

Uttara—A new cattle germplasm from Uttarakhand hills

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ABSTRACT

Surveys were conducted in Almora, Pithoragarh, Rudarpryag, Chamoli and Uttarkashi districts of Uttarakhand state, to characterize the hill cattle of the state. Herd size was larger in Kumaun (2–25) than the Garhwal (2–5) animal. Cattle were small in size with cylindrical type of body. Body colour varied in different colours and shades i.e. white, gray, black, red/reddish, brown and in different combinations of these 2 or more colours. In Kumaun region brown and black were almost in similar proportion while in Garhwal region black colour predominant. All the biometric traits in the age groups 0–3 months, 3–6 months, 6–12 months and 1–3 years did not reveal significant differences in Kumaun and Garhwal cattle. Cows and bullocks had significant differences in all morphometric traits at both the regions. Hill cattle at Rudarpryag and Chamoli districts were closest while hill cattle at Rudarpryag and Pithoragrah districts had maximum distances followed by hill cattle at Chamoli and Pithoragarh districts and Rudarpryag and Almora districts. Daily milk yield and lactation length were significantly higher in Garhwal cows than Kumaun region. The estimated lactation milk yield was 603 kg (test interval method) and 624 kg (centering date method). The average daily milk yield ranged from 1.61 kg to 2.57 kg. It was also observed that 73% cows stayed up to 13th recording, 50.4% up to 17th recording and 29% up to 20th recording indicating that average lactation length was 6 to 8 months. Blood samples of unrelated hill cattle animals were collected from Garhwal region. DNA was isolated and analyzed by a panel of 21 microsatellite markers. The different genetic diversity parameters showed that population is comparable with the hill cattle of Kumaun region and Haryana cattle. It may be concluded that hill cattle populations at different locations showed uniformity on different parameters with a slight variation. The field recording estimates indicated that there were cows those had high potential for milk production and can be exploiting for genetic improvement of this population. It may thus be considered for recognition as a distinct breed.

Kew words: Cattle, Characterization, Evaluation, Hill cattle, Performance, Uttarakhand cattle

The Uttaranchal state is located in western Himalayan region and it is the third smallest states of the country (Fig.1). In the state most of the farmers are resources poor due to undulated topography, rugged terrain, cold climate and lack of production and marketing facilities for livestock and crop production. In the state climate varies from subtropical in the valleys to temperate on the higher slopes with a summer monsoon. The temperature ranges from –5.4°C (Muketshwar) to 40.2°C (Pantnagar) in the year 2008 but it drops below freezing point in many parts of high mountain areas of the region during winter.

The state is enriched with livestock biodiversity represented by cattle, buffaloes, goats, sheep, pigs, horses,

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Fig. 1. Map of Uttarkhand

mules and poultry. The economy of the state is largely based on agriculture, forestry and animal husbandry. Livestock sector is providing livelihood to the majority of people. In the state there are larger proportions of indigenous non descriptive cattle which need to be characterized on priority so as to formulate suitable breeding policy for improvement of cattle productivity in the state. The Uttarakhand state produced 13.77 lakh tonnes of milk and its contribution was 1.22% in total country milk production. The contribution of crossbred and indigenous cattle in total milk production was 22.44 and 21.78%, respectively. The average milk yield was 1.89 kg/day for indigenous cows, 6.69 kg for crossbred cows and 4.11 kg/day for buffalo during the year 2005–06 (Anonymous 2006). In the present study an attempt was made to characterize hill cattle of the state.

MATERIALS AND METHODS

Information on various management practices opted by the livestock owners in the state and performance traits were generated by interviewing the farmers using a structured questionnaire from 32 villages of 5 districts of the State i.e. Almora, Pithoragarh, Rudarpryag, Chamoli and Gopeshwar (Table 1). Farmers (309) were interviewed to know the habitat, status, management, utility and performance of the cattle available. Farmers were interviewed for choice of breed, utility, sale and purchase of animals, animal housing, feeding, breeding, prevalent diseases in the area and performance of the breed.

Performance traits like birth weight, age at maturity and calving, lactation milk yield, lactation length, dry period, service period, calving interval and draught performance were collected by conversing with the farmers from the surveyed villages. Physical characteristics were recorded on animals of different age and sex during the survey. Eight different body measurements and physical characteristics were recorded on 819 animals of different age and sex. The body measurements recorded were body length, height at

withers, heart girth, paunch girth, face length, ear length, horn length and tail length without switch. The body measurements data were analyzed by least square maximum likelihood program (Harvey 1990) including age within sex as fixed effects. Mahalanobis distances were estimated using discriminate step-wise cluster analysis on various morphometric traits to know their closeness or distances (SPSS, 2011).

For genetic characterization 51 blood samples from unrelated cattle from Uttarkashi and Rudarpryag districts were collected to assess the genetic variability by microsatellite markers. DNA was isolated as per Sambrook *et al.* (1989). A panel of 21 bovine-specific microsatellite markers recommended by Food and Agriculture Organization (FAO 1998) and the International Society for Animal Geneticists (ISAG) was used to estimate the within breed genetic variability. The genetic variability was studied by estimating the number of observed alleles (No), number of effective alleles (Ne), observed heterozygosity (Ho) and unbiased expected heterozygosity or gene diversity (He) by GenAlEx 6.2 software (Peakall and Smouse 2008). All loci were tested for deviation from Hardy-Weinberg equilibrium as implemented in GenAlEx 6.2 software.

RESULTS AND DISCUSSION

The survey revealed that the state has a large number of hill cattle. Hill cattle are reared mainly for bullock power, milk and manure. Family size was large i.e. 4–8 members/family. Most of the animals were farm born. Sale and purchase of the animals were observed among the farmers. Land holding was small about 75% farmers had less than 20 nali of land. Singh *et al.* (2001) observed that majority of the hill farmers are small land holders and they depend on the diversification of agriculture to reduce risks and derive economic benefits from the limited resources. Weather parameters of surveyed villages are given in Table 2. The latitude of surveyed villages ranged from 122 to 2200 msl.

Table 1. Details of surveyed district, villages, farmers and animals

District	Name of the villages	No of villages	No. of farmers	No of animals
Almora	Sheel, Dhari, Chhani, Maniagar, Gajanaia, Thath, Chaikhan	7	79	173
Munsyari, Pithoragarh	Jaiti, Jalat, Dhapa, Sarmoli, Darat, Savila, Sutinda	7	82	195
Total		14	161	368
Rudarpryag	Bansu, Devshal, Trijuginarian, Fakot, Ranichauri	5	43	146
Gopeshwar, Chamoli	Bandawara, Khujao, Sitara, Dewarkhatoda, Papdiana, Padoli	6	58	192
Chinalisaur, Uttarkashi	Jesthwari, Kansi, Dharkot, Dewala, Bon, Gadat, Jokhni	7	47	113
Total		18	148	451
G. Total		32	309	819

Table 2. Weather parameters of surveyed villages

District\ Weather	Kumaun		Garhwal		
	Almora	Munsyari Pithoragarh	Ukhimath Rudraprayag	Gopeshwar Chamoli	Chinalisaur Uttarkashi
Altitude (msl)	1600–1800	1800–2200	1800–2200	1500–1600	1200–1400
Temperature minimum (°c)	02–14	0	2.3	3	0.4
Temperature maximum(°c)	15–18	30	26	30	35
Humidity (%)	-	30–90	77	30–90	30–90
Rainfall (mm)	800–1000	1400–1800	1400	1200–1500	1000–1500
Snowfall (mm)	-	frequent	80–100	-	Sometime
Sunshine (h/day)	-	6–8	6–7	8–10	6–8

Table 3. Age- and sex wise distribution of surveyed animals

District\age wise distribution	Kumaun		Garhwal			Total
	Almora	(Munsyari) Pithoragarh	Rudraprayag	(Gopeshwar) Chamoli	Uttarkashi	
Up to 6 months	05 (02.9%)	22 (11%)	07 (04.8%)	21 (11%)	04 (3%)	59 (7.20%)
6–12 months	25 (14.4%)	42 (22%)	38 (26.0%)	23 (12%)	14 (12%)	142 (17.34)
1–3 years	22 (12.7%)	35 (18%)	19 (13.0%)	46 (24%)	31 (27%)	153 (18.68)
Cows	52 (30.2%)	89 (46%)	53 (36.3%)	69 (36%)	32 (28%)	295 (36.02%)
Bullocks	69 (39.8%)	07 (03%)	29 (19.9%)	29 (15%)	31 (27%)	165 (20.14%)
Total	173	195	146	192	113	819

Rainfall ranged from 800 to 1500 mm.

The age- and sex-wise distribution of surveyed animals are given in Table 3. The survey covered 36% of the cows and 20% bullocks.

Population and trends

The state possesses 22.35 lakh cattle heads in the year 2007. Among the cattle 339,000 (15.16%) are crossbred and rest 189,600 (84.84%) are indigenous. The population trends from 1997 to 2003 and 2003 to 2007 were positive i.e. 7.39 and 2.14, respectively. During the year 2003 to 2007 crossbred cattle increased by 49.12% while indigenous cattle decreased by –3.31%. Among the defined breeds Hariana and Sahiwal heads were maximum in Haridwar districts and Red Sindhi in Tehri district. Haridwar district had 40% of Hariana cattle and 35.5% Sahiwal cattle available in the state. Haridwar district had the maximum number of cattle belonging to defined breeds. However the proportion of defined breeds was as low as 1.44% in the state. The non-defined cattle were available in maximum number in Podi district (17.76%) followed by Almora (11.62%), Pithoragarh (11.40%), Chamoli (8.82%) and Nanital (7.31%). Hill districts had more number of indigenous non-descript cattle and plain districts had higher proportion of crossbred cattle. Hill cattle of Uttarakhand being in majority in the state necessitated its appropriate characterization.

Management

Animals were reared mainly on extensive system of

management i.e. grazing from morning to evening in Kumaun region and semi intensive system in Garhwal region. Farmers were totally dependent on the locally available feed resources i.e. tree leaves and self-grown grasses. Farmers were not growing fodder crops. Ladies looked after all activities related to rearing of animals. Animals of different farmers are pooled in a group of 25–50 animals for grazing in the hilly terrain nearer to water source in Kumaun region. In Garhwal region top priority of cattle rearing was milk (34%) while in Kumaun it was draught (22%). Around 48% farmers reared cattle for milk and draught, both the purposes. Cows in milk and bullocks during the work are provided some feeds and concentrate in the evening. Animals were kept in houses only during night. Animal houses were part of owner's residence in most of the cases in Kumaun region (84%) while in Garhwal region majority of the farmers had separate houses for animals (73%). Animal houses were open and *kachha* type (68%) in most of the cases. Numbers of *paccka* animal house were more in Garhwal region as compared to Kumaun region. Drainage of the houses was not proper. Ventilation and tree shades were available in most of the cases. During milking udder and milk pots were washed. Milk is mostly used for household purposes. Herd size ranged from 2 to 5 animals in Garhwal region while in Kumaun region it was larger (5–25). Breeding was mostly natural. Calves were reared mainly through suckling of dam. Dehorning and deworming practices were not adopted. Vaccinations for HS, FMD and BQ were observed in very few cases. It was observed that in Garhwal region animals were given more



Figs 2–7. 2. Cow, 3. Bullocks, 4. Bull, 5. Cattle in Grazing, 6. Ploughing, 7. Housing and management

attention than the Kumanu region with respect to feeding, management, utility, breeding and production etc. Animals in grazing, ploughing and housing and management are shown in Figs 5–7.

Physical characteristics

Animals of Hill cattle were small in size with cylindrical type of body. Animals were well built and compact with strong legs (Figs 2–4). Body colour varied in different colours and shades i.e. white, gray, black, red/reddish, brown and in different combinations of these 2 or more colours (Table 4). In Kumanu region brown and black were almost in similar proportion while in Garhwal region black colour was predominant. The colour variability was more in Kumanu region than the Garhwal region. In Garhwal region pure black, brown and white colours confirmed to more than 75%

of the animals. Skin was tight. Eyelids were black. The colour of hoof and muzzle was black and brown. Dewlap and hump were small to moderate. Head was small. Face was short and concaves. Ears were small to moderate in length and horizontal in orientation. Neck was short in length and thin. Horns were small, black or gray in colour, stumpy and curved upwards and then towards face with pointed tips. Udder was small, not well developed and milk veins were not prominent. Sizes of fore (79%) and rear (83%) udders were small. Teats were small (6–12 cm long), in most of the cases cylindrical (78%) in shape and in some cases funnel shaped (18%). Tips of the teats were either round (67%) or funnel (26%). Naval flap was small (89%). Penis sheath flap was short and tucked up with the body. Tail was long, touching almost to ground with black (81%), brown (12%) or white (7%) switch. Temperament was docile in almost 90% animals. Typical

Table 4. Body colour pattern (%) of hill cattle

District\colour	Kumaun region			Garhwal region				G. total
	Almora	Pithoragarh	Total	Rudarpur	Chamoli	Uttarkashi	Total	
Black	33(19.2)	82(42.0)	115(31.33)	105(72.0)	134(69.8)	12(10.7)	251(55.7)	366(44.7)
Brown	20(11.6)	104(53.3)	124(33.78)	12(8.2)	29(15.1)	8(7.1)	49(10.9)	173(21.2)
White	46(26.7)	-	46(7.62)	-	8(4.1)	38(33.62)	46(10.2)	92(11.2)
Red/reddish	28(16.3)	-	28(7.7)	8(5.5)	21.0(10.9)	10(8.84)	39(8.7)	67(8.2)
Gray	13(7.6)	-	13(3.5)	-	-	45(39.8)	45(10.0)	58(7.1)
Black and white	5(2.9)	9(4.6)	14(3.8)	6(4.1)	-	-	6(1.3)	20(2.4)
Brownish black	-	-	-	15(10.3)	-	-	15(3.3)	15(1.83)
Reddish white	10(5.8)	-	10(2.7)	-	-	-	-	10(1.2)
Grayish white	9(5.2)	-	9(2.4)	-	-	-	-	9(1.1)
Whitish brown	4(2.3)	-	4(1.1)	-	-	-	-	4(0.5)
Reddish brown	4(2.3)	-	4(1.15)	-	-	-	-	4(0.5)
Total	172	195	367	146	192	113	451	818

cow, bullock and bull are shown in Figs 2–4, respectively.

Biometric traits

Mean, standard error and number of observation of different biometric traits are given in Table 5a and b. All the biometric traits from age group 0–3 months, 3–6 months, 6–12 months and 1–3 years did not reveal significant differences in Kumaun and Garhwal cattle. The cattle above 3 years were divided into 3 groups i.e. cow, bull and bullocks. In the cows from Kumaun region average body length, height at wither, heart girth, paunch girth, ear length, face length, tail length without switch and horn length were recorded. Bullocks had

higher values than the cows in both the locations. Cows and bullocks of Kumaun region had significantly higher values than the Garhwal region. Significant differences for all the morphometric traits were not observed in bulls of both the regions may be due to less number of observations. The estimates of body length, height at wither and heart girth in cows and bulls were lower than the Sahiwal, Kankrej, Hariana, Red Sindhi and Bargur breeds and within the range as in smaller breeds like Vechur and Punganaur (Pundir and Ahlawat 2007). The similar estimates of face length and horn length and higher for body length, height at wither, heart girth, paunch girth, ear length and tail length without switch

Table 5a. Morphometric traits (cm) of hill cattle

Age group	Region	Traits	Body length	Height at wither	Heart girth	Paunch girth	Ear length	Face length	
		No.	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
0–3 months male	Kumayon	1	45.00	56.00	52.00	47.00	09.00	16.00	30.00
	Garhwal	8	53.75±1.21	61.75±1.87	68.75±1.20	69.75±1.98	9.62±0.49	18.00±1.50	33.00±1.50
0–3 months female	Kumayon	1	45.00	55.00	53.00	48.00	7.00±0.00	16.00	30.00
	Garhwal	8	51.75±1.42	59.37±1.38	66.25±1.44	67.87±1.34	9.50±0.68	17.00±1.90	31.50±1.39
3–6 months male	Kumayon	13	60.46±0.95	64.61±1.00	72.23±1.55	76.92±1.87	12.53±0.31	20.92±0.57	36.38±1.16
	Garhwal	9	57.33±1.20	64.33±1.76	73.66±1.70	76.77±1.76	12.88±0.17	20.22±1.20	36.88±1.08
3–6 months female	Kumayon	11	59.63±1.97	63.45±3.38	71.00±1.76	74.18±1.65	11.00±0.64	21.18±0.34	36.54±1.99
	Garhwal	8	56.00±1.22	62.12±1.74	72.37±1.89	73.50±1.84	11.62±0.53	20.37±0.62	35.50±1.61
6–12 months male	Kumayon	23	67.60±1.69	70.78±1.71	82.08±1.26	88.95±1.23	15.52±0.45	24.65±0.79	44.56±1.88
	Garhwal	24	64.29±1.29	69.87±0.89	84.33±1.83	86.16±1.18	14.45±0.55	25.08±0.85	43.66±1.97
6–12 months female	Kumayon	32	64.78±1.50	67.06±1.31	77.78±1.75	82.75±1.09	14.71±0.36	23.62±0.68	41.25±1.20
	Garhwal	42	62.64±1.39	68.71±1.33	81.26±1.67	81.26±1.00	13.52±0.39	23.61±0.56	42.52±1.40

Table 5b. Morphometric traits (cm) of hill cattle

Age group	Region	Traits	Body length	Height at wither	Heart girth	Paunch girth	Ear length	Face length	Tail lengths	Horn length
		No.	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE
1–3 years male	Kumayon	26	79.61±1.97	82.80±1.97	99.15±1.60	106.73±1.85	17.19±0.42	30.23±0.89	56.92±1.17	7.46±0.70 (26)
	Garhwal	43	77.02±1.47	81.53±1.40	100.90±1.18	102.62±1.46	17.00±0.42	30.83±0.51	57.62±1.56	6.14±0.49 (41)
1–3 years female	Kumayon	41	79.41±1.86	82.02±1.59	103.63±1.65	104.24±1.79	16.60±0.32	28.92±0.73	54.14±1.66	6.48±0.54 (39)
	Garhwal	61	78.08±1.21	81.16±1.10	99.21±1.71	102.80±1.77	16.29±0.33	29.98±0.42	56.78±1.31	5.86±0.43 (51)
Cow	Kumayon	146	98.75±0.64 ^a	96.54±0.54 ^a	127.10±0.92 ^a	137.30±1.09 ^a	19.34±0.12 ^a	36.04±0.22 ^a	71.61±0.51 ^a	14.18±0.33 (145)
	Garhwal	154	93.63±0.56 ^b	93.75±0.52 ^b	122.41±0.73 ^b	129.62±0.90 ^b	17.58±0.17 ^b	33.86±0.18 ^b	67.25±0.54 ^b	14.37±0.32 (154)
Bullock	Kumayon	61	105.65±1.04 ^{ab}	104.14±0.81 ^a	139.16±1.62 ^a	146.49±1.97 ^a	20.08±0.19 ^a	39.29±0.30 ^a	76.18±0.68 ^a	17.82±0.80 (61)
	Garhwal	89	97.34±0.92	100.50±0.73 ^b	131.83±1.45 ^b	135.30±1.43 ^b	18.79±0.30 ^b	36.28±0.37 ^b	71.51±0.77 ^b	15.69±0.67 (89)
Bull	Kumayon	12	101.41±1.18	103.91±1.84	138.41±1.43	137.58±1.80	19.16±0.45	38.25±0.53	77.33±1.54	17.00±1.52 (12)
	Garhwal	5	98.20±3.58	98.60±2.04	132.60±1.56	131.00±15.22	17.20±1.90	35.00±4.30	68.80±1.21	16.50±1.36 (4)

were observed in Malnad gidda cattle (Singh *et al.* 2008). All the morphometric traits revealed that cows and bullocks of Kumaun region had larger size than the Garhwal region.

The discriminate step-wise cluster analysis on various morphometric traits in cows based on Mahalanobis distances revealed that hill cattle at Rudarpryag and Chamoli districts had minimum distances (3.884) means closest while hill cattle at Rudarpryag and Pithoragrah districts had maximum distances (29.03) followed by hill cattle at Chamoli and Pithoragarh districts (28.03) and Rudarpryag and Almora districts (24.42). Similar observations were also observed in bullocks also.

Genetic characterization

All the 21 microsatellite loci were polymorphic and 265 alleles were obtained in the present study. The mean observed number of alleles was 12.61 ± 4.80 , ranged from 6 (CSSMO8) to 22 (CSRM60) indicating enough amount of variability. The average effective number of alleles was 5.66 ± 2.64 and ranged from 2.41 (CSSMO8) to 11.39 (ILSTS33). The mean effective number of alleles was lower than mean observed numbers of alleles. The mean observed number of alleles in the study was higher than the Kherigarh (Pandey *et al.* 2006), Bachaur (Sharma *et al.* 2007), Tharparker (Sodhi *et al.* 2008), Rath (Sodhi *et al.* 2008) and Kumaun cattle (Pandey *et al.* 2011).

The average observed heterozygosity was 0.699 ± 0.19 and ranged from 0.271 (CSSMO8) to 0.938 (CSSM33). The expected heterozygosity ranged from 0.585 (CSSMO8) to 0.912 (ILSTS33) with the overall mean of 0.782 ± 0.10 . Heterozygosity of similar magnitude was also reported in Tharparker cattle of India (Ho, 0.643; He, 0.72) by Sodhi *et al.* (2008), Kumaun cattle (Ho, 0.64; He, 0.73) by Pandey *et al.* (2011) and exotic Burlina cattle (Ho, 0.670) by Dalvit *et al.* (2008). Lower observed heterozygosity than the present study was observed in Kenkatha (Ho, 0.540) by Pandey *et al.* (2006), Bachaur (Ho, 0.534) by Sharma *et al.* (2007) and in exotic Brown Swiss cattle (0.563) by Schmid *et al.* (1999).

The test for Hardy-Weinberg equilibrium (HWE) showed that 12 loci deviated significantly ($P < 0.05$) from HWE. Departure from HWE is mostly due to heterozygote deficiency, which may results from one or more of the following reasons: presence of null alleles, small sample size and Wahlund effect i.e presence of fewer heterozygotes in a population than predicted on account of population sub division. The estimate of heterozygote deficiency varied from -0.198 (INRA05) to 0.537 (CSSMO8) with a mean of 0.118 ± 0.17 indicating that around 12% deficiency of heterozygotes exists in this population. Heterozygote deficiency higher than the present study was observed in Sahiwal (Mukesh *et al.* 2004), Bachaur (Sharma *et al.* 2006), Gangatiri (Sharma *et al.* 2007) and Kumaun cattle (Pandey *et al.* 2011). Different parameters showed sufficient allelic diversity in the population. Population also showed little

heterozygote deficiency (FIS, 0.118) and deviated from HWE at 12 investigated loci.

Performance

The birth weight ranged from 7 to 14 kg. Body weights at 6 and 18 months of age were around 50 and 65 kg. The cows and bullocks weighed 90 to 105 and 90 to 132 kg., respectively. The estimates of birth weight and adult body weight were similar to the reports of Singh *et al.* (2008) and Ashok (2000) in Malnad Gidda cattle. The average age at first calving, daily milk yield, lactation length, dry period, service period, calving interval, herd life and number of calving during life time were 46 months (3–5 years), 1.12 kg (0.5–3.0 kg), 275 days (8–18 months), 147 days (4–6 months), 124 days (3–6 months), 456 days (12–30 months), 12–15 years and 8–10 calving, respectively. The production traits i.e. daily milk yield and lactation length significantly higher in Garhwal cows than the Kumaun region may be fact that in Garhwal region farmers rearing these cows for milk production too and providing better management and feeds and fodders. The estimates of age at first calving, daily milk yield and calving interval were within the range as reported by Singh *et al.* (2004). Higher estimates of daily milk yield were reported by Kumar *et al.* (2000), Singh *et al.* (2004) and Meena *et al.* (2007). The average daily milk yield obtained in the study was also lower than the state average for indigenous cows in the year 2005–06 (Anonymous 2006). This may be due to fact that in the district hill cattle are reared mainly for bullock power and manures. The average daily milk yield and lactation milk yield were lower than the Malnad Gidda cattle (Singh *et al.* 2008). The age at first calving and calving interval were in close agreement and lower dry period and service period were observed in Malnad Gidda cattle by Singh *et al.* (2008) as compared to the present study. The bullocks of the hill cattle were used for 20–45 days in a year for different agricultural operations. A pair of bullock may plough about 10 Nali (0.5 acre) of land in a day. The bullock performance was also observed better in Garhwal region than the Kumaun region.

Performance evaluation through field recording

The fortnightly milk yield of the hill cow was recorded in 27 villages of Ukhimath block of Rudarpryag district by 5 enumerators. The recording was started in September 2009 and completed by June 2010. A total of 688 cows fortnightly milk yield was recorded (Table 6). Maximum 20 recordings were recorded on 200 cows. It was observed that all the parameters within the range obtained during survey of Rudarpryag district. Lactation milk yield was estimated by centering date and test interval methods. The estimated lactation milk yield was 603 kg (Test interval method) and 624 kg (Centering date method). The daily milk yield ranged from 0.240 kg to 6.90 kg. The average daily milk yield ranged from 1.61 kg to 2.57 kg. It was also observed that 73% cows

Table 6. Average fortnightly daily milk yield (kg) and estimated milk yield

Recording	No.of obs.	Mean	Min.	Max.	Estimated milk yield	
1	688	2.415	0.680	6.50	Centering date method	Test interval method
2	688	2.553	0.900	6.90	74.53	62.90
3	688	2.575	0.900	6.80	113.16	101.15
4	688	2.537	0.900	6.90	151.21	137.67
5	686	2.342	0.700	6.10	186.34	172.24
6	684	2.276	0.700	5.90	220.48	205.99
7	680	2.235	0.650	5.90	254.01	238.84
8	666	2.159	0.630	4.10	286.40	271.01
9	636	2.145	0.600	4.03	318.57	302.66
10	619	2.086	0.500	3.80	349.87	333.56
11	577	2.043	0.450	3.40	380.51	364.08
12	545	2.026	0.450	3.00	410.90	393.85
13	506(73%)	1.951	0.430	0.25	440.17	422.57
14	480	1.887	0.300	2.00	468.48	450.24
15	438	1.811	0.300	2.00	495.65	477.24
16	377	1.793	0.300	1.90	522.54	503.79
17	347(50.4%)	1.756	0.250	1.90	548.88	529.81
18	320	1.723	0.300	1.90	574.63	555.23
19	295	1.675	0.250	1.60	599.86	579.83
20	200(29%)	1.615	0.240	1.70	624.08	603.98

stayed up to 13th recording, 50.4% up to 17th recording and 29% up to 20th recording indicating that average lactation length was 6 to 8 months. The field recording estimates indicated that there were cows those had high potential for milk production and can be exploiting for genetic improvement of this population.

It may be concluded that hill cattle available in Garhwal region had more uniformity. The Kumaun cattle had larger shape and size. Farmers in Garhwal region gave more attention to feeding, management and breeding. Productivity of hill cattle was better in Garhwal region than the Kumaun region. The hill cattle population showed uniformity in morphometric characteristics and contributes significantly in the economy of the state. Field recording of fortnightly milk yield indicated that cows had high potential for milk production in that difficult climate. It may thus be considered for recognition as a distinct breed.

REFERENCES

- Anonymous. 2006. Animal Husbandry Statistics, Department of Animal husbandry and Dairying, MoA, GOI, New Delhi.
- Anonymous. 2010. Animal Husbandry Statistics, Department of Animal husbandry and Dairying, MoA, GOI, New Delhi.
- Ashok C. 2000. 'Characterisation of Malnad Gidda cattle of Karnataka'. M.V.Sc. thesis submitted to the university of agricultural sciences, Bangalore.
- Dalvit C, De Marchi M, Dal Zotto, Zanetti E, Meuwissen T and Cassandro M. 2008. Genetic characterization of Burlina cattle breed using microsatellite markers. *Journal of Animal Breeding and Genetics* **125**: 137–44.
- FAO (Food and Agricultural Organization of the United Nations) 1998. Food and Agriculture Organization, Rome, repost. <http://dad.fao.org/en/refer/library/guideline/workgrp.pdf>
- Harvey W R. 1990. User's guide for LSML-PC-VERSION-2, mixed model least square maximum likelihood program, Mine graph, Columbus, Ohio, USA.
- Iype S. 1996. The Vechur cattle of Kerala. *Animal Genetic Resources Information (FAO)* **18** : 61–65.
- Kumar S, Chandre M and Harbola P C. 2000. Livestock farming system- A case study of Kumaun hills. *Himalyan Ecology and Development* **8** (2).
- Meena H R, Ram H, Singh S K, mahapatra R K, saho A and Rasool T J. 2007. Animal husbandry practices at high altitude (> 6000 feet) in Kumaun region of Uttarakhand, India. *Livestock Research for Rural Development* **10** (11).
- Mukesh M, Sodhi M, Bhatia S and Mishra B P. 2004. Genetic diversity of Indian native cattle breeds as analyzed with 20 microsatellite loci. *Journal of Animal Breeding and Genetics* **121**(6): 416–24.
- Pandey A K, Sharma R, Singh Y, Prakash B, and Ahlawat S P S. 2006a. Evaluation of Genetic Variation in Kenkatha cattle by microsatellite markers. *Asian-Australasian Journal of Animal Science* **19**(12): 1685–90.
- Pandey A K, Sharma R, Singh Y, Prakash B and Ahlawat S P S. 2006b. Genetic diversity studies of Kherigarh cattle based on microsatellite markers. *Journal of Genetics* **85**(2): 117–22.
- Pandey A K, Sharma R, Singh L V, Maitra A, Mishra B P and Kumar D. 2011. Estimation of genetic variability parameters in Kumaun hill cattle (Kumauni cattle) by STR markers. *Indian Journal of Animal Sciences* **81**(2): 194–95.
- Peakall R and Smouse P E. 2008. A heterogeneity test for finescale genetic structure. *Molecular Ecology Notes* **17**: 3389–3400.
- Pundir R K and Ahlawat S P S. 2007. Indigenous Breeds of Cattle and Buffalo. *Dairy India Yearbook*. 6th edn. pp 261–71.
- Pundir R K, Singh P K, Singh C V and Prakash B. 2010. Physical parameters and management of hill cattle of Almora district of

- Uttarakhand. *Indian Journal of Animal Sciences* **80** (11): 1145–47.
- Pundir R K, Singh P K, Sharma D, Saini A, Singh C V and Prakash B. 2011. Hill cattle of Pithoragarh district of Uttarakhand. *Indian Journal of Animal Sciences* Accepted.
- Sambrook J, Fritsch E F and Maniatis T. 1989. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbour Lab. Press, Cold Spring Harbour, NY.
- Schmid M, Saipveaova N, Gaillard, C and Dolf G. 1999. Genetic diversity in Swiss cattle breeds. *Journal of Animal Breeding and Genetics* **116**: 1–8.
- Singh P R, Singh M, Verma M L and Jaiswal R S. 2004. Animal husbandry practices in Tarikhet block of Kumaon hill of Uttaranchal. *Indian Journal of Animal Sciences* **74** (9):997–99.
- Singh P K and Pundir R K, Manjunath V K, Rudresh B H and Govindaiah M G. 2008. Features and status of miniature indigenous germplasm of cattle; e- Malnad Gidda. *Indian Journal of Animal Sciences* **78** (10):1123–26.
- Sharma R, Pandey A K, Singh S C P, Singh Y, Mishra B P, Singh S R, Mandal G K, Singh P K, Singh G and Ahlawat S P S. 2007. Diversity assessment of Bachaur cattle from India: A draft breed still relevant in mechanized Era. *Korean Journal of Genetics* **29**(3): 369–78.
- Sharma R, Pandey A K, Singh Y, Prakash B, and Ahlawat S P S. 2006. Assessment of genetic variability in Ganagtiri cattle by microsatellite marker. *Korean Journal of Genetics* **28**(1):35–42.
- Sodhi M, Mukesh M, Ahlawat S P S, Sobti R C, Gahlot G C, Mehta S C, Prakash B and Mishra B P. 2008. Genetic diversity and structure of two prominent zebu cattle breeds adapted to the arid region of India inferred from microsatellite polymorphism. *Biochemical Genetics* **46**: 124–36.