



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

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ABSTRACT

This article attempts to evaluate the present status and distribution of the ruminant genetic resources of Karnataka state *vis-a-vis* the exotic/crossbred and non-descript animals. The characteristics of the breeds of the ruminant species of the Karnataka state, including the new populations and breeds recently identified in the state like Dharwari and South Kanara buffaloes, Mouli and Yalga sheep and Nandidurga and Bidri goats, are also discussed. The total population of ruminant livestock, comprising cattle, buffalo, sheep and goat in Karnataka is 28.673 million. The density of 149.50 ruminants per km² in this state is only marginally less than the national average of 160.15. However, the density of sheep at 57.62 per km² is two and a half times than the national figure of 22.59. During 20012-2019, the total cattle and buffalo population have registered a decline of 11.01 and 14.00%, whereas, the sheep and goat population has shown an increase of 15.31 and 28.31%. During 2007-2012, periods for which the breed-wise data is available, the population of pure indigenous cattle, buffalo, sheep and goat have dwindled by 37.71, 32.93, 27.86 and 69.00%, compared to only -9.39, -19.79, 0.26 and -22.05% change in the total population of these species, respectively. Serious conservation efforts are required to arrest this decline in the ruminant genetic resources of the state of Karnataka.

Keywords: Characteristics, Distribution, Karnataka, Ruminant-genetic-resources, Status

The four ruminant livestock species, viz. cattle, buffalo, sheep and goat, with a population of 28.674 million, constitute major proportion (98.83%) of the total livestock population (29.013 million) of the state of Karnataka (Livestock census 2019). It indicates the importance of these livestock species in the livelihood of the farmers. Karnataka is proud owner of the many important breeds of these four ruminant livestock species. This article attempts to evaluate the present status, trend, distribution of the ruminant genetic resources of the state *vis-a-vis* the exotic/crossbred and non-descript animals. The characteristics of the breeds of the ruminant species of the Karnataka state are also summarized, including the new populations and breeds identified in the state of Karnataka like Dharwari and South Kanara buffaloes, Mouli and Yalga sheep and Nandidurga and Bidri goats.

Status and district-wise distribution of ruminant genetic resources of Karnataka

Karnataka is situated in the Southern Peninsular region between 11°30' and 18°30' N latitude and 74° and 78°30' E longitude. With an area of 0.192 million km², Karnataka

is the seventh largest state of India covering about 5.83% of the total area of the country. The coastal region of the state in the West receives the heaviest rainfall with an average of about 360 cm per annum, which is far in excess to about 70 and 125 cm in the North and South interior Karnataka. With 28.674 million ruminants, Karnataka holds about 5.45% of the total population of our country for these four species. The density of ruminants at 149.50 per km² is comparable to the national average of 160.15. The overall population status, the district wise distribution of population and attributes of breeds available in the state of the four ruminant livestock species of cattle, buffalo, sheep and goat are discussed in the following discussion.

Cattle

Karnataka holds 12th and 13th largest population of indigenous and total cattle of our country. The total cattle population (8.469 million) in the state has shown a decrease of 11.01% during 2012-19 compared to 30.94 experienced by the indigenous cattle. If we take these figures between 2007-19, the comparative decrease in total and indigenous cattle is 19.36 and 45.11%, respectively. However, during this period (2007-19), the exotic cattle have shown an increase of 78.21 (Table 1, Fig 1). Although, only 53.83% of the cattle population of Karnataka is of the indigenous type compared to 73.45 % at the national level (Livestock census 2019). However, as per Breed Survey (2013)

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Table 1. Total population and % change in the population of different ruminant livestock species during 2007-2012, 2012-2019 and 2007-2019 in the state of Karnataka

Species	Population			% change		
	2007 ^s	2012 [@]	2019 [£]	2007-2012	2012-2019	2007-2019
<i>Cattle</i>						
Pure	3900858	2429877	#	-37.71	-	-
Non-descript and grades	4408620	4174090	#	-5.32	-	-
Total Indigenous	8309478	6603967	4560842	-20.52	-30.94	-45.11
Exotic and cross-bred	2193042	2912517	3908162	32.81	34.19	78.21
Total cattle	10502520	9516484	8469004	-9.39	-11.01	-19.36
<i>Buffalo</i>						
Pure	483523	324291	#	-32.93	-	-
Non-descript and grades	3843457	3146214	#	-18.14	-	-
Total buffalo	4326980	3470505	2984560	-19.79	-14.00	-31.02
<i>Sheep</i>						
Pure	4626248	3337459	#	-27.86	-	-
Non-descript and grades	4913851	6206022	#	26.30	-	-
Total Indigenous	9540099	9543481	10950465	0.04	14.74	14.78
Exotic and cross-bred	18335	40280	100263	119.69	148.92	446.84
Total sheep	9558434	9583761	11050728	0.26	15.31	15.61
<i>Goat</i>						
Pure	920677	285407	#	-69.00	-	-
Non-descript and grades	5232291	4510740	#	-13.79	-	-
Total goats	6152968	4796147	6169392	-22.05	28.63	0.27
Total ruminant livestock	30540902	27366897	28673684	-10.39	4.78	-6.11

^sLivestock census (2007), [@]Livestock census (2012) and Breed survey (2013) which is derived by disintegrating the figures of livestock census (2012), [£]Livestock census (2019), #Figures not available.

estimates, which are derived by disintegrating the figures of Livestock census (2012), 25.53 and 36.79% of the total and indigenous cattle population of Karnataka belong to the recognized/defined breeds compared to the national figures of 9.35 and 11.81%, respectively. But there is substantial reduction of 37.14 in pure bred indigenous cattle between 2007-12, compared to only 20.52% reduction in indigenous cattle and 32.81% increase in exotic/crossbred cattle population. Thus, the drastic increase in the number of exotic/crossbred animals has occurred mainly at the expense of pure bred indigenous animals.

Shivamogga and Bengaluru-rural districts has the highest and lowest population (0.381 and 0.019 million), whereas, Yadagiri and Bengaluru-rural districts have the highest and lowest proportion (99.33 and 10.98%) of indigenous cattle, respectively. Belagavi district, with 0.550 million cattle, has the highest overall population of cattle. Shivamogga (44.90) and Kolar (6.0) have the highest and lowest number of indigenous and Ramanagara (81.77) and Kodagu (17.48) have the highest and lowest number of total cattle per km². On an average, the state has a density of 23.78 and 44.16 indigenous and total cattle per km². The districts of Shivamogga, Haveri and Uduppi in West-central Karnataka has the highest density of indigenous cattle (36.89) followed by the region comprising the districts of Bidar, Kalaburagi, Yadagiri and Raichur (33.22) in the North-Eastern Karnataka bordering Telangana (Table 3, Livestock

census 2019). Though, the region comprising six districts of Hasssan, Mysuru, Mandya, Ramanagara, Bengaluru-rural and Bengaluru-urban in Sothern Karnataka has the highest overall density (76.54) of cattle per km², however, this region adjoining Bengaluru city has the lowest density (21.52) and proportion (27.76%) of indigenous cattle. Karnataka is home to some of the best draught breeds of cattle of our country. Following discussion describes their distribution, characteristics and population status.

Hallikar: Hallikar is a typical Mysuru type breed of cattle found mainly in Mysuru, Mandya, Bengaluru,

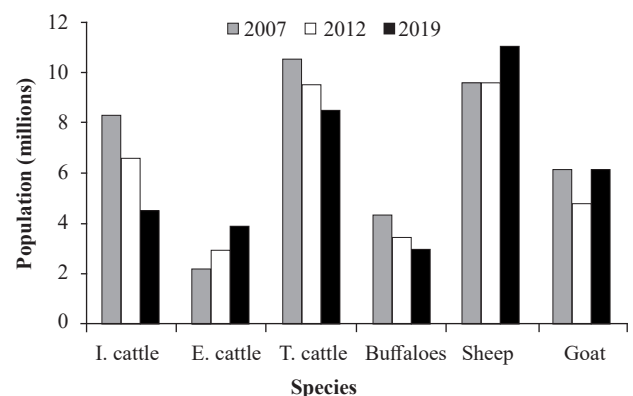


Fig. 1. Population of ruminant species during 2007, 2012 and 2019 in the state of Karnataka. (I, indigenous; E, exotic/crossbred; T, total).

Kolar, Tumakuru, Hassan and Chitradurga districts. It is one of the best draught breed of India, developed by Golla community and its sub-tribe, Hallikar. Most of the present day breeds of Southern Peninsular region of India have originated from the Hallikar. Animals are of medium size with long, slender and compact body. Coat colour is grey, dark-grey or sometimes white with slightly darker shoulders and hind quarters, especially in young breeding bulls. Muzzle is black, pinkish or admixture of the two. The tail reaches below the hocks ending in black switch. The hooves are greyish-black or light-brown. The interdigital space is short which helps the animals in draught activities. Horns are long and pinkish-brown, grey, black or admixture of these in colour. The horns emerge fairly close together from the top of the poll that grows in upward direction with a slight backward or outward curve near the base or in the middle. The ears are of horizontal orientation. The hump and dewlap are medium in size. The height at withers (HW), body length (BL) and chest girth (CG) are 134.55±10.04, 138.94±12.76 and 163.15±16.80 cm in males and 124.75±7.67, 130.17±10.35 and 148.45±8.12 cm in females, respectively (Singh *et al.* 2006a, Singh *et al.* 2008a). Average age at first calving (AFC), lactation milk yield (LMY), and lactation length (LL) are 1370 (915-1800) days, 540 (227-1134) kg and 285 (210-310) days, respectively. The calving interval (CI) is 598.9±27.36 days (Nivsarkar *et al.* 2000). The population of Hallikar cattle and its grades in the state is estimated to be 1.149 and 0.551

million, respectively, constituting about 12.07 and 5.79% of the total cattle population of the state (Breed survey 2013). The pure Hallikar cattle have registered a decline of 42.53% in the state during 2007-2012 (Table 2).

Malnad gidda: Malnad Gidda cattle inhabits hilly Malnad belt spread in Shivamogga, Chickmagluru, Uttara-Kannada, Dakshina-Kannada and Belagavi districts and also, in comparatively less number, in the coastal belt of Karnataka. The predominant coat colour is black. Animals of brown, red, fawn and white, sometimes mixture of any of these colours are also found. These animals are habituated to graze in hilly tracts. They are able to protect themselves from the wild animals due to their ability to run fast and jump over hurdles, if required. The head profile is straight in almost all the females and slightly concave in males. The ears are horizontal in orientation. The horns are small to medium in length, curved with vertical orientation and pointed tips. The hump is small in cows and prominent in bulls. The dewlap is small to medium. Malnad gidda cattle are smaller in size with compact bodies. The average HW, BL and CG of 91.0, 86.53 and 118.47 cm in adult males and 90.29, 87.04 and 118.36 cm in adult females, respectively. The AFC, LMY, LL, CI and dry period (DP) average 45.41 months, 569.13 kg, 8.38 months, 17.02 months and 7.17 months, respectively (Singh *et al.* 2008b). The population of Malnad gidda cattle and its grades in the state is estimated to be 0.898 and 0.147 million, respectively, constituting about 9.44 and 1.55% of the total cattle population of the

Table 2. Total population, their share in overall population of the species in the state and % change during 2007-2012, of registered breeds of ruminant livestock species in Karnataka

Breed	2007 ^s (Pure animals)	2012 [@]		% change in pure animals during 2007-2012
		Pure animals (% share in total population of the species)	Grades (% share in total population of the species)	
<i>Cattle</i>				
Hallikar	1999024	1148876 (12.07)	550559 (5.79)	-42.53
Malnad Gidda	1282121	897888 (9.44)	147448 (1.55)	-29.97
Khillar	452558	225207 (2.37)	495153 (5.20)	-50.24
Amritmahal	96021	105330 (1.11)	123617 (1.30)	9.69
Deoni	68820	49114 (0.52)	62080 (0.65)	-28.63
Krishna valley	2314	3462 (0.04)	10919 (0.11)	49.61
<i>Buffalo</i>				
Dharwari (estimated)	-	0.908 million [#] (30.44 [£])	-	-
Pandarpuri	11451	4731 (0.14)	12242 (0.35)	-58.68
<i>Sheep</i>				
Bellari	1754507	1337949 (13.96)	458844 (4.79)	-23.74
Deccani	1492139	809037 (8.44)	994464 (10.38)	-45.78
Hassan	645564	703012 (7.33)	157660 (1.65)	8.90
Mandya	295692	244468 (2.55)	229613 (2.40)	-17.32
Kenguri	438346	242993 (2.54)	432334 (4.51)	-44.57
<i>Goat</i>				
Nandidurga	635424	0.178 million [#] (2.89 [£])	-	71.99 [£]
Bidri	-	0.110 million [#] (1.78 [£])	-	-
Osmanabadi	208566	250085 (5.21)	206418 (4.30)	19.91

^sLivestock census (2007), [@]Livestock census (2012) and Breed survey (2013), [#]Estimated population (for Dharwari buffaloes in the four districts of Bagalkote, Belagavi, Dharwad and Gadag), [£]Derived from Livestock census 2019 - change during 2007-2019.

state (Breed Survey 2013). The pure Malnad gidda cattle have registered a decline of 29.97% during 2007-2012 (Table 2).

Khillar: This breed is found in Belagavi, Vijayapura and Dharwad districts of Karnataka and Kolhapur, Solapur, Sangali and Satara districts of Maharashtra. This breed is known for quick draught capabilities of its bullocks. Prominent coat colour is white but greyish-white and brick-dust colour is also noticed. Males are darker in fore and hind quarters. Barrel is cylindrical and long in comparison to height. Skin is tight. Forehead is long, narrow with a distinct groove in centre of forehead. Muzzle is black, carrot or mottled. Horns are long and pointed that grow first in backward and then curve upward direction. They are black, carrot or mottled in colour. Hump is firm, fleshy and moderate in size. Ears are small, pointed and always held sideways. Dewlap is thin, short and fold-less. There is slight rise in the level of back from neck to hook bones. Hooves are generally black or carrot. Khillar animals are well-developed and symmetrical. The HW, BL and CG are 136.59±12.88, 144.15±15.97 and 173.37±19.57 cm in working males, 141.76±14.99, 150.03±16.50 and 179.76±14.58 cm in breeding bulls and 126.57±9.25, 132.28±14.97 and 156.80±13.21 cm in milking females. Average AFC, LMY and LL are 1428 (1050-1930) days, 384 (240-515) kg and 228 (190-275) days, respectively. The calving interval (CI) is 450 days (Nivsarkar *et al.* 2000, Gokhale *et al.* 2009). The population of Khillar cattle and its grades in the state of Karnataka is estimated to be 0.225 and 0.495 million, constituting about 2.37 and 5.20%, respectively, of the total cattle population (Breed survey 2013). The Khillar cattle have registered a decline of 50.24% during 2007-2012 (Table 2).

Amritmahal: Amritmahal breed is found in Hassan, Chikmangluru and Chitradurga districts. It is a famous draught breed known for its power and endurance. Animals are fiery and active. Bullocks are well suited for trotting and quick transportation. Cows are white, bulls are rusty-white or dark. In some animals white or grey markings are present on face and dewlap. Muzzle and tail switch are black. The typical characteristics of this breed include long head that tapers towards muzzle, narrow and bulging forehead with a furrow in the middle and long horns that emerge fairly close together from the top of the poll growing in upward direction with a slight backward or outward curve. Ears are small and horizontal. Hump is well developed and is carried slightly forward. Dewlap is fine that does not extend very far. Skin is thin, smooth, tight and jet black. The HW, BL and HG average 150, 130 and 170 cm in males and 150, 130 and 150 cm in females. Average AFC, LMY, LL and CI are 1337.6±115.52 days, 572.0±24.0 kg, 299.0±10.0 days and 577.6±24.32 days, respectively (Nivsarkar *et al.* 2000). The population of Amritmahal cattle and its grades in the state is estimated to be 0.105 and 0.124 million, constituting about 1.11 and 1.30%, respectively, of the total cattle population (Breed survey 2013). The Amritmahal cattle have registered an

increase of 9.69% during 2007-2012 (Table 2).

Deoni: Deoni is medium sized, dual purpose indigenous breed found mainly in Latur district of Maharashtra and Bidar district of Karnataka. It is also distributed in small numbers in the neighbouring districts of Kalaburagi in Karnataka; Parbhani, Nanded and Osmanabad in Maharashtra; and Sangareddy district of Telangana. Deoni cattle has 3 colour strains, viz. *Wannera* having clear white with black colour at the sides of the face, *Shevera (Waghya)* having white body with irregular black spots and *Balankya* having clear white with black spots on the lower side of the body. This colour variation is observed in both the sexes. The forehead is prominent, broad, slightly bulged, invariably dished and white. Horns are usually short in length and emerge from the side of the polls growing in outward direction with a little upward orientation that curve near the distal ends to a small vertically tip. The dewlap is thick, pendulous and muscular with folds in majority of animals. Hump is massive and well developed in males but not so in females. Skin is thick and loosely attached with the body. The HW, BL and CG are 129.52±9.39, 128.04±9.94 and 165.99±16.25 cm in bullocks and 123.08±7.91, 121.78±8.78 and 159.31±12.37 cm in cows (Kuralkar *et al.* 2014). Singh *et al.* (2006b) have reported similar values for these parameters. Average AFC, LMY and LL are 1391 (894-1540) days, 940 (636-1230) kg and 299 (169-475) days, respectively. CI is 447 days (Nivsarkar *et al.* 2000). Kuralkar *et al.* (2014) have reported similar values for these production parameters. A pair of Deoni bulls can pull 10 to 11 q of load using wooden heavy cart with wooden wheels on mud track and 28 to 30 q using light steel cart with pneumatic wheels on metallated roads. They can plough 594 m² and harrow 1615 m² of land in one hour. The population of Deoni cattle and its grades in the state of Karnataka is estimated to be 0.049 and 0.062 million, constituting about 0.52 and 0.65%, respectively, of the total cattle population (Breed survey 2013). The Deoni cattle have registered a decline of 28.63% during 2007-2012 (Table 2).

Krishna-Valley: It is a heavy draught breed used in the black cotton soil of the Krishna river belt. It is mainly found in Belagavi, Vijayapur, Bagalkote and Raichur districts of Karnataka. The common colour is grey-white with a darker shade on fore-quarters in males. Brown-white or black-white mottled animals are also seen. The typical breed characteristics of Krishna-Valley cattle include black colour of muzzle, eyes, hooves and tail switch. Animals are large, having a massive frame with deep, loosely built body. Forehead has a distinct bulge surmounted by vertical horns that have moderately backward orientation at the base resulting in a curve. Dewlap is well developed and pendulous. Ears are small and pointed; breeders prefer them not to droop too much. Tail almost touches the ground. The average HW, BL and CG of these animals are 144.8, 153.4 and 195.8 cm in males and 121.9, 132.1 and 167.6 cm in females (Nivsarkar *et al.* 2000, Gokhale and Bhagat 2012). The population of Krishna-valley cattle and its grades in the state is estimated to be mere 3.4 and 11 thousand only

that too after an increase of 9.69% during 2007-2012 in the number of pure animals (Breed survey 2013). Krishna Valley cattle are now extinct from Maharashtra, where they were earlier reported to be present in the districts of Solapur, Sangli and Satara. To save the breed from extinction, Gokhale and Bhagat (2012) have proposed phenotypic purification of the mixed cattle population through genetic selection for conservation and improvement of this breed. Not only Krishna-Valley, as we have seen above, most of the cattle breeds, which used to be the pride of Karnataka, have suffered a decline in population and require similar efforts to arrest this decline.

Buffalo

The 2.985 million buffaloes in Karnataka constitute 2.72% of total buffaloes of the country. Karnataka holds the 11th largest population of buffaloes of our country. The

buffalo population of the state has shown a steady decrease of 19.79 and 14.00 % during 2007-2012 and 2012-2019 (Table 1, Fig 1). Belagavi (0.844 million) possesses the maximum buffalo population of the state followed by adjoining Bagalkote (0.234million) and Vijayapura (0.177million) districts. The Belagavi district also has the highest density of buffaloes (62.84) in the state followed by Bagalkote (35.77) and Bidar (23.04). The three districts of Belagavi, Bagalkote and Vijayapura, in North-Western region of the state hold the 42.07% (1.255 million) of the total buffalo population of the state with an overall density of 38.49 buffaloes per km². However, the density of buffaloes per km² (15.56) in the state is one third to that of cattle (44.16). The region comprising five Southern districts of Udupi, Dakshin Kannada, Kodagu, Mysuru and Chamarajanagar has sparse population of buffaloes with an overall density of only 1.50 buffaloes per km². Dakshin

Table 3. District wise population and density of bovine species in the state of Karnataka (Livestock census 2019)

District	Cattle						Buffalo	
	Indigenous		Exotic & crossbred		Total		Population	Density per km ²
	Population (% share in total cattle)	Density per km ²	Population	Density per km ²	Population	Density per km ²		
Bagalkote	158986 (71.35)	24.27	63837	9.74	222823	34.01	234340 ^b	35.77 ^b
Belagavi	305556 ^c (55.60)	22.75	243984 ^c	18.16	549540 ^a	40.91	844171 ^a	62.84 ^a
Bellari	229378 (80.85)	27.11	54321	6.42	283699	33.53	127407 ^c	15.06
Bengaluru-R*	18741 (10.98)	8.16	151981	66.14 ^a	170722	74.29 ^c	16924	7.36
Bengaluru-U*	18825 (12.24)	8.57	135036	61.49 ^b	153861	70.06	11168	5.09
Bidar	153479 (88.39 ^c)	28.17	20155	3.70	173634	31.87	125510	23.04 ^c
Chamarajanagar	79156 (31.34)	14.01	170205	30.14	249361	44.15	9918	1.76
Chikballapur	43395 (20.30)	10.23	170420	40.16	213815	50.38	26397	6.22
Chikmangaluru	177353 (61.15)	24.63	112654	15.64	290007	40.27	34362	4.77
Chitradurga	153250 (67.93)	18.17	72353	8.58	225603	26.74	113304	13.43
D.-Kannada*	66412 (26.50)	13.66	184157	37.88	250569	51.55	1832	0.38
Davangere	115686 (38.90)	19.53	181691	30.67	297377	50.20	123596	20.86 ^c
Dharwad	96825 (56.22)	22.73	75394	17.70	172219	40.43	61245	14.38
Gadag	79180 (58.09)	17.00	57131	12.27	136311	29.27	55798	11.98
Hassan	191940 (35.01)	28.17	356245 ^a	52.28 ^c	548185 ^b	80.45 ^b	107971	15.85
Haveri	160027 (61.30)	33.18 ^d	101033	20.95	261060	54.13	85501	17.73
Kodagu	31918 (44.53)	7.78	39766	9.69	71684	17.48	5236	1.28
Kalaburagi	371067 ^b (96.24 ^b)	33.88 ^c	14513	1.32	385580	35.20	73176	6.68
Kolar	23859 (11.38)	6.00	185783	46.69	209642	52.69	26520	6.66
Koppal	176481 (76.26)	31.68	54932	9.86	231413	41.55	63467	11.39
Mandya	76081 (20.56)	15.33	293905 ^c	59.23 ^c	369986	74.56 ^d	109443	22.06 ^d
Mysuru	175537 (35.63)	27.83	317061 ^b	50.27	492598 ^c	78.10 ^c	21682	3.44
Raichur	226830 (92.44 ^d)	26.87	18544	2.20	245374	29.07	112420	13.32
Ramanagara	80496 (28.00)	22.89	207006	58.88 ^d	287502	81.77 ^a	19644	5.59
Shivamogga	380640 ^a (73.39)	44.90 ^a	138013	16.28	518653 ^c	61.18	120563	14.22
Tumakuru	159783 (37.05)	15.08	271468 ^d	25.62	431251	40.70	142047 ^d	13.40
Udupi	116757 (45.83)	32.60 ^c	138019	38.53	254776	71.13	2408	0.67
U.-Kannada ^s	273797 ^d (81.41)	26.64	62515	6.08	336312	32.72	73993	7.20
Vijayapura	187645 (92.84 ^c)	17.87	14466	1.38	202111	19.25	177079 ^c	16.87
Yadagiri	231762 ^c (99.33 ^a)	43.98 ^b	1574	0.30	233336	44.28	57438	10.90
Total	4560842 (53.85)	23.78	3908162	20.38	8469004	44.16	2984560	15.56

*R, Rural; U, Urban; D, Dakshina; ^sU, Uttara. Superscripts ^{a, b, c, d} and ^e represent first, second, third, fourth and fifth highest value under the respective column heading.

Kannada has the lowest density (0.38) of buffaloes in the state (Table 3, Livestock census 2019). Thus, there is large difference in distribution of buffalo population in the state with Northern districts holding the major proportion compared to the Southern districts.

Earlier there were no registered buffalo breeds native to Karnataka, though, the state was home to some unique buffalo populations. Kathiravan *et al.* (2010) have characterized and documented the South-Kanara buffaloes inhabiting Dakshin-Kannada, Udupi and Shivamogga districts. Recently, Kulkarni *et al.* (2017) have described Dharwadi buffalo population that inhabits in 14 districts of central and Northern Karnataka, which was subsequently registered as the first breed of buffaloes from the state. Besides these two buffalo types, a small number of Pandharpuri buffaloes are reared in Belagavi district bordering Maharashtra. The following discussion describes the characteristics of the buffalo breeds and populations found in Karnataka.

Dharwari: Dharwari buffaloes are distributed in fourteen districts covering Northern and West-central Karnataka. The coat colour is black. Muzzle, tail switch and hooves are also generally black. Horns are usually black or grey in colour that emerge from outer edges of the poll, extending backward horizontally in a semi-circular orientation and may touch each other in the withers region with an average length of 46.34 ± 2.44 cm. The ears are horizontal. The mean HW, BL and CG are 130.56 ± 1.39 , 126.41 ± 1.75 and 179.55 ± 2.41 cm in males and 123.33 ± 1.39 , 118.20 ± 1.87 and 177.96 ± 1.83 cm in females. The AFC, LMY, LL and CI (Mean \pm SE) are 49.73 ± 0.15 months, 972.06 ± 9.16 kg, 336.06 ± 2.17 days and 17.45 ± 0.11 months, respectively. The Dharwari buffaloes constitute about 80.16% of the total buffaloes in the four districts of Belagavi, Bagalkote, Dharwar and Gadag, in which the survey was conducted (Kulkarni *et al.* 2017). The estimated population of Dharwari buffaloes is about 0.9 million in these four districts, extrapolated from total buffalo population in these districts as per Livestock census 2019 (Table 2).

South-Kanara: The South Kanara buffaloes are distributed in the districts of Dakshin-Kannada, Udupi and Shivamogga. These buffaloes are well built and medium sized animals. Head is fairly long with broad forehead. Horns are flat and corrugated that grow backward with an outward curve, then, in the neck region, turn upward. South-Kanara buffaloes are dual purpose animals used for milk production and agricultural operations in wet fields. The average HW, BL and CG are 119.00, 124.50 and 169.50 cm in males and 113.13, 112.81 and 154.23 cm in females, respectively. Average LMY and LL range between 420-2520 kg and 210-360 days, respectively. Average AFC and CI are 41.37 months and 543 days, respectively (Kathiravan *et al.* 2010). South-Kanara buffaloes are not registered as a breed yet.

Pandharpuri: Although, the main breeding tract of Pandharpuri buffaloes lies in Kolhapur, Solapur, Sangli and Satara districts of Maharashtra, they are also found in

the Belagavi district of Karnataka. Pandharpuri buffaloes are medium-sized with very long horns that extend beyond shoulder having an average length of 88.63 and 82.74 in adult females and males, respectively. The average HW, BL and CG are 141.74, 144.48, and 205.41 cm for breeding bulls and 129.81, 133.56, and 183.52 cm for milking buffaloes, respectively (Mishra *et al.* 2007). Average AFC, LMY, LL and CI are 1255 days, 1502 kg, 330 days and 465 days, respectively (Nivsarkar *et al.* 2000). The population of Pandharpuri buffaloes and its grades in Karnataka is estimated to be only about 4.7 and 12.2 thousand, respectively (Breed survey 2013).

Although, the number of graded buffaloes have increased about sixteen times with the concomitant decrease in non-descript buffaloes (-39.8%) during 2007-12. However, as per breed survey (2013), Surti and its grades constitute 7.55 and 24.25%, whereas Murrah and its grades constitute 1.66 and 9.39 % of the buffalo population of the Karnataka, pointing towards extensive use of these two non-native breeds in the cross breeding programmes. Although, exotic/crossbred cattle and large sized buffalo breeds like Murrah are better producers of milk, however, resource poor small and landless livestock keepers may not be able to sustain them. Since, a local breed of Dharwari buffaloes is available, it may be also employed for upgradation of non-descript animals.

Sheep

The state of Karnataka with 11.051 million sheep holds the 14.88% of the total sheep population of India. It has the 3rd largest population of sheep after Telangana and Andhra Pradesh. The sheep population of Karnataka, which has remained almost static during 2007-12, has shown an increase of 15.31% during 2012-19. Similar trend was observed for indigenous sheep, which with 10.950 million heads constitutes the major 99.09% of the total sheep population of the state. Although, the total population of exotic and cross-bred sheep is only about 0.100 million, during above periods, the exotic and crossbred sheep has increased by 119.69 and 148.92%, respectively (Table 1, Livestock census 2019).

Chitradurga (1.352 million) followed by Tumakuru and Bellari districts (1.290 and 1.006 million) hold the largest population of sheep. Chitradurga, Kalaburagi and Raichur districts has highest (99.98, 99.96 and 99.92%), whereas, Udupi district has the lowest (81.44%) proportion of indigenous sheep. In terms of population density, the state has 57.62 sheep per km². The density of sheep in Karnataka is about two and a half times the national figure of 22.59 sheep per km². Chitradurga followed by Chickballapur and Tumakuru districts has the highest density of sheep (160.28, 144.48, 121.73 per km²). Like buffaloes, the sheep population is also unevenly distributed in the state. The six districts of Koppal, Bellary, Chitradurga, Tumakuru, Chikballapur and Kolar in the central- and South-Eastern Karnataka bordering Andhra Pradesh hold 48.60% (5.370 million) of the total sheep population of the state with an

overall density of 129.87 sheep per km². In contrast, the districts of Uttara Kannada, Udupi, Shivamogga, Dakshin Kannada and Kadagu in central- and South-Western Karnataka has almost insignificant population of sheep (0.052 million) with an overall density of only 1.24 sheep per km² (Table 4, Livestock census 2019). As per Breed survey (2013) 34.97% of the indigenous sheep of Karnataka belong to the recognized breeds, which is comparable to the national figure of 38.81%. During 2007-2012, there was 27.86% reduction in the total population of pure animals of indigenous sheep breeds in Karnataka (Table 1).

Karnataka is home to many important sheep breeds of India like Bellari, Deccani, Hassan, Mandya, and Kenguri. Two new populations namely Mouli and Yalga were also identified and characterized during recent past. The distribution, characteristics and population status of sheep breeds of Karnataka are discussed below.

Bellary: As name suggests, Bellary breed is mainly

distributed in Bellari district south of Thungbhadra river. The animals are strongly built and medium to large in size with average BW, HW, BL and CG of 42.8±7.50 kg, 74.5±3.95 cm, 70.2±4.68 cm and 82.5±5.18 cm in rams and 31.8±5.33 kg, 68.9±3.16 cm, 65.6±3.40 cm and 76.1±4.13 cm in ewes, respectively. Body colour ranges from various combinations of black and white to complete black. About one third of the rams are horned. Ewes are generally polled. Ears are flat, medium to long and drooping. Tail is short and thin. The body is covered with coarse, hairy and open fleece. (Acharya and Bhatt 1984, Jain *et al.* 2005a). The population of Bellary sheep and its grades in the state is estimated to be 1.338 and 0.459 million, constituting about 13.96 and 4.79%, respectively, of the total sheep population of the state (Breed Survey 2013). The Bellary sheep have registered a decline of 23.74% during 2007-2012 (Table 2).

Deccani: Deccani sheep is distributed in wide area covering Maharashtra, Telangana, Karnataka and

Table 4. District wise population and density of small ruminants in the state of Karnataka (Livestock census 2019)

District	Sheep		Goat	
	Population (% share of indigenous sheep)	Density per km ²	Population	Density per km ²
Bagalkote	622856 (99.51)	95.06	383926	58.60 ^b
Belagavi	757679 ^d (99.58)	56.40	701741 ^a	52.24 ^d
Bellari	1005565 ^c (98.19)	118.85 ^c	253119	29.92
Bengaluru-R	118788 (97.17)	51.69	95156	41.41
Bengaluru-U	82873 (91.68)	37.74	62464	28.44
Bidar	85948 (99.91 ^c)	15.78	182854	33.56
Chamarajanagar	135321 (99.43)	23.96	144633	25.61
Chikballapur	613193 (97.34)	144.48 ^b	188392	44.39
Chikmangaluru	97962 (99.87)	13.60	41040	5.70
Chitradurga	1352087 ^a (99.98 ^a)	160.28 ^a	385058 ^c	45.64
D.-Kannada	289 (96.19)	0.06	32215	6.63
Davangere	505630 (99.85)	85.35	124542	21.02
Dharwad	79869 (99.53)	18.75	74069	17.39
Gadag	395899 (93.84)	85.01	191656	41.15
Hassan	199387 (99.91 ^d)	29.26	129058	18.94
Haveri	313205 (99.67)	64.94	144969	30.06
Kodagu	650 (85.85)	0.16	7603	1.85
Kalaburagi	112387 (99.96 ^b)	10.26	446200 ^c	40.73
Kolar	483892 (99.27)	121.61 ^d	93713	23.55
Koppal	625367 (99.69)	112.27	172578	30.98
Mandya	347133 (99.60)	69.96	346430	69.82 ^a
Mysuru	203463 (96.79)	32.26	208206	33.01
Raichur	657633 ^c (99.92 ^c)	77.90	282718	33.49
Ramanagara	127988 (98.90)	36.40	150130	42.70
Shivamogga	42526 (98.14)	5.02	59719	7.04
Tumakuru	1290008 ^b (99.79)	121.73 ^c	427926 ^d	40.38
Udupi	431 (81.44)	0.12	2676	0.75
U.-Kannada	8537 (99.53)	0.83	10655	1.04
Vijayapura	347070 (99.68)	33.06	569098 ^b	54.21 ^c
Yadagiri	437092 (99.85)	82.94	256848	48.74 ^c
Total	11050728 (99.09)	57.62	6169392	32.17

R-rural, U-Urban, D-Dakshina, U-Uttara. Superscripts ^{a, b, c, d and e} represent first, second, third, fourth and fifth highest value under the respective column heading.

Andhra Pradesh. In Karnataka, it is mainly distributed in Kalaburagi, Yadagiri, Koppal, Vijayapura, Raichur and Bagalkote districts (Acharya 1982). It is a medium sized breed. The average BW, HW, BL and CG, in that order, are 38.48±7.27 kg, 67.44±4.87 cm, 47.88±4.73 cm and 77.96±5.96 cm in rams and 28.58±3.60 kg, 63.79±2.94 cm, 65.21±3.27 cm and 70.75±3.27 cm in ewes. The predominant colour is black or black with white markings. White and brown/fawn animals are also seen. Rams are horned but ewes are polled. Occasionally ewes carrying stubs are also seen. Face is narrow with Roman nose. Ears are medium to long, flat and drooping. This breed has a thin neck, narrow chest, prominent spinal process, raised withers and dropping croup. Tail is short and thin. Fleece is extremely coarse, hairy and open. Belly and legs are devoid of wool. (Acharya and Bhatt 1984, Bhat *et al.* 1981). The population of Deccani sheep and its grades in the state is estimated to be 0.809 and 0.994 million, constituting about 8.44 and 10.38%, respectively, of the total sheep population (Breed Survey 2013). Deccani sheep have registered a decline of 45.78% during 2007-2012 (Table 2).

Hassan: Hassan breed is distributed in Hassan district. The animals are small to medium sized. The average BW, HW, BL and CG, in that order, are 32.8±6.25 kg, 64.4±4.52 cm, 64.3±4.75 cm and 75.3±5.27 cm in rams and 28.3±3.00 kg, 60.8±3.37 cm, 62.0±4.99 cm and 72.0±5.28 cm in ewes. The coat colour is white or white with light brown or black spots on the body. Ears are drooping and medium to long. About one third of the males are horned. Ewes are usually polled. Tail is short and thin. Fleece is white, extremely coarse and open. Belly and legs are devoid of wool. (Acharya and Bhatt 1984, Jain *et al.* 2006). The population of Hassan sheep and its grades in the state are estimated to be 0.703 and 0.158 million, constituting about 7.34 and 1.65%, respectively, of the total sheep population (Breed survey 2013). The Hassan sheep have registered an increase of 8.90 % during 2007-2012 (Table 2).

Mandya: This breed is distributed in Mandya district and bordering areas of Mysuru and Bangaluru-rural districts. It is a small sized breed. The average BW, HW, BL and CG, in that order, are 36.8±8.08 kg, 62.3±4.41 cm, 68.3±3.75 cm and 79.2±5.36 cm in rams and 26.7±4.44 kg, 54.6±4.40 cm, 60.6±3.74 cm and 69.6±5.05 cm in ewes. The coat colour is white. Some animals have brown face and colour may extend up to the neck. Almost all animals have wattles. Neck is stout and strong. Nose line is slightly Roman. Both sexes are polled. Ears are long, leafy and drooping. Tail is short and thin. Coat is extremely coarse and hairy. The Mandya sheep reared in Malvalli taluka of Mandya district, known as Bandur strain, are valued for the meat quality (Acharya and Bhatt 1984, Jain *et al.* 2005b). The population of Mandya sheep and its grades in the state is estimated to be 0.244 and 0.230 million, constituting about 2.55 and 2.40%, respectively, of the total sheep population (Breed survey 2013). The population of pure Mandya sheep dwindled by 17.32 % in the state during 2007-2012 (Table 2).

Kenguri: Kenguri, also known as Tenguri breed is distributed in Koppal and Raichur districts. It is a large sized breed. Average BW, HW, BL and CG are 52.6±7.79 kg, 81.5±3.89 cm, 74.7±4.07 cm and 89.4±4.89 cm in rams and 35.9±4.90 kg, 72.6±2.86 cm, 67.3±3.07 cm and 78.4±4.09 cm in ewes. Body colour is mostly dark brown, but colours ranging from white to black with spots of different shades are also observed. Ears are long and drooping. Males are usually horned and females polled. Tail is short and thin. (Acharya and Bhatt 1984, Jain *et al.* 2005c). The population of Kenguri sheep and its grades in the state are estimated to be 0.243 and 0.432 million, constituting about 2.54 and 4.51%, respectively, of the total sheep population (Breed survey 2013). The population of Kenguri sheep has dwindled by 44.57% in the state during 2007-2012 (Table 2).

Mouli: Mouli is a new population of sheep inhabiting Vijayapur district of Karnataka that was identified and described recently (Jain *et al.* 2017a). Mouli is a large sized sheep with wide phenotypic variation. Animals are tall with deep body and long legs. The BW, HW, BL and CG average 58.6, 88.4, 85.4, and 89.7 cm for males and 41.4, 79.3, 77.0 and 81.3 cm for females, respectively. Coat colour is white that can have light to dark brown spots or patches of varying sizes and shape. A brown ring around the eyes is present on all animals. Muzzle is pink or light brown. Nose-line is typical roman. All ewes and most of the rams are polled. Ears are long and drooping. Some animals have wattles. Tail is short and thin.

Yalga: Yalga is another new population sheep, inhabiting Bagalkote district of Karnataka, that was identified and described recently (Jain *et al.* 2017b). Yalga sheep are medium to large sized. The coat colour is white made up of thick small hair. A hair tuft is observed in the brisket region. Face is white, that may have black or brown patches of varying sizes, or completely black. The colour pattern of the face may extend up to the neck. A black ring around the eyes is common. Forehead and nose-line are straight and considered to be the characteristic of the Yalga sheep. Wattles are present in all animals. Males are mostly horned and females are polled. Ears are medium to long and drooping. Tail is short and thin. Yalga ewes have well developed udder. Average BW, HW, BL and CG, in that order, range between 28-77 kg, 68-93 cm, 66-95 cm and 71-105 cm in rams and 22-49 kg, 64-83 cm, 60-80 cm and 64-89 cm in ewes. Both Mouli and Yalga sheep are yet to be registered as breeds. Though, population status of Mouli and Yalga sheep is not known, most of the registered breeds, as we have seen in above discussion, have registered a decline during 2007-2012, which needs to be arrested.

Goat

Karnataka with 6.169 million goats holds 4.14% of the total goat population of the country. It has the 10th largest goat population among Indian states. Although, the goat population of the state has shown a decrease of -22.05% during 2007-12, it has shown an increase of 28.63%

during 20012-2019 (Table 1, Fig 1). The maximum goat population in the state is in Belagavi (0.702 million) district followed by Vijayapura (0.569 million) and Kalaburagi (0.446 million). The state has 32.2 goats per km² with Mandya district having the highest density of 69.82 goats per km² followed by Bagalkote (58.60) and Vijayapura (54.21). Udupi district has the lowest density (0.75) of goats. The region comprising five northern districts of Kalburagi, Yadagir, Vijayapur, Bagalkote and Belagavi, holds the 38.22% (2.357 million) of the total goat population of the state with an overall density of 50.90 goats per km². Whereas, the region comprising the districts of Uttara Kannada, Udupi, Shivamogga, Dakshin Kannada and Kadagu in central- and South-Western coastal Karnataka has very small population (0.113 million) of goats with an overall density of 3.46 goats per km². As we have seen in above discussion, these districts also have sparse population of sheep (Table 4, Livestock census 2019). During 2007-2012, 69.0 % reduction was observed in the total population of pure animals of indigenous goat breeds in Karnataka compared to 22.05% in reduction in total population of goats (Table 1). Recently, Tantia *et al.* (2018) have identified and described two new populations of goats, Nandidurga and Bidri, in the state, which were subsequently registered as breeds. Osmanabadi, which is widely distributed in Maharashtra, is also found in adjoining areas in of Karnataka and also in Telangana. The distribution, characteristics and population status of these goat breeds of Karnataka are discussed below.

Nandidurga: It inhabits Chitradurga, Tumakuru and Davangere districts of Karnataka. Nandidurga goats are well adapted to hard rocky areas and can efficiently graze on hillocks. Coat colour is white. Some animals have black spots on ears and forehead. Eyelids are brown or black. Horns emerge in the backward direction and then first turn downward and then inward, touching neck in few cases. Ears are leafy and pendulous. Udder is hairy and pendulous. These goats are reared for meat only and milking is not practiced. Average BW, HW, BL and CG, in that order, range between 26-56 kg, 72-95 cm, 48-69 cm and 70-98 cm in bucks and 24-41 kg, 62-82 cm, 44-63 cm and 61-90 cm in does (Tantia *et al.* 2018). The population of Nandidurga goats in 2007 was 0.635 million. Tantia *et al.* (2018) has estimated the present population of Nandidurga goats to be 0.178 million, thus registering a decline of 72% (Table 2).

Bidri: Bidri goats are distributed in Bidar and Kalaburagi districts. Coat colour is black. Some animals have white spots on ears, forehead, neck and knees. Muzzle, eyelids and hooves are also black. Orientation of horns is backward, outward and downward. Ears are pendulous. Like Nandidurga, these goats are also reared only for meat and milking is not practiced. Udder is hairy and small in size. Average BW, HW, BL and CG, in that order, range between 23-52 kg, 72-89 cm, 52-71 cm and 68-89 cm in bucks and 19-45 kg, 64-83 cm, 47-70 cm and 64-87 cm in does. The Bidri goats are a genetically distinct population from Nandidurga goats. The population of Bidri goats is

estimated to be 0.110 million (Tantia *et al.* 2018).

Osmanabadi: Osmanabadi goats, which derive their name from Osmanabad, are widely distributed in Maharashtra in the districts of Osmanabad, Latur, Parbhani, Solapur and Ahmednagar. They are also found in adjoining Telangana and North-Eastern Karnataka (Breed survey 2013, Rathod 2018). It is a tall breed. The coat colour is predominantly black. White, spotted and brown animals are also seen. Ears are medium in length. Majority of males and only half of females are horned. Tail is medium to long. The udder is small and round with small teats placed laterally. The average HW, BL and CG are 77.87±6.72 cm, 69.12±7.72 cm and 72.06±8.16 cm in bucks and 74.79±4.18 cm, 67.51±5.29 cm and 72.04±5.27 cm in does (Acharaya and Bhat 1984). The population of Osmanabadi goats and its grades in the state of Karnataka are estimated to be 0.250 and 0.206 million, constituting about 2.54 and 4.51%, respectively, of the total sheep population (Breed survey 2013). The population of Osmanabadi goats has shown an increase of 19.91% in the state during 2007-2012 (Table 2).

Besides the above breeds, some Jamanapari, Boer and Sirohi goats, that are not native to Karnataka, are also found in the state, with population of about 0.032 million, 21 thousand and 3.7 thousand, respectively (Breed survey 2013).

Conclusion

Although, Karnataka is home to some of the magnificent ruminant genetic resources of our country, however, during the recent past the population of most of these breeds have shown a drastic decline. For example, the population of Krishna-Valley cattle is now reduced to mere 3.5 thousand. Further, the rate of decrease in the number of pure bred animals of these species is much higher than the non-descript indigenous animals indicating that the increase in exotic/crossbred animals has occurred mainly at the expanse of pure bred animals. Serious conservation efforts are required to arrest this decline in the ruminant genetic resources of the state of Karnataka. The genetic improvement of these breeds through selection and the availability of improved germplasm of these indigenous breeds for breeding programmes can only reverse this trend. The use of genetically improved germplasm of the native breeds in breeding programmes will also result in the phenotypic purification of the mixed populations.

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