

## Prolific Garole Sheep: Pride of Bengal

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### Abstract

*Garole, a micro sheep breed of India, are distributed in the Sundarban area of 24-Parganas district of West Bengal and is famous for high prolificacy rate, resistance to foot rot disease, grazing in knee-deep water, good adaptability to hot humid conditions and high mothering instinct for their neonates. This meat type animal is of short stature with a light brown coarse texture coat and produces coarse wool, good quality skin and low-fat mutton. This breed is generally maintained by marginal farmers and landless labourers in its native tract. Flocks are stationary and average flock size ranges from five to seven. The animals are allowed to graze on rice fallow land and natural grass cover on the roadsides and water channels. The average live weight of adult animals ranged between 10 and 14 kg. The animal is having high fecundity rate, with mean litter size of 2.27. Twin and triplet births are very common in this breed. Owing to their high fecundity and ability to thrive on low quality forages and agro-byproducts, these animals constitute a major source of income for their owners. As the population of this sheep breed is declining sharply over the years in its home tract, so it needs more concerted efforts towards conservation as well as improvement of this breed in its home tract.*

**Keywords:** Garole sheep, body weights, genetic parameters, conservation, India

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### INTRODUCTION

Garole, a micro sheep of India, is generally found in the Sundarban area of 24-Parganas district of West Bengal. The breed is known for its bi-annual lambing, high prolificacy rate, high mothering instincts, adaptability to marsh saline as well as hot and humid climatic condition, grazing on aquatic weeds and grass in knee-dip water and resistance to some common diseases [1, 2]. This animal is of short stature with a light brown coarse texture coat and produces rough wool, good quality skin and low fat mutton [3]. These sheep are popular meat animals in the area, although average live weight of adult ranges between 10 and 14 kg only. However, the breed is best known in the region for its prolificacy, with mean litter size of 2.27 [4]. Owing to their high fecundity and ability to thrive on low quality forages and agro-byproducts, these animals constitute a major source of income for their owners.

### ORIGIN OF THE BREED

The origin of this breed is not much known. However, based on the survey work and local farmers' interrogation, it is assumed that the domestic Garole sheep (*Ovisaries*) might have originated from urial type (*O.vignei*) of Asia. In all probability, animals moved into the reverine forest area of Sunderban region with their owner, when they first invaded this belt. Early settlers were of Negroid stock followed by Proto-Australoid, Homo-Alpinus, Proto-Nordic and Aryans. Garole sheep were imported into Australia from Bengal in 1792 and is assumed to have contributed prolificacy gene to the Booroola Merino sheep [5]. There is much similarity in body and fleece characteristics of Garole sheep of the Sundarban region and that reported for early Bengal sheep of Australia [6, 7]. Physical characterization of this breed was not known till 1982 as there was no place of this unique germplasm in sheep and goat breeds of India [8].

### NATURAL HABITAT, POPULATION AND DISTRIBUTION

The natural habitat of Garole sheep is Sunderban region comprising of 13 blocks of South 24-Parganas and six blocks of North 24-Parganas district of West Bengal, located between 21–23°N latitude and 87–89°E longitude having the boundary of river Hooghly on the West and Bay of Bengal on

the South, covering an area of approximately 4226 sq.km (Figure 1) [9]. It is the low lying region at the Ganga river, the highest elevation being 200 m above sea level. Part of the region is in Bangladesh and it is expected that such type of animal (Garole) might also be found there. Some animals are also found in parts of the North 24-Paraganas and Midnapore district adjoining the South 24-Paraganas district.



Fig. 1: Breeding Tract of Garole Sheep.

The population of this breed is high in Joynagar-I, Joynagar-II, Kuttali, Mathurapur-I, Mathurapur-II, Mandir Bazar, Patharpratima, Namkhana and Kakdwip blocks of the 24-Parganas district. Ghalsasi and Nimbkar, Banerjee and Banerjee, and Banerjee *et al.* also reported that the breed is prevalent in the districts adjoining the Sunderban delta region in the state of West Bengal and the abutting districts of Bangladesh [10–12]. The breed is locally known as Garole. ‘Garole’, a colloquial Bengali word means ‘stupid’. Farmers often called the breed ‘Bheda’, which means sheep in Bengali. Garole with rudimentary or short ears are also popular as ‘Meda’, also a Bengali word meaning ‘earless’.

The breeding tract of this breed is surrounded by rivers and rivulets where agriculture is mostly rain fed and restricted to the kharif (monsoon) season only. The island areas are subjected to occasional inundation by the saline waters. South 24-Parganas is a coastal part of saline area poorly developed in agriculture due to scarce drainage in monsoons coupled with lack of irrigation facilities during the winter and summer seasons. Soils are of tidal origin and silty clay in nature. Soil pH ranges between 6.4 and 7.6 [13]. The average annual rainfall varies between 1800 and 2000 mm, 80% of which occurs between May and October. Average minimum and maximum temperature ranges between 15.5 and 32.5°C.

Relative humidity remains high, over 80% from June to September and minimum 65% in December. The grazing area for Garole sheep includes natural pastures comprising harvested crop fields, boundaries of crops, roadsides, bank of irrigated channels, waterways, rivers, water bodies and low land during ebb tides. The grazing and browsing areas of the breeding tract of Garole sheep is mainly consisted of ficus (*Ficus bengalensis*), mango (*Mangifera indica*), babool (*Acacia arabica*), banana and various mangrove species which are common feeds of the sheep. According to Breed Survey Report (2012), Govt. of India, the approximate population of Garole sheep in West Bengal was about 0.16 million.

## PHYSICAL CHARACTERISTICS AND BODY MEASUREMENTS

The Garole sheep is a small sized breed with a low-set body. The animal has a compact and square body with a small head, medium ears and a short thin tail. The head is straight and well set but is little higher than the body and appears triangular from the front. The nose bridge is straight and muzzle is small and pale cream or black in colour. The eyes are black and well set in the long face and the neck is long and fine and heavier in males. The legs are thin with black hooves. The chest and abdomen is barrel like and heavier posteriorly in females. The back is straight. Males are usually horned and females are polled (Figures 2 and 3). Garole sheep have rudimentary (1–3 cm), medium-sized (4–8 cm) or long (more than 8 cm) ears. The coarse fleece cover on the coat is not dense but covers almost the whole body and the greater part of the legs. The udder of ewes is not well developed, even during lactation and the teats are small. In adult males, the scrotum is large. The breed possess both pure and mixed coat colour. Pure colours are white, grey, black and brown. Mixed colours are formed by the combination of any two of pure colours. The prevalence of light brownish in colour is more (more than 90%). Very few sheep with completely black or white coat colour or black/white spot on the body can also be found. The average body weight in adult males and females were reported as 14.43 and 14.14 kg, respectively. The average chest girth, height at withers and body length of adult animals varied from 58–65, 42–49 and 42–53 cm, respectively [11, 14, 15]. The average ear length was 6.75 and 7.36 cm for males and females respectively [11, 15].



Fig. 2: Garole Ram having Curved Horns.



*Fig. 3: Garole Ewe with no Horn (Polled).*

### HUSBANDRY PRACTICES

The major part of the natural habitat of Garole sheep lies in the coastal area of Sunderban region where crop cultivation is poor due to scarce irrigation, the occasional cyclone and inundation by saline water and flooding. The extremely hot humid saline climate with heavy rainfall and cyclone prone riverine deltas of Sunderban made the situation hard for grazing of animals. Marginal farmers and landless labourers from socially and economically underprivileged classes maintain this sheep. The sheep keepers in its home tract mainly maintain the sheep in small flocks of 5–7 and raise them primarily on grazing field boundaries, fallow land and on the verges of the road [10]. Garole sheep are generally reared by the Haldar community; however, the

animals are kept by farmers from other castes and creeds in this area. Mostly females and children are involved in the sheep rearing practices. No organized grazing land is available. The sheep are reared only on grazing using either free or tethered grazing with no practice of flock migration. The animals are tied with a small rope and allowed to graze the surrounding area. Sheep are pegged in front of the house or on the roadside during daytime. Animals reared exclusively on grazing are allowed to graze for 8–11 h in different seasons, marginally lower during summer and highest during the rainy season.

In the rainy season, most of the fields become waterlogged. Garole sheep have the ability to swim and graze in knee deep conditions in marshy land (Figure 4). During the monsoon, in addition to grazing, animals are fed treetops and chaffed paddy straw. Farmers practice supplementary feeding of their animals depending on need and availability of supplementary feed. More supplementary feed is provided during the summer when the quality of natural pasture is low and during the rainy season when the grazing land is limited due to heavy rain, submerged pasture or unharvested crops. Harvested grass, weeds, tree leaves, dry grass, paddy straw and other crop residues (as concentrate) are used as supplementary feed. The majority of Garole sheep drink accumulated rainwater while grazing.



*Fig. 4: Garole Sheep Grazing in Saline Marshy Land.*

The animals are even found to drink saline water for several days, as there are limited sources of fresh water on many of the islands. Generally the sheep are not provided separate houses and are kept along with cattle in the home tract. During lambing, ewes and lambs are provided with paddy straw bedding and cold draught protection during winter. Since the breeding tract is located in coastal waterlogged areas, mosquito menace is high. To provide respite to the animals, farmers generally use mosquito net or put a lamp at night in the shed.

## PRODUCTION CHARACTERISTICS

### Body Weights

Growth performance of lambs at different ages was studied at farmer's flock in its home tract by various workers and they observed that the average body weight at birth, 3, 6 and 12 months of age ranged from 0.06–1.0, 4.1–5.8, 6.0–8.68 and 10.4–14.4 kg, respectively [2, 10, 14, 15]. Data on growth traits (viz. birth weight, weight at 3, 6, 9 and 12 month) of 506 Garole sheep, maintained at the State Livestock Farm, Kalyani, West Bengal, India, under the Centrally Sponsored Scheme "Conservation of Garole Sheep" over a period of 4 years were analyzed and it was found that birth weight, 3, 6, 9 and 12 month weight of Garole lamb under farm condition were  $1.00 \pm 0.03$ ,  $3.67 \pm 0.35$ ,  $6.25 \pm 0.23$  and  $10.16 \pm 0.49$  kg, respectively.

### Wool Yield

Farmers, in general, do not shear their animals and are ignorant about the use of wool. Published studies on wool characters of Garole sheep revealed that the wool of Garole sheep was of extremely coarse, hairy and not very dense [10, 14–18]. The average annual greasy fleece yield from each sheep of this breed was reported to be low and ranged from 150 to 400 g [10, 14–19]. The fibre parameters like average fibre diameter, medullation, staple length and crimp/cm of Garole sheep ranged from 53.02–67.82  $\mu$ , 75.17–78.70%, 4.99–7.13 cm and 2.08–2.86, respectively [15, 19–21]).

### Genetic Parameters

An effective breeding plan can only be devised after thorough knowledge has been obtained

about the inheritance of economically important traits. Estimates of heritability and genetic and phenotypic correlations form the basis of such information. This knowledge is required to formulate optimum breeding objectives and an effective genetic improvement program. The heritabilities estimates of birth weight, 3, 6, 9 and 12 month weight of this breed, maintained at the State Livestock Farm, Kalyani, West Bengal, India, were  $0.07 \pm 0.04$ ,  $0.35 \pm 0.23$ ,  $0.11 \pm 0.11$ ,  $0.06 \pm 0.04$  and  $0.18 \pm 0.07$ , respectively. The direct and maternal heritability of birth weight of this sheep was also estimated by REML fitting an animal model and ignoring or including maternal genetic or permanent environmental effects. The study revealed that direct heritability estimates for birth weight ranged from 0.03 to 0.24 depended on the models used. Maternal heritability for birth weight was 0.10 whereas; the estimate of the fraction of variance due to maternal permanent environmental effects was 0.12 for this breed.

### Reproduction and Breeding

Generally both male and female sheep are housed and grazed together at farmers' flock; hence no controlled mating is practiced at farmers' level. The farmers' only allow their animals to be naturally bred. The Garole sheep generally breed round the year in their home tract with no pronounced breeding season; however, maximum lambing takes place between December to February and August to September. The age at first service is 7 to 9 months and age at first lambing is 12 to 14 months. Gestation period is 150 days and lambing interval is 8 months [9]. They lamb twice in 15–18 months. Multiple-birth is common, mostly twins and triplets (Figure 5). Ewes also give birth to quadruplets. The lambing interval of this breed is reported as  $205 \pm 2.23$  days. According to the survey conducted in the breeding tract of Garole sheep by various workers, it was found that the average number of lambs born per ewe (prolificacy rate) of Garole sheep ranged from 1.63 to 2.27 with 7.3–40% single, 53.3–66.4% twins, 5–21.8% triplet and 0.2–5.45% quadruplet in the home tract [1, 7, 10, 14, 15]. Banerjee *et al.* also reported that the mean number of lambs born per Garole ewe was 2.04 (prolificacy =204%) in its home tract

whereas, the average value of native and out tract of Bengal, it was 1.93 (prolificacy =193%) [21]. On the other hand, Sharma *et al.* reported the average number of lambs born per ewe in this breed was 1.68 under farm condition [14]. They also observed the percentages of ewes giving birth to single lambs, twins, triplets and quadruplets were 40, 53.33, 5.0 and 1.67 respectively.

Pan and Sahoo reported that the Garole males generally reach puberty at the age of  $8.3 \pm 0.05$  months, with a range of 5–12 months in their home tract [22]. They also reported that the semen volume per ejaculate of this breed varied from 0.3 to 0.95 ml, with an average of  $0.52 \pm 0.02$  ml. The colour of semen is milky white to creamy white with moderately thick consistency. The mass activity of spermatozoa lies between 3 and 5, with an average of  $4.3 \pm 0.11$  and pH of the semen ranged from 6.5 to 7.0. The average number of spermatozoa is reported as  $3570 \pm 146.62$  million/ml with a range of 2100 to 5430 million/ml.



**Fig. 5:** Garole Ewe with Two Lambs.

### Carcass Evaluation

The Garole sheep are maintained only for meat production in their home tract. Generally, surplus sheep and lambs are sold for slaughter prior to the rainy season to avoid mortality. Some farmers do not sell ewes for slaughter. However, in some places, ewes are sold after six-seven lambings. Carcass composition of Garole sheep has been evaluated by various workers and they observed the dressing % of Garole sheep varied from 48.3 to 66.6% [9, 11, 16, 23, 24]. According to Pan and Sahoo

and Pan *et al.*, carcass parameters like slaughter age of Garole sheep were 8–12 months in male and above 24 months in female; whereas slaughter weights were on an average 10–12 and 13 kg for male and female, respectively [15, 20]. Carcass weights of male and female were, however, 6.6–8.7 and 6.6 kg, respectively. They also reported that skin parameters like skin length, skin width, skin area, skin weight and skin weight percentage of skin of adult sheep was around 65.3–84.1, 59.7–63.2 cm, 4048.3–5474.1 sq.cm, 1.2–2.3 kg and 10.5–12.0%, respectively. Pan and Sahoo and Banerjee *et al.* reported the moisture (70.7–76.02%), protein (17.3–18.2%), fat (3.53%), ash (1.1–1.65%) and carbohydrate content (0.60%) in Garole meat [22, 24]. Banerjee *et al.* also reported that the meat had pH, water holding capacity and refrigeration loss of 6.0, 43.3 and 0.86%, respectively [24]. The optimum age of slaughter of this breed was reported as 12 months of age at a slaughter weight of 12 kg [22].

### Prevalent Diseases and Mortality

Garole sheep appear to be fairly tolerant to diseases, particularly considering their living conditions. Interestingly this breed has naturally developed resistance against foot rot, FMD and reproductive disorders etc. and considerably more resistant to dreaded round worm *Haemonchus contortus* as well as to the tropical liver fluke [25]. In the home tract of this breed, it was found that parasitic infection and diarrhoea in the rainy season were the main health problems of animals. Pan *et al.* observed the incidence of gastrointestinal infection of 54.6% followed by miscellaneous infection cases [15]. Different parasites identified in the home tract of Garole sheep were *Strongyloides* sp., *Moniezia* sp. and *Eimeria* sp. However, no trematode infection was observed. Further, Pan *et al.* also recorded the highest morbidity (38.4%) and mortality rates (30.8%) for Garole lambs up to 1 month of age in field condition [15]. Singh and Bohra reported about 30% mortality in farmers' flocks and the mortality rate was higher in lambs and adults during the winter and rainy season, respectively [7]. Diarrhoea, which occurs mostly due to amphistomiosis infection, was one of the main reasons of death. Bose observed that overall lamb and

adult mortality was 33.2 and 12.2%, respectively and reported that death of lambs was highest in the rainy season (42%) followed by winter (39%) and summer (19%), whereas in adults it was highest in summer (40.3%) followed by winter (44.8%) and the rainy season (14.9%) [16]. He also reported that the mortality of lambs born as single, twin, triplet and quadruplet were 15.5, 36.1, 44 and 50%, respectively. In the home tract of Garole sheep, some reproductive disorders like abortion (7.82%), repeat breeding (9.35%), and placental retention (2.62%) were also observed.

### UTILITY OF THE BREED

The Garole sheep are self-sustainable in their breeding track due to their adaptability to the agro-climatic conditions, survivability under low input system and their utility as meat animals. Moreover, the animal is having some unique characteristics like high prolificacy, knee-deep water grazing habit, resistance to foot rot disease and adaptability to hot humid conditions. These animals are valued for production of quality mutton, skin and manure. There is no practice of shearing the sheep in the home tract although they produce coarse hairy fibre with more than 80% medullation. The faeces and urine collected from night shelters are good fertilizers with high nitrogen value. The Garole's ability to survive on scarce resources and their disease resistance also make them more attractive. The presence of naturally occurred beneficial mutation in a major gene (FecB) in Indian Garole is related to higher prolificacy and lambing frequency in its native tract [26].

According to Turner, high prolificacy Booroola Merinos can be traced back to an early Australian flock known to include prolific Indian Garole sheep [5, 27, 28]. Studies of different researchers established the possible link regarding transmission of this beneficial mutation (FecB gene) present in Bengal Garole to Australian Booroola Merino with higher litter size and lambing frequency [29, 30]. Piper and Bindon defined the acclaimed genesis of Fecundity gene, FecB (Booroola) in Australian Merino as from the Garole line having high prolific trait [6]. Due to the presence of FecB gene, the Garole sheep

is considered to be the most prolific sheep breed of India and hence this breed is used as an improver breed for improving the fecundity rate of the less prolific breeds of sheep like Deccani, Bannur, Pattanwadi and Sonadi etc. Considering the importance of multiple births in sheep breeding, Garole sheep had been introduced into the Mutton Project at the Central Sheep and Wool Research Institute, Avikanagar, Rajasthan, for introgression of prolific genes into relatively less prolific breeds of sheep like Malpura. Nimbkar *et al.* established prolific Garole sheep farm in the semi-arid deccan plateau of Maharashtra through selection and breeding and crossing was made with Garole rams with other local breeds like Deccani and Bannur sheep at Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra, and significant improvement in prolificacy of local sheep breeds was achieved [19].

### CONSERVATION AND IMPROVEMENT

There has been severe decline in the population of the Garole breed in its home tract day by day. According to Livestock Census Report in 2003, the total population of Garole sheep in West Bengal was 0.27 million, which has declined to the tune of 0.16 million in 2012. Since the population of this breed has declined sharply over the years, so it needs more concerted efforts towards conservation as well as improvement. There is an urgent need to launch an effective breed improvement programme in the home tract of the Garole sheep with the help of national and international collaboration in order to make sheep rearing more profitable and for conservation of this unique sheep genetic resource of India. Earlier, Das and Dasgupta and Das strongly recommended that as the population size of true to the breed was reducing fast in their home tract, so native environment (*in-situ*) conservation and development of Garole sheep through strategic breeding policy and with the direct involvement of stake holders and farmers of West Bengal is urgently required [23, 31]. It is also demonstrated that Garole sheep had suffered enough degradation leading to diluted genetic quality. Pan *et al.* reported that Garole sheep was facing a constant threat from gradual shrinkage of grazing land and other

feed resources [15]. Therefore, *in-situ* conservation of this genetic material with available feed resources was the crying need of the time. But, so far little effort has been made to improve and conserve this unique sheep breed both at institute as well as village level. The Government of India has launched a conservation programme on Garole sheep, which is being implemented by the Government of West Bengal. Under the program, an island called “Machranga” located in the core area of the breeding tract, has been developed as an ideal site for Garole breeding and improvement. The program also includes training of Garole farmers in scientific management and promotion of valuable genetic resources.

At present, as an *ex-situ* conservation program, this breed are being maintained at Krishi Vigyan Kendra, Nimpith, and State Livestock farm, Kalyani with an aim to produce superior germplasm (rams) for breed improvement program. The selected rams have been supplied in the field for effective improvement in farmers’ flocks. The maintenance of an elite flock of the Garole sheep at State Livestock Farm, Kalyani, is an attempt in this direction. Genetic improvement at the farmer’s level is hoped to generate more benefits, which could promote the conservation of the germ plasm of this breed. Besides, other organizations like Central Sheep and Wool Research organization (CSWRI), Avikanagar, Rajasthan and Nimbkar Agricultural Research Institute (NARI), Phaltan, Maharashtra, also play a vital role for the Garole sheep breed development programmes in India.

## CONCLUSION

Realizing the importance of Garole sheep due to its high fecundity rate, it becomes utmost important to improve and conserve this unique sheep genetic resources in its home tract. A strategic breeding policy with direct involvement of stake holders and farmers should be developed for *in-situ* and *ex-situ* conservation of this breed.

## REFERENCES

- Banerjee R. *Conservation and in-situ Development of a Prolific Indigenous Sheep in the Sunderban and Sagar Island*. Ph.D. Thesis, University of Calcutta, Kolkata, West Bengal, India, 2008.
- Sahana G, Gupta SC, Nivsarkar AE. Garole: The Prolific Sheep of India. *Anim Genet Resour Inf*. 2001; 31: 55–63p.
- Banerjee R, Mandal PK, Pal UK, et al. Productivity and Genetic Potentiality of Garole Sheep of India: A Review. *Asian J Anim Sci*. 2010; 4(4): 170–189p.
- Nimbkar C, Ghalsasi RR, Gray GD. Establishment of Prolific Garole Sheep from West Bengal in the Semi-Arid Decan Plateau of Maharashtra. *Proc 6th World Cong Genet Applied Livestock Prod*, Armidale. 1998; 25: 257–260p.
- Turner HN. The Booroola Merinos. In: Piper LR, Bindon BM, Nethery RD, editors. *Merino Improvement Programs in Australia*. Melbourne, Australia: CSIRO; 1982.
- Piper LR, Bindon BM. The Booroola Merino. In: Fahmy MH. *Prolific Sheep*. Wallingford, UK: CAB International; 1996; 152–160p.
- Singh RN, Bohra SDJ. Garole Sheep a Profile. *Indian J Small Rumin*. 1996; 2: 38–42p.
- Acharya RM. Sheep and Goat Breeds of India. *FAO Animal Production and Health Paper 30*. Rome, Italy: FAO; 1982; 135–158p.
- Bose S, Maitra DN. Bengal Breed of Sheep in the Sundarbans. *Asian Livestock*. 1995; 20(2): 16–17p.
- Ghalsasi PM, Nimbkar BV. The Garole: Microsheep of Bengal, India. *Anim Genet Resour Inf*. 1993; 12: 73–79p.
- Banerjee S, Banerjee S. Garole Sheep of Bengal. *Asian Livestock*. 2000; 24(3): 19–21p.
- Banerjee S, Galloway S, Davis GH. Distribution of Prolific Garole Sheep in West Bengal, India. *Anim Genet Resour*. 2011; 48: 29–35p.
- Gangopadhyay S. Agricultural Characteristics in the Agro-Climatic Zones of Indian States: West Bengal. In: Ghosh SP, editor. *Agro-Climatic Zone-Specific Research, Indian Perspective under NARP*. ICAR Publication; 1991; 438–462p.
- Sharma RC, Arora AL, Narula HK, et al. Characteristics of Garole Sheep in India. *Anim Genet Resour Inf*. 1999; 26: 57–64p.



15. Pan S, Sahoo AK, Tantia MS, *et al.* Garole Sheep, NATP (MM) on Animal Genetic Resource Bio-diversity, WBUAFS, Mohanpur and Kolkata, West Bengal and NBAGR Karnal, Haryana, India, 2004.
16. Bose S. *Studies on the Productive and Reproductive Performance of Sheep in Saline and Semi-Saline Belt of West Bengal.* Ph. D. Thesis, West Bengal University of Animal and Fishery Sciences, Kolkata, India, 1996.
17. Bose S, Maitra DN. Prospects of Bengal Sheep (Garole): A Hidden Wealth in West Bengal. *Indian J Anim Prod Manag.* 1999; 15: 17–19p.
18. Bose S, Dasgupta R, Maitra DN. Phenotypic Characteristics and Management Practices of Bengal Goat. *Indian J Anim Prod Manag.* 1999; 15: 18–22p.
19. Prasad J. *Goat, Sheep and Pig Production and Management.* New Delhi: Kalyani Publishers; 1997; 151–163p.
20. Pan S, Sahoo AK. Garole Sheep, Report of Ad-hoc Research Scheme on Survey Evaluation of Garole sheep in Sundarban Area of West Bengal. WBUAFS, Mohanpur, West Bengal, 2003.
21. Banerjee S. Utilisation of Garole Sheep Wool: A Step towards the Alleviation of Poverty. *Anim Genet Resour Inf.* 2009; 45: 85–89p.
22. Pan S, Sahoo AK. The Garole Sheep: History, Management, Production and Current Status. In: Use of the FecB (Booroola) Gene in Sheep-Breeding Programs. *Proceedings of the Helen Newton Turner Memorial International Workshop* held in Pune, Maharashtra, India. 10–12 Nov 2009; 32–43p.
23. Das D. *Phenotypic, Genotypic Performance of Garole Sheep.* Ph. D. Thesis, West Bengal University of Animal and Fishery Sciences, Kolkata, India, 2000.
24. Banerjee R, Mandal PK, Bose S, *et al.* Quality Evaluation of Meat, Skin and Wool from Garole Sheep: A Promising Breed from India. *Asian J Anim Sci.* 2009b; 3: 39–46p.
25. Nimbkar C. Gains from Garole the Wonder Sheep of West Bengal. *Partners Res Dev, ACIAR.* 2002; 15: 31–36p.
26. Banerjee R, Gupta A, Roy K. Assessment of the FecB Mutation in Three Indian Sheep Breeds Including Garole in its Native Tract and its Effect on Prolificacy. *ACIAR.* 2009a; 133: 229–230p.
27. Turner HN. Origin of the CSIRO Booroolain the Booroola Merinos. *Wool Technol Sheep Breed.* 1980; 31: 10–13p.
28. Turner HN. Origin of the CSIRO Booroola. In: *The Booroola Merino, Proceedings of the Workshop held in Armidale, N.S.W.* 24 Aug 1980; 1–7p.
29. Davis GH, Galloway SM, Ross IK, *et al.* DNA Test in Prolific Sheep from Eight Countries Provide New Evidence of Origin of the Booroola (FecB) Mutation. *Bio Reprod.* 2002; 66: 1869–1874p.
30. Montgomery GW, Galloway SM, Davis GH, *et al.* Genes Controlling Ovulation Rate in Sheep. *Reproduction.* 2001; 121: 843–852p.
31. Dasgupta SK, Das N. Plenary Session Recommendations. *Proceedings of the State Level Symposium and Round Table on Breeding Policy for Conservation of Small Ruminants of West Bengal (SLSRTBPCSRWB'05),* Belgachia, Kolkata. 2005; 36–39p.

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