

Research Paper

Morphometric features and performance of Nagfani goats in their native tract

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ABSTRACT

Nagfani goat is the most adaptable, dual purpose (chevon and milk), widely distributed and prominent goat in Alwar, Bharatpur and nearby districts of Rajasthan state in India. In order to study the morphometric features and performance of Nagfani goat, the first field survey in India was conducted at their native tract in Alwar and Bharatpur districts of Rajasthan in the year 2023-24. According to the interview schedule, a total of 29 villages were randomly selected based on the Nagfani goat population and 185 goat keepers were randomly selected for this study. Measurements of the data related to morphometric features and performance were taken at different age groups of 9650 animals. The size of Nagfani animals typically ranges from medium to large. The white colour coat with black or pale red spots on the body was a significant characteristic of the Nagfani goat. Ears length was 29.28 ± 0.25 cm, the lower part of the ear hanging about 2 to 3 cm away from its face and remaining fully open in the front like a Nag/Cobra hood, making it stand out from other goats. The nose line exhibited Roman shape characteristic. Horns are of medium length with 17.05 ± 0.99 cm, twisted and directed backward horns. Dewlap was well developed in male goats. The tail was observed in the medium length of 20.65 ± 0.27 cm. The overall body weight of male and female individuals from birth to adulthood were recorded as 3.65 ± 0.02 to 89.51 ± 0.73 kg and 3.60 ± 0.02 to 64.42 ± 0.18 kg, respectively. The average overall chest girth, body length and height at withers was recorded as 54.86 ± 0.63 , 51.59 ± 0.61 and 53.35 ± 0.63 cm in male goats and 77.76 ± 0.22 , 75.45 ± 0.21 and 75.72 ± 0.22 cm in female goats respectively. The milk yield was recorded at 983.71 ± 1.85 gm/day with richer milk constituents of $3.27 \pm 1.01\%$ fat and $8.14 \pm 0.02\%$ SNF respectively. The average lactation length in lactating goats was recorded as 281.42 ± 0.30 days. The first mating age was 414.07 ± 3.60 days in males and 310.39 ± 1.57 days in females. Female goats had their first oestrus at 310.23 ± 1.58 days, with a cycle duration of 20.52 ± 0.19 days respectively. The first kidding occurred at 514.88 ± 1.66 days, with an average kidding interval of 368.36 ± 0.64 days. In Nagfani goats, the average litter size was 1.99 ± 0.01 and the lifetime number of kiddings was recorded as 10.94 ± 0.85 .

Key words: Biometry, Body weight, Milk constituents, Milk yield, Morphometric, Nagfani goat

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INTRODUCTION

In Indian livestock, small ruminants (sheep and goat) play an important role for landless, marginal and small farmers economy (Lalljee *et al.*, 2019). India is endowed with vast domestic animal diversity, contributing to its status as a mega-biodiverse country (Ahlawat and Sharma, 2022). In the globe, India contributes about 17.93% of goat genetic resources of total goat population with thirty recognized and registered goat breeds alongside a significant proportion of non-descript and lesser-known goat populations (Bhardwaj *et al.*, 2018). In 2019, India's total livestock population reached an impressive 536.76 million, distributed across various states and union territories, as reported in the 20th Livestock Census of 2019 (Nirmala *et al.*,

2023). Goats contribute 27.80% to the total livestock population (Singh *et al.*, 2023). The present population of Indian goats stands at 148.88 million, as per the 20th Livestock Census of 2019, marking a notable increase of 10.14% compared to the population recorded in the Livestock Census of 2012 (Dinesh *et al.*, 2023). Among the various states, Rajasthan state has leading goat population of 20.84 million, followed by West Bengal with 16.28 million and Uttar Pradesh with 14.48 million, respectively (Ahari and Waiz, 2024). The rise in goat numbers across the country underscores their growing popularity and significance due to their economic value, efficient resource utilization, short generation interval, rapid reproduction rates, and adaptability to diverse climatic conditions (Aggarwal *et al.*, 2022).

Considering the total goat breed and their population in India, there is limited information available about lesser-known breeds such as Nagfani, Totapari, Battisi, Lahuri, Sitamarhi, Sarguja, Vagdi, Arunachali, Shivalik, Malra or other non-descript goat populations. The proportion of identified Indigenous breeds along with lesser known ones to the total population of goats out of 148.88 million Indigenous goats (including non-descript), 27.4% (4,08,32,430) are pure breed, 9.1% (1,34,90,860) are graded breeds and the remaining 63.5% (9,45,61,496) are non-descript breeds (GOI, 2022). Despite the aforementioned facts, goats play an integral role in the Indian agrarian economy due to their ability to survive on various types of vegetation, setting them apart from other livestock species. Nagfani goat is among these breeds, distributed across Rajasthan state of India and it is being raised for its dual-purpose role in producing both milk and chevon.

Indigenous goats play a crucial role in securing the livelihoods of a significant portion of small and marginal farmers and livestock keepers. These resources are sustained through low or zero-input extensive management systems (Mishra *et al.*, 2016). Nevertheless, the interbreeding of nearby breeds and the introduction of exotic sheep breeds have resulted in a decrease in the number of purebred animals within a specific breed (Bhatia and Arora, 2005).

Hence, there is an urgent need for detailed characterization of different populations, especially those that are lesser known. This manuscript presents a compilation of information derived from a survey study conducted in the year 2023-24. The primary objective was to characterize the Nagfani goat population, focusing on delineating its native habitat,

recording various body biometric traits, body weight measurements, husbandry practices, and different management techniques, along with their genetic characterization. The information generated will serve as a crucial stepping stone toward gaining deeper insights into this valuable goat genetic resource. The authors anticipate that this manuscript will provide valuable insight to scientists, research scholars and policymakers involved in the field of animal sciences, with a particular focus on *Capra* genetic resources. Furthermore, the determination of the status and characterization of Indigenous goat genetic resources is a crucial step in the planning of domestic animal diversity and developed strategies for their conservation and sustainable utilization.

MATERIALS AND METHODS

The survey was conducted for the identification of morphometric characters, body weight, biometry, raw milk constituents, production performance and lactation length of Nagfani goat of their native tract. The survey was pre-planned and conducted in the Alwar and Bharatpur districts of Rajasthan state. In 2 tehsil of each district a total of 29 villages were randomly selected based on the 9650 Nagfani goat population and 185 goat keepers were randomly selected for this study. An interview schedule was designed for the identification of external body characteristics, body weight, biometry, productive performance, reproductive performance and lactation length.

The data related to external body characters was recorded visually and measurements of body weight were also recorded on animals of various age groups by electronic weighing machine (Fig. 1). The biometry



Fig. 1: Recording the body weight of Nagfani goat by electronic weighing machine.



Fig. 2: Measuring the biometry parameter using the measuring tape.

of the animals was measured by a measuring tape (Fig. 2). Data related to the milk yield of each goat were recorded by using an automatic electric milk meter. Individual goat milk samples (500 mL) were collected and analysed in duplicates by an automatic milk analyser (Lactoscan, SM Electronic & Trading) to work out milk constituents. The lactation length was recorded by visual observation till the daily milk yield dropped to 200 mL/day. The respondents were deliberately selected to represent diverse segments of society.

RESULTS AND DISCUSSIONS

Natural Habitat and Distribution

Nagfani goat is distributed in Alwar, Bharatpur and nearby districts of Rajasthan, India (Fig. 3). The exact origin of this goat breed remains unclear, however, local goat breeders in Harsana village of Lachhmangarh tehsil in Alwar district have reported that these animals have been raised within their families from several generations. The breeding tract of Nagfani goat lies in Western India and is situated at 27°18' 55"- 27°37' 10" N & 76°50' 35"-77°11' 45" E in terms of latitude and longitude. The estimated area of distribution

covers 1000 sq km. The goats are primarily maintained through grazing, utilizing an extensive system. Goat rearing plays a crucial role in ensuring the livelihood security and economic stability of the goat farmers. The majority of farmers reported that they have been raising this population for over 20 to 50 years. The total goat population of Rajasthan is 20840203 heads which are only 31.02% of the total goat (148.88 million) population of the country (20th Livestock census, 2019). The goat population of Alwar and Bharatpur districts as per 2019 census were 403117 and 168158 heads; respectively (20th Livestock census, Rajasthan, 2019).

The climatic classification of the area can be categorized as tropical steppe and flood prone eastern plain for Alwar and Bharatpur districts. The region experiences mainly dry conditions with very hot summers (up to 40°C) and cold winters (around 8°C), except during the monsoon season. The average annual rainfall of the region is 500 to 700 mm, distributed unevenly over the entire area. The region is situated on the alluvial deposits left by the river Yamuna and its tributaries. It covers the eastern part of the state and constitutes the western fringe of the Indo-Gangetic plain.

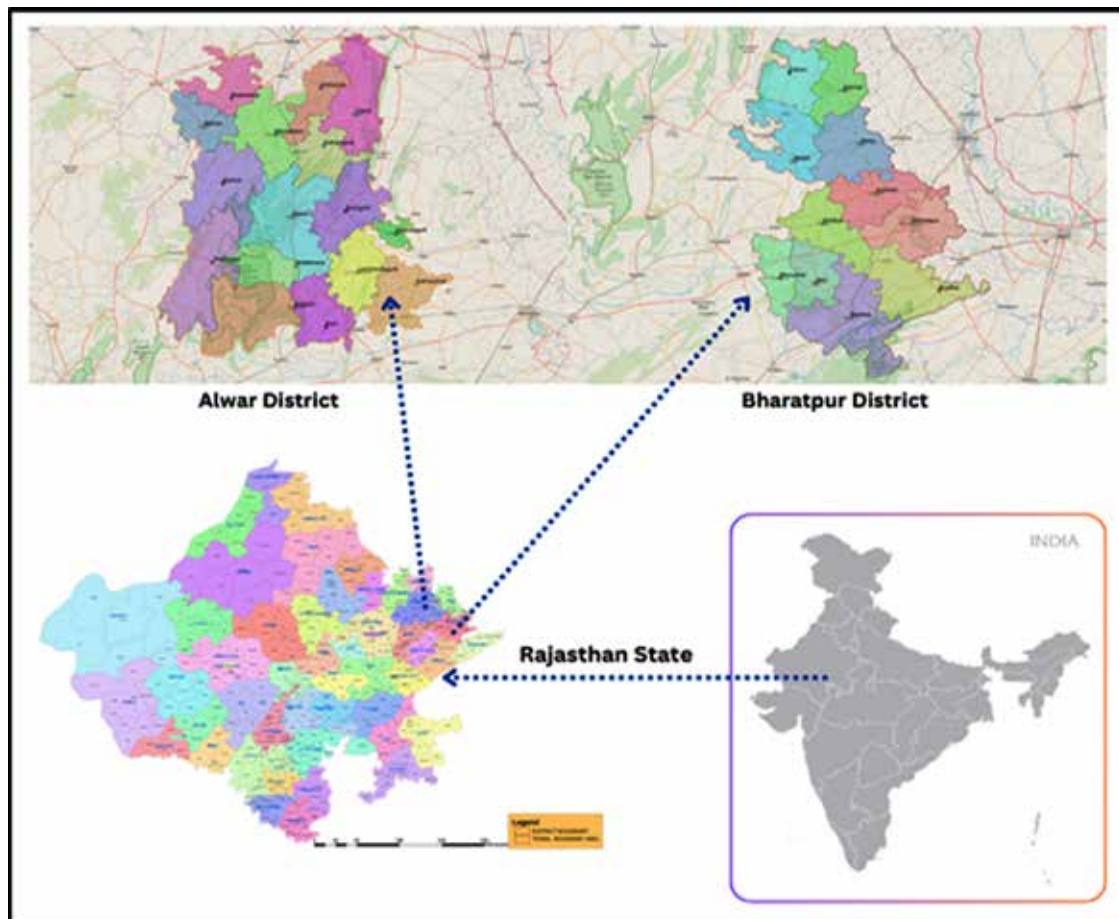


Fig. 3: Selected areas Alwar and Bharatpur district in Rajasthan is located between 27°34'12" and 27°13'12" N latitude and 76°36'00" and 77°28'48" E longitude.

Physical Appearances

The Nagfani goat is a dual-purpose breed found in the districts of Alwar, Bharatpur, and nearby districts in Rajasthan. The size of Nagfani goats is typically large. Nagfani goat has two colour variants: White/Kaajli Nagfani and Chitti Nagfani. White/Kaajli Nagfani animals have completely white coat and black/brown circles around the eyes (Fig. 4). However, Chitti Nagfani have black or pale-red spots around the body with varying degrees on white coat (Fig. 5).

The Nagfani goats have large size ears 29.28 ± 0.25 cm in length. The goat named "Nagfani" is easily distinguished by its unique ear shape which hanging about 2 to 3 cm away from its face and the lower part of its ears remains fully open in the front like a Nag/Cobra hood, which

makes it stand out from other goats. In another body features length of legs are medium to long and very strong than other local goats. Nagfani goat has medium to large size mouth with the nose line was typical Roman type and males have a small tuft of hair. The udder has medium sized with medium teats. Horns are medium 17.05 ± 0.99 cm in length, twisted, and directed backward horns. Dewlap are well developed in male goats. Tail was also recorded in medium 20.65 ± 0.27 cm. Hoofs are predominantly light black to brown. The Nagfani goat exhibits a distinctive phenotypic appearance, characterized by unique color patterns on the face, eyes, ears, and back part of the body, as well as specific features such as ear size and shape, a Roman nose, and tail length.



Fig. 4: Adult White/Kaajli Goat.



Fig. 5: Adult Chitti Goat.

Body Weight and Biometry

The average body weight and biometry of Nagfani goat in different age groups are shown in (Table 1&2). The body weight of different age groups at birth, 3, 6, 12, 15 and 18 months was recorded as 3.65 ± 0.02 , 23.12 ± 0.07 , 30.94 ± 0.22 , 44.75 ± 0.47 , 51.24 ± 1.32 and 89.51 ± 0.73 kg in male animals and 3.60 ± 0.02 , 22.31 ± 0.05 , 28.68 ± 0.21 , 42.54 ± 0.19 , 41.89 ± 0.21 and 64.42 ± 0.18 kg in females respectively. The mean value

of body weight was significantly higher from birth to adult age. It was also observed that the body weight of animals had been affected by various environmental conditions, type of feeding, health status, age of animal, sex, and management systems (Dereje *et al.*, 2015 and Sanchez-Macias *et al.*, 2018). A similar data related to body weight was also recorded in Jakhrana goats (Bhusan, 2012), Sangamneri goats (Patil *et al.*, 2013), and Sojat goats (Gupta *et al.*, 2021).

Table 1: Body weight of Nagfani goat at different age group

Weight at	Male			Female		
	Mean $\pm$ SEM	Range	N	Mean $\pm$ SEM	Range	N
Birth	3.65 ± 0.02	3-4	625	3.60 ± 0.02	3-4	459
3 months	23.12 ± 0.07	20-28	409	22.31 ± 0.05	20-38	690
6 months	30.94 ± 0.22	20-38	378	28.68 ± 0.21	20-38	444
12 months	44.75 ± 0.47	38-65	176	42.54 ± 0.19	34-60	917
15 months	51.24 ± 1.32	32-65	40	41.89 ± 0.21	32-62	1569
18 months	89.51 ± 0.73	75-103	219	64.42 ± 0.18	50-90	3721

In Table 2 the chest girth, body length and height at withers in males were 54.86 ± 0.63 , 51.59 ± 0.61 and 53.35 ± 0.63 cm, respectively and corresponding figures in females were 77.76 ± 0.22 , 75.45 ± 0.21 and 75.72 ± 0.22 cm respectively. The biometry parameters (body length,

chest girth and height at wither) were significantly increased from birth to 18 months. It was also reported by some researchers that body measurements in goats may be affected by the increase in age and body weight (Rakib *et al.*, 2022; Gupta *et al.*, 2021 and Samad, 2021).

Table 2: Body measurements (cm) of Nagfani goat

Body measurement	Male			Female		
	Mean $\pm$ SEM	Range	N	Mean $\pm$ SEM	Range	N
Chest girth	54.86 ± 0.63	20-101	1847	77.76 ± 0.22	20-101	7803
Body length	51.59 ± 0.61	15-99	1847	75.45 ± 0.21	15-93	7803
Height at withers	53.35 ± 0.63	17-101	1847	75.72 ± 0.22	17-93	7803

Raw Milk constituents, Milk yield and Lactation length

Nagfani goat is well known for its milk potential (Table 3). The average milk yield recorded was 983.71 ± 1.85 gm/day and varied from 500 to 1500 gm. Data show that the milk of Nagfani goat was also richer in fat $3.27 \pm 1.01\%$ and SNF $8.14 \pm 0.02\%$. During the survey, the average lactation length of Nagfani goat was recorded 281.42 ± 0.30 days and the range of lactation length was recorded between 250 to 300 days. However,

similar values for fat and SNF contents in the milk of selected breeds were within the estimated range recorded for dairy goats (Singh *et al.*, 2023). Raw milk constituents, milk yield and lactation length may be affected by the type of feed ingredients, breed, age, purpose of animal, stage of lactation, length of lactation, milk yield, number of milking per day, and time of milking (Adamu, 2021; Goetsch *et al.*, 2011; Hristov *et al.*, 2020 and Mioc *et al.*, 2008).

Table 3: Dairy performance of Nagfani lactating goat

Parameters	Mean $\pm$ SEM	Range	N
Daily milk yield (g)	983.71 ± 1.85	500-1500	5290
Total lactation milk yield (kg)	283.06 ± 0.24	260-300	3721
Lactation length (days)	281.42 ± 0.30	250-300	3721
Fat%	3.27 ± 1.01	2.3-4.1	5290
SNF%	8.14 ± 0.02	3.1-9.4	5290

Reproductive performance

Table 4 presents the reproductive performance of male and female goats. The age of first mating was observed to be 414.07 ± 3.60 days for males and 310.39 ± 1.57 days for females. In female goats, the age at first oestrus and the duration of the oestrus cycle were recorded as 310.23 ± 1.58 days and 20.52 ± 0.19 days, respectively. The age at first kidding was noted as 514.88 ± 1.66 days,

with an average kidding interval of 368.36 ± 0.64 days. In Nagfani goats, the average litter size was 1.99 ± 0.01 , and the lifetime number of kiddings was observed to be 10.94 ± 0.85 . These findings align with previous studies by Singh and Ramachandran (2007); El-Abid and Nikhaila (2010); Pathodiya *et al.*, (2010); Fatet *et al.*, (2011) and Bhateshwar *et al.*, (2022), which also examined reproductive performance in goats.

Table 4: Reproductive performance of Nagfani goat

Parameters	Mean $\pm$ SEM	Range	N
Age at first mating in males (days)	414.07 ± 3.60	365-510	279
Age at first mating in females (days)	310.39 ± 1.57	250-500	917
Age at first oestrus (days)	310.23 ± 1.58	250-510	907
Oestrus cycle duration(days)	20.52 ± 0.19	17-24	6305
Age at first kidding (days)	514.88 ± 1.66	390-660	1569
Kidding interval (days)	368.36 ± 0.64	270-415	3721
Service period (days)	49.23 ± 0.15	30-60	5290
Litter size	1.99 ± 0.01	1-3	5290
Lifetime numbers of kiddings	10.94 ± 0.85	7-14	666

CONCLUSION

The current study provides a complete insight about the morphometric characteristics, performance and production of Nagfani goats in Rajasthan state of India. Nagfani goats are typically medium to large, characterized by a well-built body structure featuring a Roman nose, long cobra hood ears, long sturdy legs, medium-sized tails and horns. The distinctive phenotypic appearance of the Nagfani goat includes a white coat color adorned with black or pale red patches on the chest, face, back, legs and abdomen. These features serve to distinguish the Nagfani goat from other existing goat breeds in the region. It is imperative to expand the Nagfani goat population by employing elite breeding bucks on a large scale, alongside the development of systematic breeding plans for faster genetic gains. According to the field survey findings, there appears to be significant potential for utilizing this breed as an enhancer in goat breeding programs aimed at achieving higher weight gain and milk production through selective breeding. Nagfani goat should be recognised and registered as a distinct goat breed at national level.

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