Review

Ruminant genetic resources of Rajasthan state: Status, distribution and characteristics

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ABSTRACT

Rajasthan is situated in the North-Western region of India having semi-arid to arid environmental conditions. The total population of ruminant livestock, comprising cattle, buffalo, sheep and goats, in the state is 56.375million. It is home to many of the important breeds of these species. Despite its tough environmental conditions, the density of ruminants per square km at 164.72 is more than the national average of 160.15. During 2007-2019, the total cattle and buffalo populationshave registered an increase of 15 and 23.45 percent, whereas, the sheep and goat populations have shown a decline of 29.37 and 3.08 percent. Between 2007 and 2012, when population of individual breeds of ruminant livestock species is available, the populations of pure indigenous cattle, buffalo, sheep and goat have shown a decline of 46.06, 53.47, 45.47 and 32.30 percent, respectively. This article attempts to evaluate the present status, distribution and characteristics of the ruminant genetic resources of Rajasthan state.

Key Words: Ruminant, Animal Genetic Resources, phenotypic characteristics, Rajasthan

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INTRODUCTION

Rajasthan, with an area of 0.342 million square km, is the second largest state of India, situated in the North-Western region between 23°30' and 30°11' N latitude and 69°29' and 78°17' E longitude. It is surrounded by Punjab and Haryana in the North, Uttar Pradesh and Madhya Pradesh in the East, Gujarat in the South and Pakistan in the West. It houses the biggest desert of India, the TharDesert, covering almost 70 percent of total landmass of thestate. The Aravalimountains split the state into two geographical zones: arid to the West and semi-arid to the East. Theaverage annual rainfall is less than 25 cm. The state is proud owner of 56.801million livestock and 14.623million poultry (Livestock census 2019). Four livestock species *viz*. cattle, buffalo, sheep and goats with a population of 56.375millionconstitutes major proportion of the total livestock population of the state. It indicates the importance of these livestock species in the livelihood of the farmers. The state of Rajasthan is home to many of the important breeds of these four ruminant livestock species. This article attempts to evaluate the present status, trend, distribution and characteristics of the ruminant genetic resources of Rajasthan state.

Status and distribution of ruminant genetic resources of Rajasthan

The total ruminantlivestock population (56.375million) of Rajasthan stateis abouteleven percent of the total ruminant livestock population of our country. Despite its semi-arid to arid topography, the density of ruminants per square km at 164.72 is more than the national average of 160.15 that indicates the importance of these livestock in the livelihood of the farmers (Table 1). The district wise population status and distribution of ruminant genetic resources and attributes of breeds or populations available in the state are discussed below.

Cattle

The total cattle population (13.938 million) in the state of Rajasthan has shownan increase of 15 and 4.60 percent during 2007-2019 and 2012-2019, whereas, the indigenous cattle population (11.615 million) has shown increase of only 2.75 and 0.22 percent during these periods. However, during these periods, the exotic cattle has shown an increase of 184.8 and 33.89 percent, respectively.Although only 83.33 percent of the cattle population of Rajasthan is of the indigenous type compared to 92.27 percent at the national level (Livestock census 2019). As per Breed survey (2015)estimates, which are derived by disintegrating the figures of Livestock census (2012), 24.61 percent of the total cattle population and 21.41 percent of the indigenous cattle of Rajasthan belong to the recognized/defined breeds of cattle compared to the national figure of 11.81 and 9.35 percent, respectively. However, there is drastic reduction in the percent of cattle of recognized breeds during 2007-2012 when 43.63 and 46.77 percent of the total and indigenous cattle population of Rajasthan was of recognized breeds. Some of the drastic reduction in the population of pure animals of indigenous breeds of cattle during 2007-2012 may be attributed to probably more stringency applied to assigning an animal to a breed, as the number of grades of these breeds during this period has

shown a steep increase of 1554 percent. But even the combined population of pure and graded indigenous cattle has shown a decline of 9.95 percent during this period (Table 1).Barmer district has the highest percentage (99.83) and Jhunjhunu district has the lowest percentage (27.33) of indigenous cattle. Bikaner district has the largest population of indigenous cattle (1.065 million) as well as total cattle population (1.195 million).In terms of population density, Banswara district has highest number of indigenous (139.48) as well as total cattle (145.38) per square km (Table 3 and 5) (Livestock census 2019).Rajasthan is home to some of the best milch and draught cattle breeds. Following discussion describes their distribution, population status and characteristics. *Rathi:*This breed takes its name from nomadic pastoralist tribe called Raths. These animals are mainly distributed in Western part of Rajasthan in the districts of Bikaner, Sriganganagar, Hanumangarhand Jaisalmer.Rathi is a medium sized breed with symmetrical body. The usual coat colour is brown with white patches all over the body, but animals with completely brown or black coat are also encountered. Face is broad between eyes and slightly dished. Muzzle and hooves are black. Horns are short to medium in size curving outward and upward. Ears are of

Table 1: Population dynamics of different ruminant livestock species during 2007-2012, 2012-2019 and 2007-2019 in the state of Rajasthan

Species	Population			Percent change		
	2007[$]	2012[@]	2019[£]	2007-2012	2012-2019	2007-2019
Cattle						
Pure	5287341	2852206	#	-46.06	-	-
Grades	122035	2018992	#	1554.44	-	-
Pure and grades	5409376	4871198	#	-9.95	-	-
Non-descript indigenous	5894461	6718192	#	13.97	-	-
Total Indigenous	11303837	11589390	11614597	2.53	0.22	2.75
Exotic and cross-bred	815675	1735072	2323033	112.72	33.89	184.80
Total cattle	**12119512**	**13324462**	**13937630**	**9.94**	**4.6**	**15**
Buffalo						
Pure	5208161	2423209	#	-53.47	-	-
Grades	188623	4940252	#	2519.11	-	-
Pure and grades	5396784	7363461	#	36.44	-	-
Non-descript	5695190	5612634	#	-1.45	-	-
Total buffalo	**11091974**	**12976095**	**13693316**	**16.99**	**5.53**	**23.45**
Sheep						
Pure	8599225	4689760	#	-45.46	-	-
Grades	80508	1887214	#	2244.13	-	-
Pure and grades	8679733	6576974	#	-24.23	-	-
Non-descript indigenous	2455625	2411667	#	-1.79	-	-
Total Indigenous	11135358	8988641	7855551	-19.28	-12.61	-29.45
Exotic and cross-bred	54497	91061	48306	67.09	-46.95	-11.36
Total sheep	**11189855**	**9079702**	**7903857**	**-18.86**	**-12.95**	**-29.37**
Goat						
Pure	12401469	8395596	#	-32.3	-	-
Grades	221613	3625955	#	1536.17	-	-
Pure and grades	12623082	12021551	#	-4.77	-	-
Non-descript	8879914	9644988	#	8.62	-	-
Total goats	**21502996**	**21665939**	**20840203**	**0.76**	**-3.81**	**-3.08**
Total ruminant livestock	**55904337**	**57046198**	**56375006**	**2.04**	**-1.18**	**0.84**

[$]Livestock census 2007, [@]Livestock census 2012 and Breed survey (2015) which is derived by disintegrating the figures of livestock census (2012), [£]Livestock census 2019, #Data not available

medium length. Dewlap is voluminous. Tail is long, fine, tapering to a good black switch. Udder is well developed with prominent milk vein. The height at withers (HW), body length(BL)and chest girth (CG) is 121.24, 132.63 and 164.23 cm. Average age at first calving (AFC), lactation milk yield (LMY), lactation length (LL), calving interval (CI) and dry period (DP) is 1411 (1104-1581) days, 1560 (1062-2810) kg, 336 (306-431) days, 519 (445-617) days and 181 (132—234) days, respectively (Bhat*et al*.. 1981, Nivsarkar*et al*. 2000). Dangi*et al*. (2013) reported the LMY, LL, DP, service period (SP) and CI to be 1589.49±75.55 kg, 267.09±08.04 days, 155.28±09.65 days, 153.03±22.80 days and 427.44±12.30 days, respectively. They are particularly concentrated in Lunkaransar tehsil of Bikaner district. As per Breed survey (2015) estimates their population in Rajasthan is 0.900 million which is 7.42 and 6.45 percent of the indigenous and total cattle population of the state. Another 0.358 million cattle have been listed as grades of Rathi cattle. Pure Rathi cattle have registered a decline of 6.94 percent in the state during 2007-2012 (Table 2).

*Malvi:*Malvi is a draught breed found primarily in Malwa region of Madhya Pradesh. In Rajasthan, it is mainly distributed in Jhalawar and adjoining areas.The coat colour is grey, which is darker in males. The neck, shoulders, hump and quarters are almost black. Cows and bullocks become pure white as they advance in age. They have short, deep and compact body. Legs are short and strong. Dewlap is well developed. Head is short and broad with dished forehead. Muzzle is dark black and slightly upturned. Horns are strong, pointed and emerge from the outer angles of poll in an outward and upward direction.

Table 2 : Percentchange in the population of major breeds of ruminant livestock species n Rajasthan state during 2007-2012

Breed[£]	2012[@]	2007[$]	Percent change during 2007-2012
Cattle			
Rathi	859890	924057	-6.94
Malvi	475599	789375	-39.75
Kankrej	451691	1195814	-62.23
Nagauri	369670	837334	-55.85
Tharparkar	132352	460201	-71.24
Gir	329035	506096	-34.99
Hariana	230582	574464	-59.86
Buffalo			
Murrah	1918065	4256986	-54.94
Surti	503209	951175	-47.10
Sheep			
Marwari	2461033	4211525	-41.56
Jaisalmeri	974080	1901516	-48.77
Magra	499652	313004	59.63
Chokal	251998	577093	-56.33
Malpura	245251	375336	-34.66
Sonadi	157694	114334	37.92
Pugal	99579	166751	-40.28
Nali	#	939666	-
Goat			
Marwari	5344346	7574466	-29.44
Sirohi	1793464	2904271	-38.25
Jakhrana	976106	1922732	-49.23
Jamnapari	157320	0	-
Barbari	124360	0	-

[$]Livestock census 2007, [@]Livestock census 2012 and breed survey (2015) which is derived by disintegrating the figures of livestock census (2012), [£]Population of minor breeds, not native of Rajasthan like Deoni, Red Kandhari, Sahiwal cattle, Bhadawari and Jaffarabadi buffaloes, Bonpala sheep, Aattapadi goats not shown in the table.

Table3: Total population and population density of bovine species in different districts of Rajasthan (Livestock census 2019)

District	Area (Sq. km)	Cattle						Buffalo	
		Exotic		Indigenous		Total			
		Population	Cattle per sq km	Population (% of total cattle in district)	Cattle per sq km	Population	Cattle per sq km	Population	Buffalo per sq km
Ajmer	8481	80571	9.50	304086(79.05)	35.85	384657	45.36	520779	61.41
Alwar	8380	100662	12.01	141194 (58.38)	16.85	241856	28.86	1144753	136.61
Banswara	4522	26666	5.90	630723 (95.94)	139.48	657389	145.38	361245	79.89
Baran	6992	2822	0.40	295281 (99.05)	42.23	298103	42.63	266017	38.05
Barmer	28387	1560	0.05	903639 (99.83)	31.83	905199	31.89	222727	7.85
Bharatpur	5066	75831	14.97	129570 (63.08)	25.58	205401	40.55	760323	150.08
Bhilwara	10455	140020	13.39	565403 (80.15)	54.08	705423	67.47	477272	45.65
Bikaner	30239	130177	4.30	1064552 (89.10)	35.20	1194729	39.51	208251	6.89
Bundi	5776	19255	3.33	174254 (90.05)	30.17	193509	33.50	325032	56.27
Chittorgarh	7822	34398	4.40	344628 (90.92)	44.06	379026	48.46	473245	60.50
Churu	13835	60461	4.37	378122 (86.21)	27.33	438583	31.70	277343	20.05
Dausa	3432	50514	14.72	101011 (66.66)	29.43	151525	44.15	526460	153.40
Dholpur	3033	20376	6.72	48381 (70.37)	15.95	68757	22.67	371410	122.46
Dungarpur	3770	6668	1.77	424733 (98.45)	112.66	431401	114.43	329357	87.36
S.ganganagar	10978	187353	17.07	449349 (70.57)	40.93	636702	58.00	200125	18.23
Hanumangarh	9656	149963	15.53	394301 (72.45)	40.83	544264	56.37	302203	31.30
Jaipur	11143	375902	33.73	315555 (45.64)	28.32	691457	62.05	1214213	108.97
Jaisalmer	38401	18154	0.47	388894 (95.54)	10.13	407048	10.60	4638	0.12
Jalore	10640	8908	0.84	290351 (97.02)	27.29	299259	28.13	587826	55.25
Jhalawar	6219	8739	1.41	242084 (96.52)	38.93	250823	40.33	344217	55.35
Jhunjhunu	5928	195556	32.99	73540 (27.33)	12.41	269096	45.39	347110	58.55
Jodhpur	22850	88388	3.87	980639 (91.73)	42.92	1069027	46.78	317852	13.91
Karauli	5524	10754	1.95	62401 (85.30)	11.30	73155	13.24	518622	93.89
Kota	5217	8151	1.56	208192 (96.23)	39.91	216344	41.47	240628	46.12
Nagaur	17718	91620	5.17	482371 (84.04)	27.22	573991	32.40	545342	30.78
Pali	12387	16430	1.33	344441 (95.45)	27.81	360871	29.13	329807	26.63
Pratapgarh	4449	22816	5.13	352986 (93.93)	79.34	375802	84.47	206072	46.32
Rajsamand	4655	36271	7.79	208460 (85.18)	44.78	244731	52.57	234272	50.33
S.Madhopur	4498	6057	1.35	71570 (92.20)	15.91	77627	17.26	301792	67.09
Sikar	7732	247834	32.05	135707 (35.38)	17.55	383541	49.60	488798	63.22
Sirohi	5136	10862	2.11	194241 (94.70)	37.82	205103	39.93	211005	41.08
Tonk	7194	9083	1.26	162653 (94.71)	22.61	171736	23.87	437452	60.81
Udaipur	11724	80211	6.84	751285 (90.35)	64.08	831496	70.92	597128	50.93
Total	**342239**	**2323033**	**6.79**	**11614597(83.33)**	**33.94**	**13937630**	**40.72**	**13693316**	**40.01**

Table 4: Total population and population density of small ruminants in different districts of Rajasthan (Livestock census 2019)

District	Sheep						Goat	
	Exotic		Indigenous		Total			
	Population	Sheep per sq km	Population	Sheep per sq km	Population	Sheep per sq km	Population	Goats per sq km
Ajmer	1	0.0001	363892 (100.00)	42.91	363893	42.91	739132	87.15
Alwar	1123	0.13	59309 (98.14)	7.08	60432	7.21	403117	48.10
Banswara	121	0.03	7837 (98.48)	1.73	7958	1.76	720497	159.33
Baran	35	0.01	11357 (99.69)	1.62	11392	1.63	184809	26.43
Barmer	221	0.01	1013198 (99.98)	35.69	1013419	35.70	2946662	103.80
Bharatpur	1881	0.37	74812 (97.55)	14.77	76693	15.14	168158	33.19
Bhilwara	1124	0.11	358777 (99.69)	34.32	359901	34.42	829826	79.37
Bikaner	1347	0.04	660789 (99.80)	21.85	662136	21.90	626769	20.73
Bundi	305	0.05	55664 (99.46)	9.64	55969	9.69	306938	53.14
Chittorgarh	140	0.02	26591 (99.48)	3.40	26731	3.42	488760	62.49
Churu	948	0.07	280809 (99.66)	20.30	281757	20.37	594230	42.95
Dausa	3256	0.95	56541 (94.55)	16.47	59797	17.42	311068	90.64
Dholpur	48	0.02	13782 (99.65)	4.54	13830	4.56	100811	33.24
Dungarpur	168	0.04	65615 (99.74)	17.40	65783	17.45	803899	213.24
Sriganganagar	1244	0.11	232673 (99.47)	21.19	233917	21.31	303487	27.65
Hanumangarh	858	0.09	169163 (99.50)	17.52	170021	17.61	180537	18.70
Jaipur	4043	0.36	249663 (98.41)	22.41	253706	22.77	787220	70.65
Jaisalmer	1345	0.04	835647 (99.84)	21.76	836992	21.80	1104272	28.76
Jalore	2610	0.25	413848 (99.37)	38.90	416458	39.14	352280	33.11
Jhalawar	18	0.003	10155 (99.82)	1.63	10173	1.64	285594	45.92
Jhunjhunu	15140	2.55	137850 (90.10)	23.25	152990	25.81	442134	74.58
Jodhpur	931	0.04	618537 (99.85)	27.07	619468	27.11	1640570	71.80
Karauli	1076	0.19	81849 (98.70)	14.82	82925	15.01	340529	61.65
Kota	0	0.00	22434 (100.00)	4.30	22434	4.30	137387	26.33
Nagaur	3327	0.19	443340 (99.26)	25.02	446667	25.21	1195815	67.49
Pali	228	0.02	764559 (99.97)	61.72	764787	61.74	682447	55.09
Pratapgarh	6	0.001	23087 (99.97)	5.19	23093	5.19	417383	93.82
Rajsamand	17	0.004	68330 (99.98)	14.68	68347	14.68	537215	115.41
SwaiMadhopur	399	0.09	109612 (99.64)	24.37	110011	24.46	256260	56.97
Sikar	5678	0.73	169776 (96.76)	21.96	175454	22.69	920453	119.04
Sirohi	5	0.001	154460 (100.00)	30.07	154465	30.07	352535	68.64
Tonk	356	0.05	218821 (99.84)	30.42	219177	30.47	319250	44.38
Udaipur	307	0.03	82774 (99.63)	7.06	83081	7.09	1360159	116.01
Total	**48306**	**0.14**	**7855551**(99.39)	**22.95**	**7903857**	**23.09**	**20840203**	**60.89**

Table 5: : Districts with maximum population and density of major ruminant livestock species in Rajasthan (Livestock census 2019)

Species	Total population	Animals per square kilometers
Indigenous cattle	Bikaner (1064552, 9.17), Jodhpur (980639, 8.44), Barmer (903639, 7.78), Udaipur (751285, 6.47), Banswara (630723, 5.43)	Banswara (139.48), Dungarpur (112.66), Pratapgarh (79.34), Udaipur (64.08), Bhilwara (54.08)
Exotic and crossbred cattle	Jaipur (375902, 16.18), Sikar (247834, 10.67), Jhunjhunu (195556, 8.42), Sriganganagar (187353, 8.07), Hanumangarh (149963, 6.46)	Jaipur (33.73), Jhunjhunu (32.99), SwaiMadhopur (32.05), Sriganganagar (17.07), Hanumangarh (15.53)
Total cattle	Bikaner (1194729*, 8.57#), Jodhpur (1069027, 7.67), Barmer (905199, 6.49), Udaipur (831496, 5.97), Bhilwara (705423, 5.06)	Banswara (145.38), Dungarpur (114.43), Pratapgarh (84.47), Udaipur (70.92), Bhilwara (67.47)
Buffalo	Jaipur (1214213, 8.87), Alwar (1144753, 8.36), Bharatpur (760323, 5.55), Udaipur (597128, 4.36), Jalore (587826, 4.29)	Dausa (153.40), Bharapur (150.08), Alwar (136.61), Dholpur (122.46), Jaipur (108.97)
Indigenous sheep	Barmer (1013198, 12.90), Jaisalmer (835647, 10.64), Pali (764559, 9.73), Bikaner (660789, 8.41), Jodhpur (618537, 7.87)	Pali (61.72), Ajmer (42.91), Jalore (38.90), Barmer (35.69), Tonk (30.42)
Exotic and crossbred sheep	Jhunjhunu (15140, 31.34), Sikar (5678, 11.75), Jaipur (4043, 8.37), Nagaur (3327, 6.89), Dausa (3256, 6.74)	Jhunjhunu (2.55), Dausa (0.95), Sikar (0.73), Bharatpur (0.37), Jaipur (0.36)
Goat	Barmer (1013419, 12.82), Jaisalmer (836992, 10.69), Pali (764787, 9.68), Bikaner (662136, 8.38), Jodhpur (619468, 7.84)	Pali (61.74), Ajmer (42.19), Jalore (39.14), Barmer (35.70), Bhilwara (34.42)
	Barmer (2946662, 14.14), Jodhpur (1640570, 7.87), Udaipur (1360159, 6.53), Nagaur (1195815, 5.74), Jaisalmer (1104272, 5.30)	Dungarpur (213.34), Banswara (159.33), Sikar (119.04), Udaipur (116.01), Rajsamand (115.41)

Values in parenthesis are *total population, # percent of the total population of the state under respective row heading

Tail switch is black. The HW, BLandCG is 140, 150 and 200 cm in males and 130, 140 and 170 cm in females. The AFC, LMY, LL, CI and DP is 1432 (1175-2009) days, 1074 (627-1227) kg, 306 (275-320) days, 419 (411-530) days and 180 (125-265) days, respectively (Nivsarkar*et al*. 2000). As per Breed survey (2015) estimates the population of Malvi cattle in Rajasthan is 0.476 million which is 4.1 and 3.57 percent of the indigenous and total cattle population of the state. It is 41.06 percent of the total population of Malvi cattle in India. Another 0.195 millioncattle have been listed as grades of Malvi cattle. Pure Malvi cattle population registered a decline of 39.75 percent in the state during 2007-2012 (Table 2).

Kankrej: Although, the main breeding tract of Kankrej cattle lies in Gujarat state, in Rajasthan it is mainly distributed in the Barmer and Jodhpur districts. The coat colour of these animals varies from silver grey to iron grey or steel-black. In males and a few females, forequarters, hind quarters and hump are slightly darker than rest of the body. Forehead is broad and slightly dished in the center. Face is short and muzzle is slightly upturned. Ears are large, pendulous and open, which is characteristic for this breed. Horns are thick, strong, curved and lyre shaped. They are covered with skin to a longer distance. Dewlap is thin and pendulous. Temperament is furious. Nivsarker*et al*. (2000) has reported the HW, BLandCG, to be 158, 148 and 194 cm in males and 133.6, 113.6 and 166.2 in females. Pundir*et al*. (2011) reported the HW, BLandCG to be 124.495.64, 123.447.46 and 162.5611.29, cm, respectively. Pundir*et al*. (2007) had reported the daily milk yield (DMY), LMY, LL, AFC and CI in the range of 2-5 kg, 800-1400 kg, 240-320 days, 3.75-5.00 years, 365-750 days, respectively. A pair of Kankrej bullocks is reportedlyable to plough an area of 0.4-0.6 ha a day and pull a load of 1.5-1.8 tons for 20-22 km. As per Breed survey (2015) estimates the population of Kankrej cattle in Rajasthan is 0.452 million which is 3.9 and 3.39 percent of the indigenous and total cattle population of Rajasthan.

It is 23.22 percent of the total Kankrej population of India. Another 0.316 million cattle have been listed as grades of Kankrej cattle. Pure Kankrej cattle population registered a decline of 62.23 percent in the state during 2007-2012 (Table 2).

*Nagauri:*The Nagauri breed of cattle is primarily reared for draught quality of its bullocks. Its home tract lies in Nagaur district and a sizable population of the breed is also found in adjoining Jodhpur district and Nokha tehsil of Bikaner district.Nagauri animals are white or light grey in colour. In some cases head, face and shoulders are slightly greyish. Muzzle, hooves and horns are black. Skin is tight and black. Face is long and narrow. Ears are medium in size with pinkish inside. Horns are of medium size emerging from the outer angle of the poll in outward direction and carried upward with gentle curve to turn in at points. Poll is very small and absent in animals true to the breed. Body is long, deep and powerful with well-developed fore and hind quarters and straight back. Hump is well developed, black and straight. Dewlap is small, fine and buttoned up with the body. Cows have shallow and small udder. Bullocks are big and powerful. The HW, BLandHG ranges between 145 to 152, 140 to 150 and 191 to 203 cm in males and 118 to 132, 130 to 148 and 157 to 175 cm in females. Average AFC, LMY, LL and CI is 1440 (1287-1505) days, 603 (479-905) kg, 267 (237-299) days and 461 (423-549) days, respectively. The DP rages between 82 and 155 days (Nivsarkar*et al*. 2000).As per Breed survey (2015) estimates the population of Nagauri cattle in Rajasthan is 0.370 million which is 3.19 and 2.77 percent of the indigenous and total cattle population of Rajasthan. Another 0.134 million cattle have been listed as grades of Nagauri cattle. Pure Nagauri cattle population registered a decline of 55.85 percent in the state during 2007-2012 (Table 2).

*Tharparkar:*Animals with typical characteristics of this breed are found in Jodhpur, Barmer and Jaisalmer districts of Rajasthan besides Kutchch district of Gujarat state. Some animals are found in Suratgarh tehsil ofSriganganagardistrict. The coat colour is white or grey. Neck, hump and quarters are dark in bulls. Body is strongly built, medium sized, well proportionate and deep. Limbs are short, straight and strong with firm joints. Face is moderately long with comparatively long poll. Head is of medium size. Forehead is broad and flat or slightly convex above eyes. Horns are medium sized, set well apart curving gradually upward and outward in the plane of the poll. Tail switch is black which reaches up to fetlocks. The HW, BLandCG averaged 133, 142 and 184 cm in males and 130, 132 and 173 cm in females. Average AFC, LMY, LL, CI and DP is 1247 (1116-1596) days, 1749 (913-2147) kg, 286 (240-377) days, 431 (408-572) days and 138 (115—191) days, respectively (Bhat*et al*. 1981, Nivsarkar*et al*. 2000). Hussain*et al*. (2015) reported averages for first lactation traits*viz* -305 day MY, total MY, LL, averageMY per day of first lactation (FL), DP, SP, CIand average MY per day of first CI to be 1618.47 ± 49.39 (kg), 1822.65 ± 70.2 (kg), 321.47 ± 8.87 (days), 5.65 ± 0.16 (kg/day), 99.80 ± 10.62 (days), 151.13 ± 16.27 (days), 436.75 ± 16.18 (days), 4.59 ± 0.20 (kg/day). Mishra *et al*. (2018) reported the SP, gestation period, DP and CI to be 117.53± 23.29, 281.62± 3.61, 105.03 ± 20.37 and 399.97 ± 23.78 days, respectively. The population of Tharparkar cattle in Rajasthan is estimated to be 0.132 million which is 1.14 and 0.99 percent of the indigenous and total cattle population of Rajasthan. It is 67.08 percent of the total Tharparkar cattle population of India. Another 0.354 million cattle have been listed as grades of Tharparkar cattle. (Breed survey 2015). During 2007-2012 there is 71.24 percent reduction in the population of pure Tharparkar cattle in Rajasthan (Table 2).

*Nari:*Nari cattle are native to Sirohiand Pali districts of Rajasthan andSabarkantha andBanaskantha districts of adjoining Gujarat. They are mainly reared by Raika community.They are mediumin size with excellent ability of migration and thrive well on grazing and adaptation to open housing during all kinds of weather. Coat colour is whitein majority of cows and white, greyish-white and sometimes black in bulls. Horns arelong and spirally curved.Theaverage horn length is 51.68 cm, which is more than Kankrej. Forehead is broad and slightly concave in majority of cases. It is adual purpose breed used both for milk and draught purposes. Bullocks are excellent for draught work, both in plains and hilly forest areas. The animals are kept both under pastoral farming and extensive system. Herds are big in size ranging between 20-100 animals. The peak MY ranges between3 to 8 kg.The LMYbetween 1119-2223 kg.The average HW, BL and CG of these animals is 130.59±7.43, 129.22±6.29 and 175.16±2.18 cm in males and 120.87±3.84,119.3±4.89 and 153.0±7.41 cm in females. When compared with Kankrej breed of cattle, the body biometry*viz.* HW, BL, CG and paunch girth of Nari cattle are lower as compared to those ofKankrej. The population of Nari cattle is estimated to be approximately 0.055 million(Singh *et al*. 2016). The Nari cattle has been registered as new breed of Indian cattle in the year 2020.

*Sanchori:*It is another new cattle population identified in Rajasthan. The Sanchori cattle, having good milk production potential, are maintained by the farmers of Jalore district of Rajasthan. Sanchori cattle have compact body, deep belly. They are strong and active. The cows are generally white or grey and the bulls are white or dark grey to black. The orientation of horns is mostly outward,

upward, inward ending with pointing tip. The dewlap is mostly large. Udder shape is pendulous and teats are cylindrical in majority of the cows. The average HW, BL and CG is 138.57±1.31, 137.86±2.54 and 188.7±3.82 cm in males and 122.95±4.21, 129.3±8.04 and 167.03±9.28 cm in females.TheAFC, DMY,LL, CI, DP and SP ofSanchori cows are 39.5 (36–48) months, 9.08 (3.05-16.3) l, 10.16 (8–15) months, 14.4 (12–20) months, 4.3 (0.5–10) months and 5.44(2–11) months, respectively. The population of Sanchori cattle in the breeding tract was reported about 2000 only(Singh *et al*. 2015).

Besides the above described breeds, Gir and Hariana are also reared in Rajasthan. The home tract of Gir breed lies in Kathiawar in Gujarat. The population of Gir cattle in Rajasthan is estimated to be 0.329 million which is 2.84 and 2.47 percent of the indigenous and total cattle population of Rajasthan and 23.84 percent of the total Gircattle population of India. Another 0.444 million cattle have been listed as grades of Gir cattle. (Breed survey 2015). Pure Gir cattle of Rajasthan registered a decline of 34.99 percent in the state during 2007-2012 (Table 2).Similarly, although the main breeding tract of Hariana lies in Southern Haryana, in Rajasthan they are mainly distributed in Jodhpur, Alwar and Bharatpur districts (Nivsarkar et al. 2000). The population is estimated to be 0.231 million which is 1.99 and 1.73 percent of the indigenous and total cattle population of Rajasthan and 14.07 percent of the total population of Hariana cattle of India. Another 0.231 million cattle have been listed as grades of Hariana cattle. (Breed survey 2015). During 2007-2012 there is 59.86 percent reduction in the population of pure Hariana cattle in Rajasthan (Table 2).

Some reports have also described the presence of Mewati in Alwar and Bharatpur districts, Rath cattle in Alwar and Sahiwal in Sriganganagar districts (Bhat*et al*. 1981, Nivsarkar*et al*. 2000, Singh and Pundir 2007). Breed survey (2015) has also shown the presence of a few Deoni, Sahiwal and Red Kandhari(1143, 972 and 1272) cattle in Rajasthan.

Buffalo

The 13.693 million buffaloes in Rajasthanconstitute12.47 percent of total buffaloesof the country. It has shown increase of 23.45 and 5.53 percent during 2007-2019 and 2012-2019 (Table 1).Jaipur (1.214 million) possesses the maximum buffalo population of the state followed byAlwar(1.145million) andBharatpur (0.760million) districts.In terms of population density, Dausa has highest number of buffaloes per square km (153.40) followed by Bharapur (150.08), Alwar (136.61) districts (Livestock census 2019) (Table 3 and 5).Although, there are no buffalo breeds native to Rajasthan, Murrah and Surti breeds are reared in Rajasthan and 18.66percent buffalo population of Rajasthan belong to these two breeds. A very few animals are of Bhadawari and Jaffarabadi (966 and 969) breeds (Table 2)(Breed survey 2015). During 2007-2012 there is 53.47 percent reduction in the population of pure animals of indigenous breeds of buffaloes in Rajasthan. However, if pure and graded animals are taken together, there is 36.44 percent increase during this period (Table 1).

Murrah is considered best milch-cum-meat breed of buffaloes. Although, its home tract lies in southern Haryana it is reared in almost all parts of India including Rajasthan. The population of Murrah buffaloes in Rajasthan is estimated to be 1.918 million which is 14.78 percent of total buffalo population of Rajasthan. It is 16.41 percent of the total population of Murrah buffaloes of India. Another 4.530 million buffaloes have been listed as grades of Murrah buffaloes (Table 2) (Breed survey 2015).

Similarly, though the home tract of Surti buffaloes lies in South-Western part of Gujarat, they are also reared in Rajasthan. The population of Surti buffaloes in Rajasthan is estimated to be 0.503 million which is 3.88 percent of total buffalo population of Rajasthan and27.25 percent of the total population of Surti buffaloes of India. Another 0.389 million buffaloes have been listed as grades of Surti buffaloes. (Breed survey 2015). During 2007-2012 there is 47.10 percent reduction in the population of pure Surti buffaloes in Rajasthan (Table 2)

Sheep

The state of Rajasthan with7.904 million sheepholds 10.64 percent of the total sheep population of India. The sheep population in the state has dwindled by 29.37 and 12.95 percent during 2007-2019 and 2012-2019.The indigenous sheep population (7.856 million) has also decreasedby29.45 and 12.61 percent during these periods, respectively. During these periods, the exotic and crossbred sheep has decreased by 11.36and 46.95 percent. The indigenous sheep represents99.51 percent of the total sheep population of the states compared to 94.79 percent at the national level (Table 1) (Livestock census 2019).Barmer followed by Jaisalmer and Palidistricts has the highest populationof the total (1.013, 0.837 and 0.765 million) and indigenous (1.013, 0.836 and 0.765million) sheep. In Kota, Sirohi and Ajmerdistricts 100 percent sheep are of indigenous type. Even, inJhunjhunu district,which has the lowest percentage of indigenous sheep,90.1 percent sheep are of indigenous type. The population density was highest inPali followed by Ajmer and Jalorefor total (61.74), 42.19, 39.14) as well as indigenous (61.72, 42.91, 38.90) sheep per square km (Table 4 and 5). As per Breed survey (2015) 51.65 percent of the total sheep and 52.17 percent of the indigenous sheep of Rajasthan belong to the recognized breeds of

sheep compared to the national figure of 36.55 and 38.81 percent, respectively. During 2007-2012 there is 45.47 and 24.23 percent reduction in the total population of pure animals and combined pure and graded animals of indigenous sheep breeds in Rajasthan (Table 1).Rajasthan is home to many important sheep breeds of India. Their distribution, population status and characteristics are discussed below.

*Marwari:*Marwari breed is mainly distributed in Jodhpur, Jalore, Nagaur, Pali, Sirohi and Barmer districts of Rajasthan. Animals are medium in size. Average BW, HW, BL and CG are 40.69±5.54 kg, 74.50±3.28 cm, 74.42±4.61cm and 81.71±3.97 cm in rams and 30.11±4.39 kg, 67.23±3.29 cm, 67.33±3.14 cm and 74.25±4.23 cm in ewes, respectively. Face colour is black which may extend up to the lower part of neck. Ears are extremely small and tubular. Both the sexes are polled. Tail is thin and short to medium in length. Fleece is white and not very dense (Acharya and Bhatt, 1984, Singh *et al*. 2007). The population of Marwari sheep in Rajasthan is estimated to be 2.461 million which is 27.38 and 27.10 percent of the indigenous and total sheep population of Rajasthan. Anotherr0.857million sheep have been listed as grades of Marwari sheep (Breed survey 2015). Population of Marwari breed dwindled by 41.56 percent during 2007-2012 (Table 2)

*Jaisalmeri:*The Jaisalmeri breed is distributed in Jaisalmer district and in the adjoining areas of Jodhpur, Pali and Barmer districts. The animals of this breed are tall and well built. The average BW, HW, BL and CG, in that order, are54.15±5.80 kg, 76.20±4.47 cm, 76.64±7.73 cm and 94.71±5.2 cm in rams and 35.07±5.21 kg, 69.15±8.87 cm, 69.03±5.85cm and 83.73±8.20 cm in ewes. The face is black or dark brown which may extend up to neck. Nose is typically Roman. Ears are long and drooping with a cartilaginous appendage. Both the sexes are polled. The tail is medium to long. The fleece is white, not very dense and of medium carpet quality. Head is devoid of wool (Acharya and Bhatt, 1984, Gupta *et al*. 2007a).The population of Jaisalmeri sheep in Rajasthan is estimated to be 0.974 million, which is 10.84 and 10.73 percent of the indigenous and total sheep population of Rajasthan. Another 0.704 million sheep have been listed as grades of Jaisalmeri sheep (Breed survey 2015). The population of Jaisalmeri breed dwindled by 48.77 percent during 2007-2012 (Table 2).

Magra: Magra breed is distributed in Bikaner, Nagaur, Jaisalmer and Churu districts. The characteristic feature of this breed is white face with light brown patches around the eyes. Ears are tubular and small to medium in size. Both sexes are polled. Tail is thin and medium in length. The skincolour is pink. The fleece is white, lustrous and of medium carpet quality. The animals of Magra breed are medium to large sized. . The animals can walk long distances. The height at withers of adult male and female Magra animals ranges between 55-76 and 55-80 cm. The body length ranges between 54-76 (male) and 50-70 cm (female). The chest girth ranges between 66-90 (male) and 58-96 cm (female).The body weight ranges between 25-52 (male) and 19.5-43kg (female)(Acharya and Bhatt, 1984, Jain *et al*. 2018).The population of Magra sheep in Rajasthan is estimated to be 0.500 million which is 5.56 and 5.50 percent of the indigenous and total sheep population of Rajasthan. Another 0.026 million sheep have been listed as Magra grades. (Breed survey 2015). The population of pure Magra sheep increased by 59.63 percent in the state during 2007-2012(Table 2).

*Chokla:*Chokla sheep is mainly distributed in Churu, Sikar, and Nagaur districts. The animals are small to medium in size. The BW, HW, BL and CG, in that order, are 41.3±4.92 kg, 69.2±5.19 cm, 70.9±4.34 cm and 82.1±4.11 cm in rams and 30.7±4.18 kg, 63.1±3.54 cm, 63.1±3.70 cm and 74.9±3.70 cm in ewes (Acharya and Bhatt, 1984, Jain *et al*., 2005). The face is reddish brown which may extend up to the middle of the neck. The skin is pink. The ears are tubular and small in length. Both the sexes are polled. The tail is thin and of medium length. The coat is dense and relatively fine. The population of Chokla sheep is estimated to be 0.252 million which is 2.78 percent of total sheep population of the state. Another 0.105 million sheep have been listed as grades of Chokla sheep. (Breed survey 2015). The population of pure Chokla sheep dwindled by 56.33 percent in the state during 2007-2012 (Table 2).However, Jain *et al*., 2005 during their study on Chokla sheep, have observed that the population of Chokla sheep may be few thousands only.

*Malpura:*Malpura breed is mainly distributed in Jaipur, Tonk, Swaimadhopur, Ajmer, Bhilwara, Kota and Bundi districts. The animals are fairly well built with long legs. Average BW, HW, BL and CG, in that order, are49.14±7.09 kg, 76.44±4.25 cm, 73.8±4.25 cm and 86.17±7.09 cm in rams and 36.40±3.34 kg, 70.48±3.34 cm, 67.62±4.17 cm and 78.52±4.17 cm in ewes. The face is light brown. The ears are short and tubular with small cartilaginous appendage on the upper side. Both the sexes are polled. Tail is thin and medium to long in length. The fleece is white, extremely coarse and hairy. Face, belly and legs are devoid of wool (Acharya and Bhatt, 1984, Gupta *et al*. 2007b). The population of Malpura sheep in Rajasthan is estimated to be 0.245 million which is 2.70 percent of total sheep population in the state. Another 0.094 million sheep have been listed as grades of Malpura sheep. (Breed survey 2015). The population of Malpura sheep has dwindled by 34.66 percent in the state during 2007-2012 (Table 2).

*Sonadi:*This breed is mainly distributed in Udaipur, Dungarpur, Chittorgarh and Banswara districts. Sonadi animals are somewhat smaller than Malpura. Average BW, HW, BL and CG, in that order, are40.4±6.7 kg, 72.9±4.08 cm, 71.6±5.25 cm and 80.3±4.66 cm in rams and 28.5±3.92 kg, 66.3±3.92 cm, 64.3±3.92 cm and 73.9±3.92 cm in ewes (Acharya and Bhatt, 1984, Jain *et al*. 2006). Face colour is light brown, which may extends up to middle of the neck. Ears are large flat and drooping with cartilaginous appendage. Both the sexes are polled. Udder is fairly well developed. Tail is long and thin. The fleece is white, extremely coarse and hairy. Face, belly and legs are devoid of wool. The estimated population of Sonadi sheep (0.158 million) is 1.74 percent of the total sheep population in the state. Another 0.114 million sheep have been listed as grades of Sonadi sheep (Breed survey 2015). The population of pure Sonadi sheep in the state dwindled by 37.92 during 2007-2012 (Table 2).

*Pugal:*It is mainly found in Bikaner and Jaisalmer districts. Pugal animals have black face with small light brown stripes above the eyes. Lower jaw is typically light brown. The black colour of the face may extend to the neck. Ears are short and tubular. Both the sexes are polled. Tail is thin and short to medium in length. The fleece is white, dense and of medium carpet quality. The animals are fairly well built. Average BW, HW, BL and CG, in that order, are 31.79±5.63 kg, 64.88±4.11 cm, 68.62±4.74 cm and 77.49±5.28 cm in rams and 26.96±2.46 kg, 62.07±2.71 cm, 65.64±3.92 cm and 79.68±4.38 cm in ewes(Acharya and Bhatt, 1984).The estimated population of Pugal sheep in Rajasthan (0.100 million) is 1.10 percent of the total sheep population in the state. Another 0.042 million sheep have been listed as grades of Pugal sheep (Breed survey 2015). The population of pure Pugal sheep dwindled by 40.28 percent in the state during 2007-2012 there is reduction in (Table 2).

*Nali:*This breed is mainly distributed in Sriganganagar, Hanumangarh, Churu, Sikar and Jhunjhunu districts of Rajasthan. The animals are medium size in size. Average BW, HW, BL and CG, in that order, are38.85±9.06 kg, 69.16±4.99 cm, 68.95±5.54 cm and 80.03±6.02 in rams and 31.38±5.52 kg, 64.39±4.18 cm, 64.17±4.35 cm and 75.95±4.87 cm in ewes. The face colour is light brown. The skin colour is pink. The fleece is white, coarse, dense and long stapled. Face and legs are devoid of wool. Ears are medium and tubular. Both the sexes are polled. Tail is short to medium in length (Acharya and Bhatt, 1984, Singh *et al*. 2006). The population of Nali sheep in Rajasthan (0.940 million) was 8.40 percent of the total sheep population in the state (Livestock census, 2007).This breed is not listed in the Breed survey (2015).

*Chitrangi:*Chitrangi is a new population of sheep of Rajasthan described by Mishra *et al*. (2020). The breeding tract of the sheep population lies in Sriganganagar districts and adjoining areas of Rajasthan which extends to Fazilka, Muktsar districts of Punjab. It is also known as *Shamaki-wali* derived from Shamaki village of Ghadsana tehsil of Sriganganagar district. Chitarangi animals are medium to large in size. The coat colour and face is white with brown, chocolaty and black colour patches around eyes, muzzle and distal end of the ear pinna. Ears are large in size and leafy. The distal end of ear pinna is serrated in different shape and depth, a characteristic feature of the animals of this population. Both the sexes are polled, however, horns were observed in few males. Tail is medium in length and thin. (Mishra *et al*. 2020).

Besides above described breeds, Kherisheep is another breed of sheepfound in Rajasthan. Bhatia *et al*. (2005) have reported that this medium sized breed is found in Nagaur, Jodhpur and Tonk districts. They are medium to large sized animals and relatively heavier than Marwari sheep. The animals of this breed have black or brown face, which may extend up to neck. The ewes of the Kheri breed are comparatively good milk yielders. The population is not listed in the Livestock census (2007) or Breed survey (2015).

Goat

The goat population of Rajasthan(20.840 million) constitutes 14.00 percent of the total goat population of the country and has shown a decline of 3.08 and 3.81 percent during 2007-2019 and 2012-2019 (Table 1). The maximum goat population in the state is inBarmer (2.947 million) followed byJodhpur (1.641 million) and Udaipur (1.360million). In terms of population density, Dungarpur has highest number of goats per square km (213.34) followed byBanswara (159.33) and Sikar (119.04) districts (Livestock census 2019) (Table 4 and 5). During 2007-2012 there 32.30 and 4.77 percent reductionwas observed in the total population of pure animals and combined pure and graded animals of indigenous goat breeds in Rajasthan (Table 1).Rajasthan is home to many good breeds of goats like Marwari, Sirohi and Jakhrana.

*Marwari:*Marwai goats are mainly distributed in Jodhpur, Pali, Nagaur, Bikaner, Jalore, Jaisalmer and Barmer districts. Marwari goats are of medium size. Average BW, HW, BL and CG, in that order, are100.36±19.70 kg, 79.17±4.84cm, 75.03±5.19 cm and 78.11±5.81 cm in bucks and 80.92±5.98 kg, 71.25±1.71 cm, 68.63±2.14 cm and 73.63±2.14 cm in does. The coat colour is predominantly black with long shaggy hair coat. Ears are flat, medium in length and drooping. Horns are short, pointed, corkscrew type and directed upward and

backward in both the sexes (Acharya and Bhatt, 1984, Dixit *et al*. 2005). The estimated population of Marwari goats in Rajasthan (5.344 million) is 24.67 percent of total goat population in the state. Another 1.835 million goats have been listed as grades of Marwari goats (Breed survey 2015). The pure Marwari goats dwindled by 29.44 percent in the state during 2007-2012 (Table 2).

*Sirohi:*Sirohi goats are mainly distributed in Sirohi district. They are also found along the Aravali Hills in central and Southern Rajasthan (Verma*et al*. 2006). They are medium sized animals with compact body. The average BW, HW, BL and CG are 50.37±10.08 kg, 85.6±5.60 cm, 80.0±4.08 cm and 80.3±4.00 cm in bucks and 22.54±3.15 kg, 68.4±3.70 cm, 61.3±3.70 cm and 62.4±3.70 cm in does. Coat colour is predominantly brown with light brown or dark brown patches. Wattles are present in majority of the animals. Ears are flat, leafy, medium in size and drooping. Horns are small and curved upward and backward (Acharya and Bhatt, 1984). The estimated population of Sirohi goats in Rajasthan (1.793 million) is 8.28 percent of total goat population in the state. Another 1.192 million goats have been listed as grades of Sirohi goats. (Breed survey 2015). The population of pure Sirohi goats dwindled by 38.25 percent in the state during 2007-2012 (Table 2).

*Jhakhrana:*The core breeding tract of this breed is found in Jakhrana and few surrounding villages in Behror Tehsil of Alwar district. Animals are large. Average BW, HW, BL and CG are 55.0±8.03 kg, 87.85±4.67 cm, 82.07±5.40 cm and 86.01±5.26 cm in bucks and 36.98±6.20 kg, 77.42±4.19 cm, 73.66±5.89 cm and 76.58±4.83 cm in does. Coat colour is predominantly black with white spots on ears and muzzle. Forehead is narrow and slightly bulging. Ears are long, leafy and pendulous. Both males and females have thick, stumpy, short, greyish black and slightly curved horns (Acharya and Bhatt, 1984, Verma*et al*. 2005). The estimated population in this region of Jakhrana breed is about 7000 to 8000 (Verma*et al*. 2005). The overall estimated population of Jakhrana goats in Rajasthan (0.976 million) is 4.51 percent of total goat population in the state. Another 0.456 million goats have been listed as grades of Jakhrana goats (Breed survey 2015). The population of pure Jakhrana goats dwindled by 49.23 percent in the state during 2007-2012 (Table 2).

Besides the above three main breeds, some other indigenous goat breeds of India like Jamnapari and Barbari are also reared in the state of Rajasthan. The estimated population of Jamnapari goats in Rajasthan (0.157 million) constitutes0.73 percent of total goat population of Rajasthan and 9.84 percent of the total population of Jamnapari goats of India. Another 0.099 million goats have been listed as grades of Jamnapari goats. Similarly, the estimated population of Barbari goats in (0.124 million)constitutes 0.57 percent of total goat population in the state and 5.67 percent of the total population of Barbari goats of India. Another 0.043 million goats have been listed as grades of Jamnapari goats (Table 2) (Breed survey 2015).

Genetic characterization

Various studies on the indigenous breeds of ruminant livestock species of Rajasthan had tried to decipher the genetic relationship amongst these breeds. In a study, by Sodhi*et al*. (2011), on six indigenous cattle breeds from North-Western Region of India using 25 bovine specific microsatellite markers, inneighbor-joining (NJ) tree based on D_A distances,Kankrej, Mewati and Nagori breeds grouped together, while Tharparkar and Rathi breeds grouped in the other cluster. Correspondence analysis plotted Rathi, Tharparkar and Gir individuals into three separate areas of multivariate space; whereas, Kankrej, Mewati, and Nagori cattle showed low breed specific clustering. This reflected the existence of discrete genetic structure for Tharparkar, Rathi, and Gir, the prominent dairy breeds of the region; whereas, admixture was observed for Kankrej, Mewati, and Nagori animals.

In another study, by Arora *et al*. (2011), on seventeen sheep breeds of India using twenty-five microsatellite loci, in un-rooted NJ consensus tree constructed from D_A genetic distance, Kheri and Malpura clustered together then with the cluster containing Pugal, Nali, Magra and Jaisalmeri. Chokla, Sonari and Marwari clustered together and then with the above cluster. In principal component analysis based on covariance matrix also, Pugal, Nali, Magra and Jaisalmeriwere placed in a tight cluster. The Chokla, Sonadi and Marwari grouped into another closely placed cluster.

Similarly, genotyping of seven goat breeds of Indiausing seventeen microsatellite loci, that included the three goat breeds of Rajasthan, Marwari and Sirohi showed the least genetic distance. In un-rooted NJ tree also, Marwari and Sirohi clustered together then with Jakhrana which clustered with Jamnapari and Black-Bengal. Barbari clustered with Pashmina independently of above cluster (Rout *et al*. 2008). In another study, by Dixit *et al*. (2012), on twenty two Indian goat breeds using twenty-five microsatellite loci, in NJ consensus tree based on pair-wise $D_A$genetic distances, Marwari and Jakhrana clustered together along with Jamunapari, whereas, Sirohi clustered near to Kutchhi goats. In three dimensional scatter plot constructed based on three principal components derived on the basis of allele frequencies also corroborated the above results.

CONCLUSION

In conclusion, we can say that despite difficult agro-climatic conditions Rajasthan is home to some of the magnificent ruminant genetic resources of our country. However, during recent past the population of the most of these breeds of has shown a decline. As mentioned above, some of the drastic reduction in the population of pure animals of indigenous breeds of ruminant livestock species during 2007-2012 may probably be due to more stringent criteria applied to assigning an animal to a breed as the number of animals belonging to grades of these breeds during this period has shown a steep increase. But even the combined population of pure and graded indigenous animals of cattle, sheep and goats has shown a decline of 9.95, 24.23 and 4.77 percent during this period. Serious conservation efforts are required to arrest this decline.

REFERENCES

Acharya RM and Bhat PN. 1984. Livestock and poultry genetic resources of India. IVRI, Izatnagar Publication (Research bulletin no 1).

Arora R, Bhatia S, Mishra BP and Joshi BK. 2011. Population structure in Indian sheep ascertained using microsatelliteinformation. Animal Genetics 42:242-50.

Bhat PN, Bhat PP, Khan BU, Goswami OB and Singh B.1981. Animal Genetic Resources of India.NDRI Karnal Publication (Publication no. 192).

Bhatia S, Arora R and Ahlawat SPS.2005. Sheep Genetic Resources of India: Kheri – Pastoralists evolved sheep of Rajasthan. NBAGR, Karnal Publication (Monogram 17).

Breed survey. 2015. Estimated livestock populationbreed wise (Based on breed survey2013), Animal Husbandry Statistics Division, Department of Animal Husbandry ,Dairying and Fisheries, Ministry of Agriculture.

Dangi, Singh R, Pundir RK, Singh A, Chaudhary V and VermaNK.2013. Study of various performance traits in Rathi cattle. Indian Journal of Animal Research 47: 321-6.

Dixit SP, Verma NK, Aggarwal RAK, Kumar D, Sharma R and Ahlawat SPS. 2005. Goat Genetic Resources of India: Marwari – The pride of hot arid region of India. NBAGR, Karnal Publication (Monogram 14).

Dixit SP, Verma NK, Aggarwal RAK, Vyas MK, Rana J and Sharma A. 2012.Genetic diversity and relationship among Indian goat breeds based onmicrosatellite markers. Small Ruminant Research105: 38– 45

Gupta SC, Arora AL, Gupta N, Kumar D, Ahlawat SPS and Singh G. 2007a. Sheep Genetic Resources of India: Jaisalmeri – A hardy sheep breed. NBAGR, Karnal Publication (Monogram 47).

Gupta SC, Arora AL, Gupta N, Kumar D, Singh G and Ahlawat SPS. 2007b. Sheep Genetic Resources of India: Malpura – An excellent mutton breed. NBAGR, Karnal Publication (Monogram 48).

Hussain A, Gupta AK, Dash SK, Manoj M and Ahmad S. 2015. Effect of non-genetic factors on first lactation production and reproduction traits in Tharparkar cattle.Indian Journal of Animal Research 49:438-41.

Jain A, Arora R, Yadav DK, Singh V and Ranjan A. 2018. Sheep Genetic Resources of India: Magra sheep. NBAGR, Karnal Publication (Monogram 112).

Jain A, Singh G, Arora R and Bhatia S. 2006. Sheep Genetic Resources of India: Sonadi. NBAGR, Karnal Publication (Monogram 40).

Jain A, Singh G, Kumar D and Choudhary V. 2005. Sheep Genetic Resources of India: Chokla sheep. NBAGR, Karnal Publication (Monogram 24).

Livestock census. 2007. 18th Livestock census - 2007, Department of Animal Husbandry,Dairying and Fisheries, Ministry of Agriculture.

Livestock census. 2012. 19th Livestock census - 2012, Department of Animal Husbandry,Dairying and Fisheries, Ministry of Agriculture.

Livestock census. 2019. 20th Livestock census - 2019, Department of Animal Husbandry,Dairying and Fisheries, Ministry of Agriculture.

Mishra AK, JainA and SinghS.2020.Chitarangi sheep: A new carpet type ovine genetic resource ofnorth-western India.Indian Journal of Animal Sciences 90: 285–7.

Mishra G, Siddiqui MF, Ingle VS and Pal RS. 2018. Genetic analysis of reproductive Traits of Tharparker cattle at organized farms in Rajasthan. Indian Journal of Animal Research 52: 1129-33.

Nivsarkar AE, Vij PK and Tantia MS. 2000. Animal Genetic Resources of India : Cattle and Buffalo. DIPA-ICAR publication.

Pundir RK, PathakBLandAhalawat SPS.2007. Characterization and evaluation of Kankrej breed of cattle in its native tract. Indian Journal of Animal Sciences 77: 323-7.

Pundir RK, Singh PK, Singh KP andDangi PS. 2011. Factor Analysis of Biometric Traits of Kankrej Cows to Explain Body Conformation. Asian-Australasian Journal of Animal Sciences 24: 449-56.

Rout PK, Joshi MB, Mandal A, Laloe D, Singh Land Thangaraj K.2008. Microsatellite-based phylogeny of Indian domestic goats. BMC Genetics 9:11

Singh G, Jain A, Yadav DK, Sodhi M, Mukesh M and Bhatia S. 2006. Sheep Genetic Resources of India: Nali sheep. NBAGR, Karnal Publication (Monogram 30).

Singh G, Yadav DK, Jain A, Arora R, Bhatia S and Chander R. 2007. Sheep Genetic Resources of India: Marwari sheep. NBAGR, Karnal Publication (Monogram 43).

Singh P K and Pundir R K. 2007. Phenotypic characterization of Mewati breed of cattle in its native tract. Indian Veterinary Journal 84:1048-1051

Singh PK, Pundir RK and Sadana DK. 2015. Physical features and performance of unexplored Sanchori cattlepopulation of Rajasthan state. Indian Journal of Animal Sciences 85: 923-6.

Singh PK, Pundir R K, Sadana D K and Rathore HS. 2016. Physical features and management of migratory Nari cattle population of Rajasthan. Journal of Livestock Biodiversity 6: 19-24.

SodhiM, Mukesh M, Mishra BP, AhlawatSPS, Prakash B, Sobti RC. 2011. Microsatellite analysis of genetic population structure of zebu cattle (*Bos indicus*) breeds from North-Western region of India. Animal Biotechnology 22:16-29.

Verma NK, Dixit SP, Aggarwal RAK, Sharma R, Chander R, Kumar S and Ahlawat SPS. 2006. Goat Genetic Resources of India: Sirohi – a popular goat of arid and semi-arid region. NBAGR, Karnal Publication (Monogram 29).

Verma NK, Dixit SP, Kumar D, Aggarwal RAK, Sharma R and Ahlawat SPS. 2005. Goat Genetic Resources of India: Jakhrana – a high potential milch goat breed of semi-arid region of India. NBAGR, Karnal Publication (Monogram 12)