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Genetic resources on goat in India: A review

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Abstract
In India, the agricultural sector in general and livestock sector in particular acts as a backbone of the nation's economy. However, the distribution pattern of various livestock species varies among different parts *w.r.t* topography and socioeconomic status. The goat, commonly known as poor man's cow, acts as a source of crop insurance and supplementary income along with nutritional security for lower/poor/small and marginal farmers. The profitable goat production depends on the four basic pillars of management i.e. breeding, feeding, housing and disease management. Moreover, it is well known fact that production is inversely associated with reproduction. Therefore, more the balance between production and reproduction, better will be the animal's performance. Thus, it becomes inevitable to determine the performance characteristics of each breeds of goat, hence the present paper describes the identification characteristics along with production and reproduction characteristics of various valuable germplasm of goats available in different parts of India.

Keywords: goat, production, reproduction, identification and germplasm

Introduction
The India is bestowed with largest livestock sector in the world i.e. 11.6% of the world's total livestock, which plays an important role in Indian economy [1]. In 2019, the goat population in India is 148.88 million and is increasing at the rate of 10.1% over the last Census [2], which might be due to the awareness of the people's towards goat farming as one of the important source of livelihood. Among the different species of livestock *viz.* cattle, buffalo, sheep, goat and swine, there is specific distribution pattern of livestock on the basis of either topographical location or on the basis of their socio-economical status [3]. Considering the socioeconomic status, in general, the cattle are more concentrated in those areas where the agricultural sector is well developed and the farmers can bear the high investments needed for cattle/buffalo rearing, however, where the farmers are poor enough to bear such investments, goat farming seems to be the best possible alternative for income for poor/landless/marginal farmers. This may be one of the reason that about 76 percent of such farmers were involved in goat production practices, as it is not only a source of income, but also for livelihood and nutritional security [4, 5] and hence popularly known as the "poor man's cow" [6]. Thus, it is believed that goats rearing may be helpful in doubling the income of farmers by 2022 [7]. However, for such target the goat management practices needs to be improved at commercial as well as farmers level.

One of the major constraints in successful goat rearing at farmer's level is the prevalence of non-descript or poor genetic-make-up of animals (About 70%) along with unorganized breeding programme [5]. The India is endowed with large biodiversity of goat breeds (34 breeds) distributed in different agro-ecosystems throughout the country, which vary in their genetic potential for the production of milk, meat, and fiber; disease resistance; heat tolerance; and fecundity. Hence, the information about the different breeds of goats available in different agro-climatic zones are of utmost importance and has been presented in this paper.

Physical characteristic of Goat breeds– The selection of dairy goats in the past was based primarily in morphological traits, because no records were available for productive traits of the animals [8]. The morphological traits of animals played an important role in the identification of breeds with desirable characteristics. The most efficient management of goat requires thorough knowledge of breed characteristics, including physical descriptions, pattern of distribution and agro-climatic environments. The phenotypic characterization of breed is the

is the first step in the description of breed and is useful in identification as well as classification of the populations, strains or breeds within a species. The absence of such information may leads to underutilization and miss use of the resources (replacement and genetic dilution) [9]. The physical characterization of different goats breeds of India are as follows:-

Table 1: Physical Characteristics of Indigenous Goat breeds of India

S. No.	Breed and their breed-ing tract	Colour		Horn		Ear
		Body	Present or not		Orientation	
1	Black Bengal (West bengal)	Predominant black, brown, grey and white are also found	Present		Upward and sometime backward	-
2	Beetal (Ferozpur of Punjab & Gurdaspur of Amritsar)	Black coat is common, brown with white spots also available	Present		Horizontally with slight twist, directed backward and upward	Long ears
3	Berari (Akola, Amravati & Wardha of Maharashtra)	Light to dark tan	Present		Flat, small, oriented and backward	-
4	Bhakarwal (Poonch & Rajouri of Jammu-Kashmir)	-	Present		White, some have black face	-
5	Bidri (Bidri & Gulbergh of Karnataka)	Black, some have white spot on ears, forehead, neck and knees	Present		Curved and directed backward outward and downward	Ears are pendulous
6	Changthangi (Leh, Kargil of Jammu & Kashmir)	Predominantly white but admixture of brown	Present		Large and twisted like corkscrew turned outward, upward	Ears small, erected stumpy
7	Chegu – (Chamba & Kinnaur of Himachal Pradesh)	Compact white, black, grey, brown and mixture of these colours are common	-		Long, cork shaped, directed upward, backward and inward/outward medium to large	-
8	Gaddi – (Chamba, Kangra, Kullu, Simla of Himachal Pradesh and Jammu)	White is dominant colour, black coloured animals are also present	Present		Directed upward and backward and occasionally twisted horns are long in size	Ear are drooping and pointed
9	Ganjam (Ganjam, Rajagada, Gajapati of Odisha)	Black or brown black	Present		Twisted and curved pointed backward and upward	Ears are long and drooping
10	Gohilwadi (Amreli, Bharnagar, Rajkot of Gujrat)	Black	Present		Slightly and turned upward outward and backward	Ears are tubular and drooping
11	Jakhrana (Alwar of Rajasthan)	Predominantly black, black with white spot	Present		Curved upward and backward medium sized	-
12	Jamunapari (Etawah of Uttar Pradesh)	White with patches of tan mostly on head and neck	Present		Small, sword shaped running backward and upward	Ear are long flat and drooping
13	Kahmi – (Jamnagar & Junagadh of Gujrat)	Coat colour is unique neck and face are reddish brown	Present		Curved upward and backward	Long, tubular
14	Kanni Adu (Tiruneveli of Tamilnadu)	Generally black with two white stripes on either side of the face	Present		Directed backward outward are and curved upward are predominantly present	-
15	Kodi Adu – (Ramanathapuram & Thoothukodi of Tamilnadu)	White with splashes of black or reddish brown colour	Present		Upward, backward and curved downward or upward	-
16	Konkan (Sindhudurg & Kanyal of Maharastra)	Black with white marking on collar, lower jaw and ventral surface	Present		Cylindrical, backward and medium in size	-
17	Kutchi (Banas, Kantha, Mahesana and Ratan of Gujrat)	Black with white spot on neck, mouth & ear	Present		Small to long, corkscrew type and directed upward	-
18	Malabari (Malappuram and Wayanad Kerela)	Majority complete white, some are black or brown or admixture.	present		Slightly twisted horns directed outward and upward	Medium sized ears, directed outward and downward reaching up to the nose
19	Marwari (Barmer, Bikaner and Jaisalmer of Rajsthan)	Black	Present		Corkscrew type, directed upward and backward	Pendulous ears.
20	Mehsana (Ahmdebad, Banas and Kantha of Gujarat)	Black with white ear base, few reddish brown with white ear base.	Present		Screw type. Twisted slightly curved upward and backward and pointed at the tips	-
21	Nandidurga (Chitradura & Tumkur of Karnatak-a)	White. Some have black/brown spot on ears	Present		Curved. Directed backward downward, inward and touching neck in few.	Ears are leafy and pendulous
22	Osmanabadi (Ahmednagar, Solapur & Osmana- bad of Mah-arashtra)	Predominantly black. White colour is noticed only on ears, neck and forehead	Present		Straight/curved and small in size running backward, upward and downward	-
23	Pantja – (Nanital and Udham Singh Nagar of Uttarakand)	Fawn to brown colour, which become lighter ventrally	Present		Small sized. Triangular, twisted slightly upward and backward, pointed tip	Ears are pendulous
24	Rohikhandi (Bareilly, Bdaun and Pilibhit of Uttar Pradesh)	Mostly black. Few are brown	Present		Slightly curved and directed laterally and outwards	-
25	Salem Black (Salem and Dharmapuri of Tamilnadu)	Completely black with glossy hair coat	Present		-	Ears are medium in length, leaf-like & semi pendulous
26	Sangamneri (Nashik and Ahmednagar of Maharashtra)	Generally white. White mixed with Black and brown	Present		Horns are thin pointed, directed backward and upward	-
27	Sirohi (Ajmer, Bhilwara and Sirohi of Rajsthan)	Brown with lighter dark brown patches	Present		Horns are slightly twisted and curved directed upward and backward	Flat & leaf like drooping ears
28	Sumi-Ne (Zunhebeto of Nagaland)	White with characteristic black marking on head, neck and legs	Present		Small sized and slightly curved backward, horns are pointed	Ears are horizontal

29	Surti (Vadodara and Bharuch of Gujrat)	White, black, tan, coffee and grayish colour	Present	Directed backward. Small to medium in size	Pendulous and medium sized ears
30	Teressa (Andaman & Nicobar)	Dark tan, brown, white and brown mixed, black brown mixed	Present	Flat at base and pointing towards tip, slight curvature towards back/side wards. Size small	-
31	Zalawadi (Rajkot and Surendranagar of Gujrat)	Black	Present	Cork-screw type moving straight upward backward and slightly outward	Long, wide leaf like drooping ears.
32	Assam Hill (Dima and Haso of Assam)	Usually white with occasional black	Present	Cylindrical and tapering toward the end and pointed at the tip.	Ears are medium in size, horizontally & pointed tip
33	Attapady Black (Palghat of Kerala)	Black	Present	Curved and oriented backwards. Small in size	-

[10]

Body Measurement-

The knowledge regarding body features of small ruminant is very useful for goat farm management *viz.* medication doses, monitoring growth rate and for other activities. Since, the weighing device is too expensive for most of the small/marginal farmers, hence body mass can be estimated by height, body length & heart girth.

Table 2: Body measurements of Indigenous Goat breeds of India

S. No.	Breed	Height (cm)	Body length (cm)	Heart girth (cm)	Adult body weight (kg)
1	Assam Hill	M-48.06 F-47.21	M-57.63 F-54.98	M-52.79 F-51.02	M-19.81 F-18.61
2	Attapady Black	M-79.5 F-66.8	M-66.6 F-62.8	M-71 F-68.9	M-34.5 F-31.3
3	Barbari	M-70.67 F-56.18	M-77.04 F-58.68	M-75.53 F-64.3	M-36.7 F-20.3
4	Beetal	M-91.3 F-81.3	M-87.3 F-78.2	M-87.4 F-83.2	M-57.12 F-44.97
5	Berari	M-75.5 F-72.2	M-70.2 F-64.4	M-76.2 F-74.3	M-36.0 F-30.0
6	Bhakarwali	M-73.56 F-71.82	M-79.26 F-71.74	M-74.82 F-71.2	M-30.15 F-28.6
7	Bidri	M-79.25 F-74.84	M-58.17 F-56.06	M-80.75 F-77.12	M-36.78 F-32.36
8	Black Bengal	M-44.9 F-44.3	M-43.8 F-42.6	M-60.3 F-58.9	M-32.37 F-20.38
9	Changthangi	M-51.6 F-49.0	M-52.4 F-49.8	M-65.2 F-63.0	M-21.8 F-21.4
10	Chegu	M-66.2 F-58.1	M-72.9 F-65.5	M-72.9 F-65.5	M-39.4 F-25.7
11	Gaddi	M-66.23 F-64.69	M-65.12 F-63.2	M-F-70.3 68.31	M-28.0 F-23.4
12	Ganjam	M-67.23 65.62	M-59.67 F-58.32	M-66.72 F-73.0	M-53.05 F-28.87
13	Gohilwal	M-88.4 F-80.4	M-85.9 F-79.3	M-83.9 F-78.8	M-52.04 F-41.67
14	Jakhrana	M-87.85 F-77.42	M-82.07 F-73.66	M-86.0 F-76.58	M-57.8 F-44.5
15	Jamunpari	M-78.17 F-76.11	M-77.37 F-75.15	M-79.52 F-76.11	M-44.66 F-38.03
16	Kahmi	M-88.56 F-81.33	M-82.15 F-76.27	M-84.09 F-81.53	M-56.4 F-48.35
17	Kanni Adu	M-81.46 F-74.83	M-73.06 F-68.43	M-75.22 F-70.07	M-34.05 F-28.17
18	Kodi Adu	M-82.39 F-79.16	M-74.08 F-71.94	M-75.46 F-73.79	M-33.43 F-30.94
19	Konkan Kanyal	M-84.2 F-74.2	M-81.6 F-72.7	M-83.2 F-73.3	M-49.9 F-31.8
20	Kutchi	M-85.96 F-79.78	M-83.17 F-79.78	M-80.91 F-76.88	M-46.96 F-39.91
21	Malabari	M-76.29 F-64.46	M-77.29 F-68.38	M-79.17 F-73.0	M-38.96 F-31.12
22	Marwari	M-77.93 F-70.12	M-73.85 F-67.55	M-76.88 F-72.48	M-39.51 F-31.86
23	Mehsana	M-79.4 F-75.2	M-72.4 F-76.9	M-77.95 F-76.8	M-37.0 F-32.0
24	Nandidurga	M-79.4 F-71.92	M-59.65 F-55.31	M-81.47 F-75.07	M-38.92 F-30.11
25	Osmanabadi	M-77.87	M-69.12	M-72.06	M-33.66

		F-74.79	F-67.51	F-72.04	F-1.7
26	Pantja	M-63.57 F-59.63	M-56.24 F-54.21	M-65.81 F-63.65	M-22.91 F-18.81
27	Rohilkhandi	M-68.58 F-65.22	M-59.84 F-57.23	M-73.5 F-70.21	M-29.92 F-25.33
28	Salem Black	M-80.1 F-73.6	M-70.2 F-67.1	M-73.7 F-69.1	M-38.16 F-31.58
29	Sangamneri	M-75,04 F-69.76	M-74.75 F-69.67	M-74.75 F-73.63	M-39.1 F-32.62
30	Sirohi	M-78.89 F-74.57	M-77.94 F-74.19	M-77.5 F-74.1	M-42.83 F-35.27
31	Sumi-Ne	M-46.45 F-45.8	M-50.5 F-45.53	M-52.4 F-47.5	M-16.18 F-13.5
32	Surti	M-68.94 F-69.3	M-61.5 F-64.3	M-69.67 F-72.26	M-29.03 F-31.06
33	Teressa	M-68.27 F-58.88	M-66.16 F-57.89	M-77.34 F-66.75	M-39.85 F-31.94
34	Zalawadi	M-84.61 F-73.16	M-81.07 F-73.16	M-86.11 F-75.89	M-38.8 F-33.0

[10]

Reproductive trait – Reproductive efficiency of goats is very important, from the aspect of milk as well as meat production. Reproductive goat traits, as stated by [11], are the main traits which determine the productivity of goats, which especially relates to meat production. These traits are under the influence of genetic and factors of the environment [12, 13]. In general, the lifetime production in the small ruminants with high reproduction capacity will higher as it yields more income and profitability as compared to those with low reproduction capacity [14].

Table 3: Reproductive traits of Indigenous Goat breeds of India

S. No	Breed	Age at 1st parturition (Months)	Kidding Interval (Months)	Litter size	Body weight at birth (kg)
1	Assam Hill	13.34	7.63	1.56	M-1.26; F-1.13
2	Attapady Black	13.6	8.14	1.28	M-1.73; F-1.6
3	Barbari	20.82	11.4	1.42	M-1.99; F-1.78
4	Beetal	24.45	10.94	1.66	M-3.3; F-2.68
5	Berari	15.16	7.9	1.6	M-2.46; F-2.36
6	Bhakarwali	24.43	12.36	1.08	M-2.98; F-2.89
7	Bidri	15.95	9.04	1.71	M-2.5; F-2.2
8	Black Bengal	17.43	6.8	1.6	M-1.5; F-1.4
9	Changthangi	27.4	13.05	1.0	M-2.24; F-2.04
10	Chegu	22.33	12.0	1.13	M-2.0; F-1.9
11	Gaddi	54.0	_	1.2	M-3.41; F-3.14
12	Ganjam	19.19	11.09	1.0	M-2.36; 2.06
13	Gohilwadi	18.0	9.86	1.5	-
14	Jakhrana	18.5	9.5	1.54	M-2.83; F-2.57
15	Jamunapari	24.2	7.5	1.5	Av- 4.24
16	Kahmi	22.45	9.57	1.38	M-2.75; F-2.67
17	Kanni Adu	13.9	6.9	1.9	M-2.11; F-2.05
18	Kodi Adu	15.3	7.6	1.63	M-2.9; F-2.76
19	Konkan Kanyal	16.7	7.9	1	M-2.23; F-2.05
20	Kutchi	24.14	10.38	1.12	M-3.57; F-3.08
21	Malabari	20.1	9.4	1	M-2.22; F-2.0
22	Marwari	15.4	8.2	1	M-2.63; F-2.53
23	Mehsana	20.32	10.6	1	-
24	Nandidurga	16.94	7.07		M-3.32; F-2.28
25	Osmanabadi	12.69	7.1	1.6	M-2.1; F-1.7
26	Pantja	13.5	8.6	1	M-1.96; F-1.85
27	Rohilkhandi	17.27	8.27	1.57	M-1.94; F-1.73
28	Salem Black	14.8	7.1	1.6	M-2.27; F-2.22
29	Sangamneri	14.06	10.97	1.4	-
30	Sirohi	26.14	10.06	1.0	M-2.29; F-2.22
31	Sumi-Ne	12.8	7.0	1.12	M-1.3; F-1.22
32	Surti	-	-	1	M-2.36; F-2.22
33	Teressa	12.3	7.7	1.56	M-1.4; F-1.22
34	Zalawdi	22.17	11.27	1	M-3.06; F-2.84

(M-Male; F-Female) [10]

Productive trait – The goats are raised principally for their meat, milk, fibre and skin. Goat farming can be very suited to production with other livestock such as sheep and cattle on low quality grazing land. However, the status of production varies with the adaptability of the breed to different agro-climatic and managemental conditions.
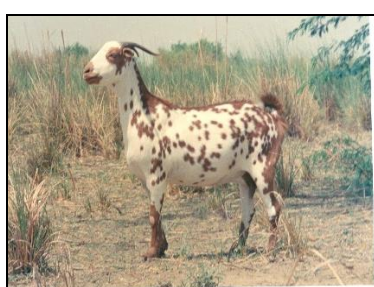
Table 4: Productive traits of Indigenous Goat breeds of India

S. No.	Breed	Utility of breed (Milk/Meat/Hair)	Fleece weight (Kg/year)	Dressing Percentage	Milk yield /Lactation(kg)
1	Assam Hill	Meat	-	46	10.19
2	Attapady Black	Meat	-	43	17.33
3	Barbari	Milk&Meat	-	47.5	78.5
4	Beetal	Milk&Meat	-	49.68	157.0
5	Berari	Meat	-	48	77.7
6	Bhakarwali	Meat,Milk &Hair	0.75	53	140.65
7	Bidri	Meat	-	-	-
8	Black Bengal	Meat,Skin	-	55.5	144
9	Chanthangi	Hair, Pashmina	0.136	-	-
10	Chegu	Hair, Pashmina	0.12	46	69.5
11	Gaddi	Meat, Hair	0.3	-	52.5
12	Ganjam	Meat, Milk	-	-	65.0
13	Gohilwadi	Meat, Milk	3.17	-	240.0
14	Jakhrana	Meat, Milk	-	47.0	152.87
15	Jamunapari	Milk, Meat	-	-	201.96
16	Kahmi	Milk, Meat	-	52.0	326.87
17	Kanni Adu	Meat	-	45.0	-
18	Kodi Adu	Meat, Skin	-	48.0	-
19	Konkan kanyal	Meat	-	53.0	59.0
20	Kutchi	Meat, Milk	-	58.4	114.5
21	Malabari	Milk, Meat	-	-	43.78
22	Marwari	Milk, Meat	0.18-0.33	56.3	85.8
23	Mehsana	Milk, Meat	-	58.0	208.0
24	Nandidurga	Meat	-	50.0	-
25	Osmanabadi	Meat	-	50.0	40.75
26	Pantja	Meat, Milk	-	56.0	127.0
27	Rohilkhandi	Milk, Meat	-	46.0	52.83
28	Salem Black	Meat, Milk	-	50.0	-
29	Sangamneri	Meat, Milk	-	46.0	77.4
30	Sirohi	Meat, Milk	-	58.0	81.5
31	Sumi-Ne	Fibre	0.197	47.0	-
32	Surti	Meat, Milk	-	46.6	317.0
33	Teressa	Meat	-	47.0	56.0
34	Zalawadi	Milk, Meat	-	-	294.0

[10]

| Attapady Black Female | Barbari Female | Beetal male | Berari Male |

| Black Bengal | Female Chanthangi | Female Gaddi Male | Ganjam Male |
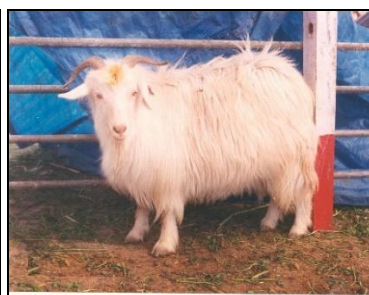
Gohilwal Male   **Jakhrana Female**   **Jamunapari Male**   **Chegu Male**

Kanni Adu Female   **Kodi Adu Female**   **Konkan Kanyal**   **Female Kutchi Male**

Malabari Female   **Marwari Female**   **Mehsana Male**   **Osmanabadi Male**

Pantja Male   **Salem Black Male**   **Sangamneri Male**   **Sirohi Male**

Sumi Ne Male   **Surti Female**   **Teressa Male**   **Zalawadi Female**
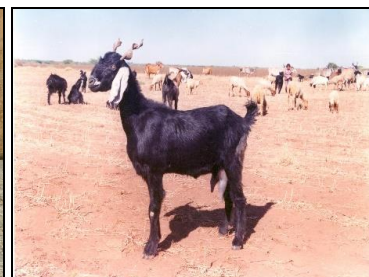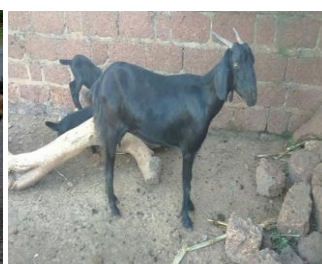
Assam Hill Female   **Bhakarwali Female**   **Bidri Female**   **Nandidurga Female**

Kahmi Female　　　　　　　　　　**Rohilkhandi Male**

Conclusion
The goats are multipurpose type of animal among all domestic animals and can be used for meat, milk or fiber under local management and limited resources. Hence, they can easily be reared by small farmer and even landless farmers The different goat breeds, found in varying agro-climatic zones of India, have some special economical/commercial characteristics, hence the information about breeds will be helpful for to fulfill the specific desired utility, besides improving the various management practices.

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