-15	902

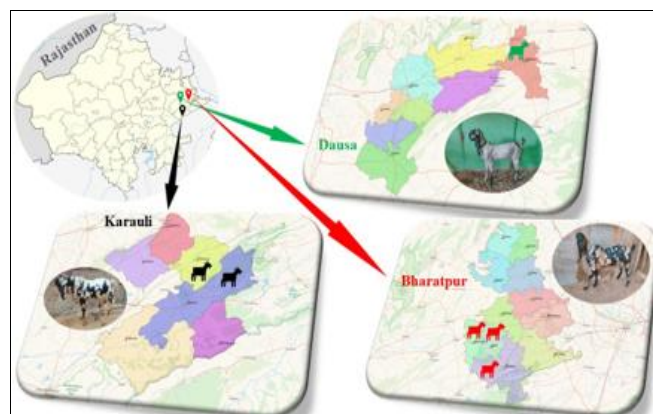
**Fig 1:** Biometric observations of the Kandri goat collected during the field survey. (A) Chest girth; (B) Body length; (C) Horn length and (D) Ear length.**Fig 2:** The surveyed districts of Bharatpur, Dausa, and Karauli in Rajasthan



Fig 3: Morphometric observations of the Kandri goat collected during the field survey. (A) Coat colour; (B) Ear shape; (C) Head profile and (D) Horn shape.

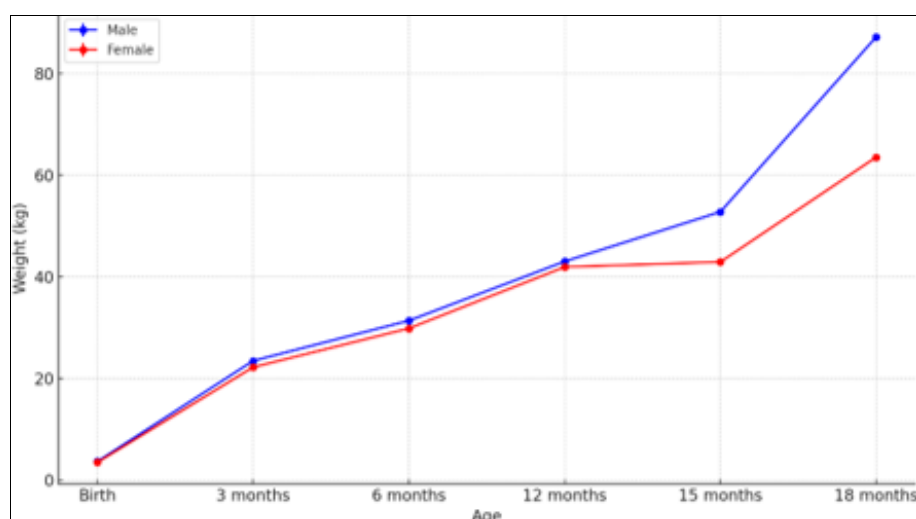


Fig 4: Graphical representation of body weight of Kandri goats across different sex-specific age groups.

Conclusion

Kandri goats possess distinct morpho-biometric characteristics, including a large body size, roman nose, long pendulous ears, and a characteristic creamy white coat with black patches, which differentiate them from other indigenous goat breeds. The breed exhibited satisfactory growth performance, with significant increases in body weight and biometric measurements from birth to adulthood. Kandri goats also demonstrated good milk production potential with moderate lactation length and desirable milk composition. Reproductive performance revealed early maturity, favorable kidding interval, and high litter size, indicating strong reproductive efficiency and adaptability under field conditions.

The findings suggest that Kandri goats are a valuable indigenous genetic resource with considerable potential for meat and milk production under extensive management systems. Therefore, conservation, genetic improvement, and organized breeding strategies are essential for sustainable utilization and long-term preservation of this breed.

Conflict of Interest: Authors have no conflict of interest in this study.

Ethical Statement: This study is based on a survey and visual observations, without any direct intervention or experimentation on animals. Therefore, ethical approval was not required.

Data Availability Statement: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: VB: involved in the investigation, data generation, and original draft preparation; BKB, SK: contributed to conceptualization, data calculation, supervision, and final editing; PP: responsible for statistical analysis, methodology, and editing.

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