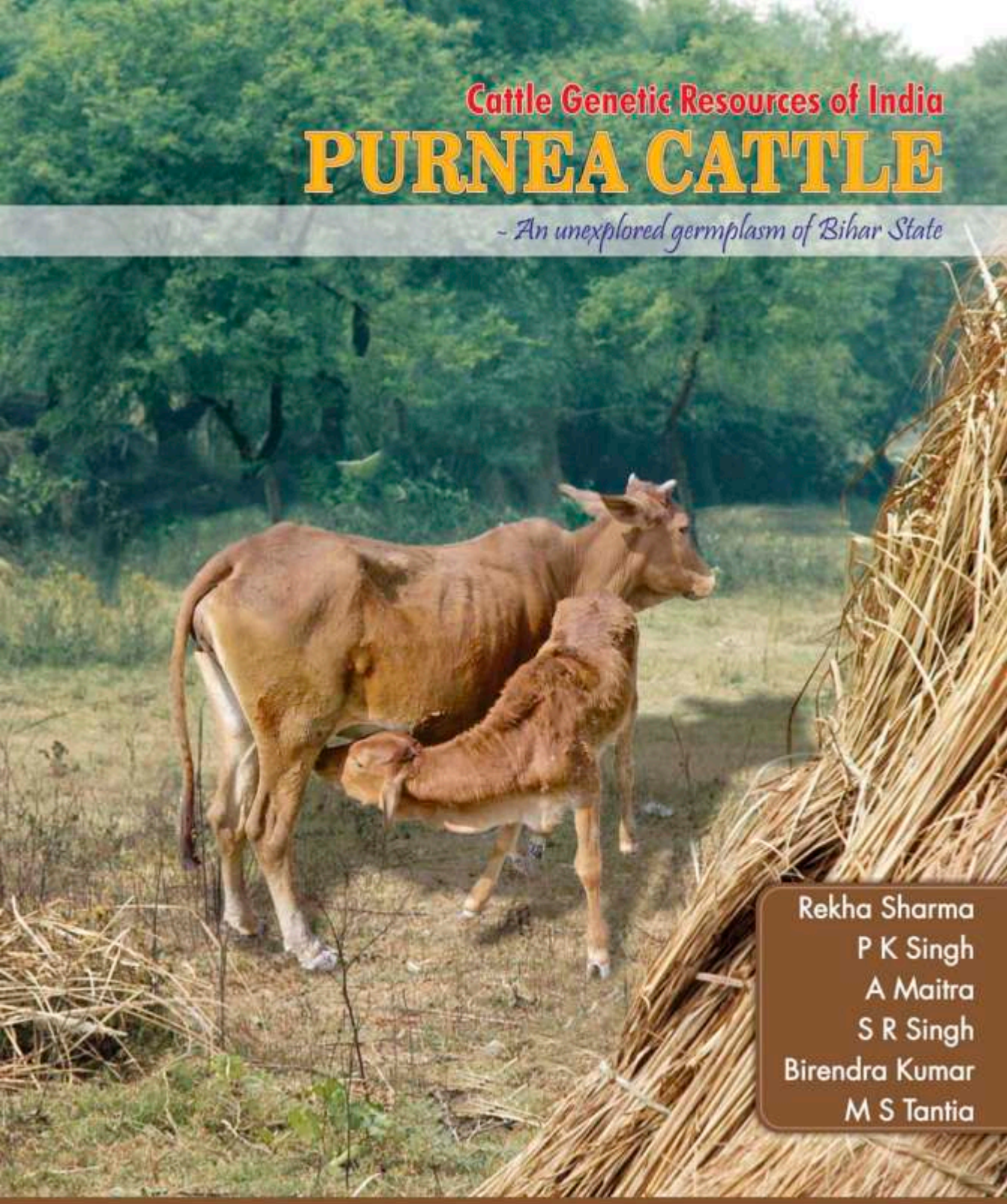
Cattle Genetic Resources of India

PURNEA CATTLE

- An unexplored germplasm of Bihar State



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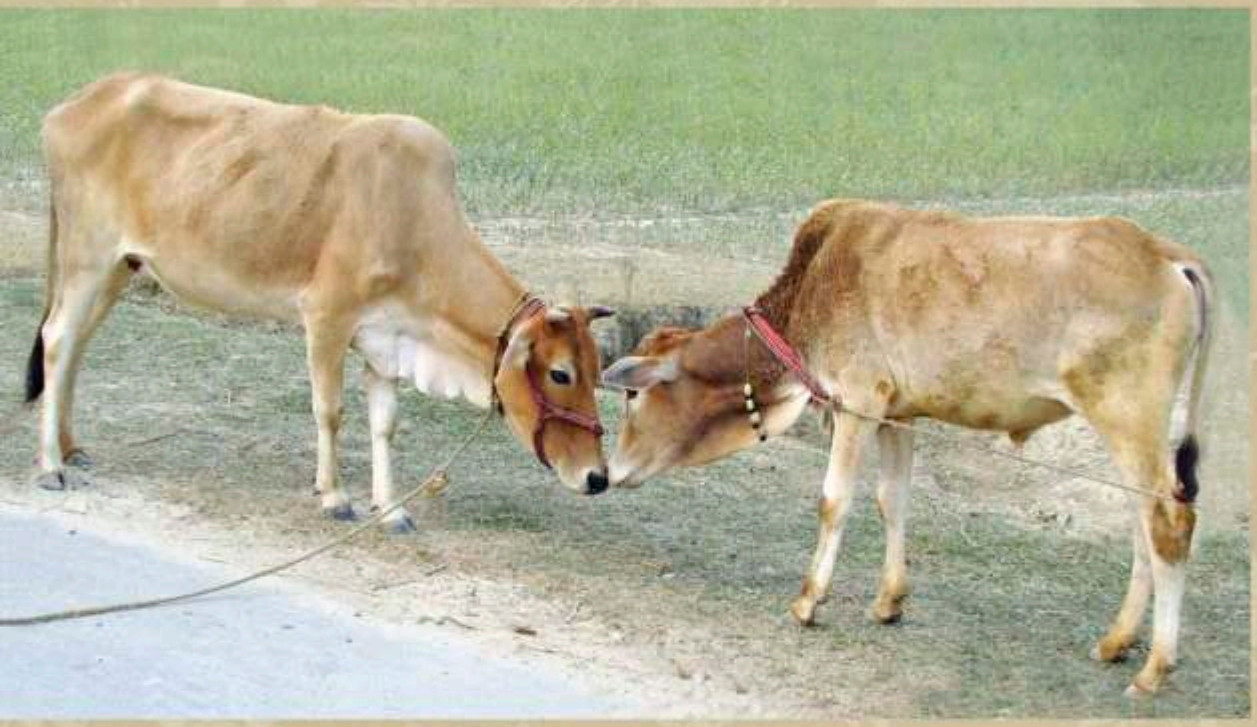

"Cow is the source of progress and prosperity. In many ways it is superior to one's mother."

– Mahatma Gandhi

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- An unexplored germplasm of Bihar State

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The cattle are the largest livestock species in India and constitute 37.5% of its total livestock population. A large and divergent range of agro-ecological zones in India has helped to develop a number of cattle breeds and population groups. The Livestock Census 2007 (http://dahd.nic.in/dahd/statistics/livestock-census.aspx) has listed head counts of 44 cattle breeds. However, the FAO list of livestock breeds has included 60 local, 8 regional trans boundary and 7 international trans boundary cattle breeds for India. It is surprising to note that only 11.6% of total cattle (199.08 million) belong to pure indigenous breeds, whereas, 69.7% were classified as non-descript indigenous cattle. The large, so called non-descript population is also significantly contributing to the total GDP from livestock sector. In addition, indigenous AnGR known for heat and draught tolerance and disease resistance, have vast scope for allele mining for these traits. Thus the need of hour is to describe, characterize and document lesser known populations in the country so that the proportion of non-descript population is considerably transformed in to well defined breeds.

(B.K. Joshi)
Director, NBAGR

PREFACE

Purnea population of Indian zebu cattle (*Bos indicus*) evolved as draft cattle over centuries under low levels of management. As a result of natural selection and human intervention Purnea animals adapted to harsh native environment, resistance to tropical diseases and external parasites and sustenance on low quality roughages and grasses. The breed is primarily employed for agricultural operations, for carrying load and transportation. The breeding tract of this breed encompasses Purnia commissionery of Bihar state. The breed is primarily maintained by small and marginal farmers. Bullocks are fast in speed and good for light draught (carting) and agricultural operations. The Purnea population in the breeding tract has been on a declining trend (Singh 2009). This calls for urgent conservation and improvement strategies for this breed.

In the present document attempt has been made to describe the characteristics of the population based on the information generated and compiling all possible available information especially on status of the breed, physical characteristics, morphometric traits, production and reproduction performance and molecular characterization and put them in to the shape of a monograph. This monograph will be useful to researchers, academicians and planners for formulating programmes and strategies for the improvement and conservation of the Purnea population.

Authors

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INTRODUCTION

India is a reservoir of cattle diversity. In addition to 37 registered breeds of cattle, various cattle populations exist in India, which have not been documented. Effort is in progress to characterize these populations at the phenotypic and molecular levels, and to document their status, production, management and utilization patterns. Local cattle are important to preserve as they are well adapted to climate, food supply and other local environmental factors, which often shows in their superior robustness. The use of new breeding techniques, introduction of highly productive breeds, demographic pressure and support of industrial agriculture is contributing to the loss of valuable traits or decrease in number of animals of local breeds. Bachaur is the only registered cattle breed from Bihar. Bachaur, a famous draught purpose cattle breed is concentrated in Bachaur Pargana (Madhubani, Sitamarhi and Darbhanga districts) of Bihar state. The breeding tract of Bachaur has shrunken with time to northern part of Bihar bordering Nepal. The animals are white to grey in colour with black muzzle, and eyelids. The cows are poor milker, producing an average of 2.2 kg of milk per day and are managed under extensive management. Non- descript cattle population of Bihar state includes Shahabadi and Purnea. Shahabadi cattle are mainly distributed in Buxar, Bhojpur, Kaimoor and Rohtas (Sasaram) districts of Bihar. The milk production varies from 2 to 6 liters in a day. Purnea cattle population evolved as a draft breed over centuries under low inputs/ production system or crop-livestock production system. The animals are of small size and compact body. The animals are primarily employed for agricultural operations, for carrying load and transportation. The breeding tract of Purnea cattle encompasses Purnia commissionery of Bihar state (Purnia, Araria, Katihar and Kishanganj districts). Two decades earlier typical animals of these populations were available in their native

tracts in optimum number to constitute viable breeding populations. But at present, all of these populations need immediate attention, failing which our ancestral efforts of artificial selection, operative since time immemorial, may go in vein and there may be a non-repairable loss of eco-system as well as eco-friendly genes from the national and world gene pool. Thus the present monograph aimed to document the characteristic of Purnea cattle. Diverse attributes of a population are effective in its characterization, taking account of phenotypic traits (monogenic and polygenic), production, reproduction, geographic distribution, origin and habitat. The genetic characterization of populations, breeds and species allows the evaluation of genetic variability, a fundamental element in working out breeding strategies and genetic conservation plans. Molecular markers have been comprehensively exploited to access this variability as they contribute information on every region of the genome, regardless of the level of gene expression. Microsatellites (highly polymorphic simple sequence repeats) have been effectively exploited to enlighten bovine domestication and migration prototype (Bradley *et al*. 1994, Edwards *et al*. 2000) and to evaluate genetic diversity and relationships among cattle populations (MacHugh *et al*. 1997, Kim *et al.* 2002, Metta *et al.* 2004, Mukesh *et al.* 2004). We intend to describe not only morphometric characters but also the current diversity as well as relationship of Purnea population with recognized breeds and with other populations of the area for conservation of genetic diversity in the context of biodiversity management programs.

GEOGRAPHY AND CLIMATE OF BIHAR

Bihar is located in the eastern part of the country. It is bordered on the north by the Kingdom of Nepal, on the west by Uttar Pradesh, south by Jharkhand, and north – east by West Bengal. Bihar with a geographical

area of 94,163 sq km (2.85 % of the country) lies between 24°-20′-10″ ~ 27°-31′-15″ North Latitude and 82°-19′-50″ ~ 88°-17′-40″ East longitude. Bihar can be broadly divided into two physiographic units, the Plains and the Plateau. The topography is mainly plain in the North, sloping towards the South. State has big rivers like Ganges, Gandak, Kosi, flowing through it. The state enjoys a continental monsoon type of climate owing to its great distance from the sea. Hence its climate is tropical to sub tropical characterized by high temperature during summers. Winters days are warm but after sunset temperature drops abruptly. The average annual rainfall varies from 1100 to 1250 mm. The mean annual temperature of the State is 25°C with mean annual maximum of 39°C and mean annual minimum of 11°C. The state is divided into three agro – climatic zones:

Agro–Climatic Zone I	Agro–Climatic Zone II	Agro–Climatic Zone III
36%	20%	44%
North Bihar Plains (West Champaran, East Champaran, Gopalganj, Siwan, Saran, Sitamarhi, Muzaffarpur, Vaishali, Madhubani, Darbhanga, Samastipur)	North Eastern Plains (Saharsa, Araria, Madhepura, Kishanganj, Purnia, Katihar, Begusarai, Khagaria).	South Bihar Plains (Bhojpur, Patna, Rohtas Nalanda, Aurangabad, Gaya, Jehanabad, Nawada, Munger, Bhagalpur).
Average Rainfall: 1234.7mm	Average Rainfall: 1382.2mm	Average Rainfall: 1102.1mm
Soil and Topography: Medium acidic, heavy textured, sandy loam to clayed, flood prone (Large area remains under water called Chaur, Maun & Tal lands)	Soil and Topography: Light to medium textured, slightly acidic, sandy to silty loam (Large area comprise of Tal and Diara lands)	Soil and Topography: Old alluvium to sandy loam

BIHAR DEMOGRAPHICS

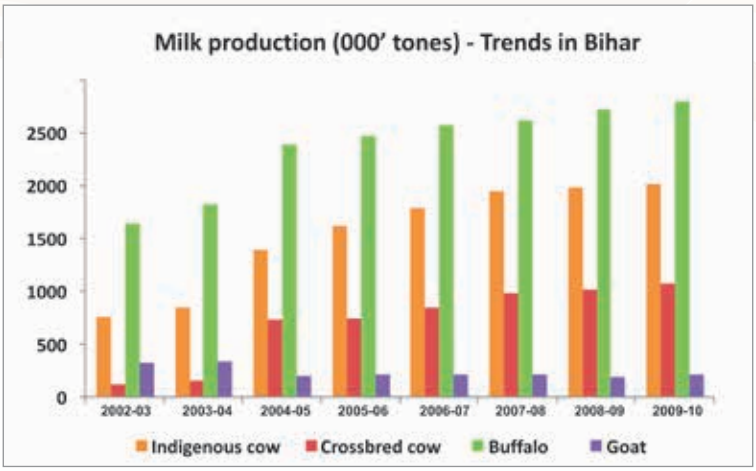
The human population of Bihar is 103,804,637 (2011 census). It is ranked 3rd in India based on state population. Only 11 countries in the world have more population than the population of Bihar. Out of total population, 5,41,85,347 are male and 4,96,19,290 are females. Bihar constitutes 8.58% of total population of India. That would mean that there are 916 female

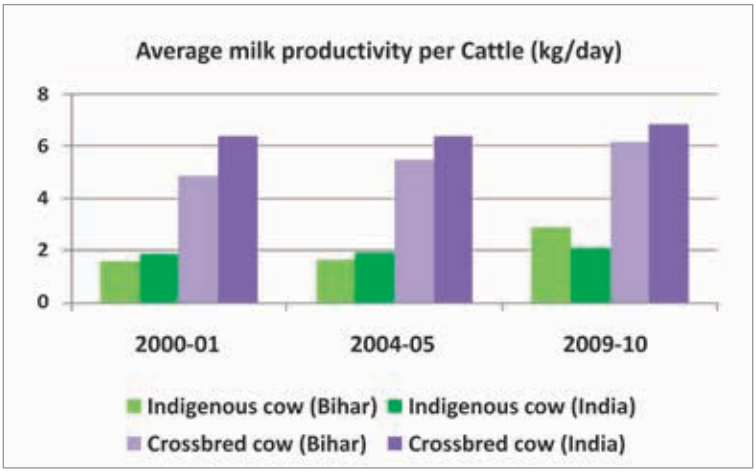
per 1000 male. Bihar has shown 25.07% decadal growth between 2001 and 2011. The population density comes out to be 1102 person per km^2. The literacy rate in Bihar of Bihar is 63.82%. The literacy rate of male is 73.39% while that of female is 53.33%.

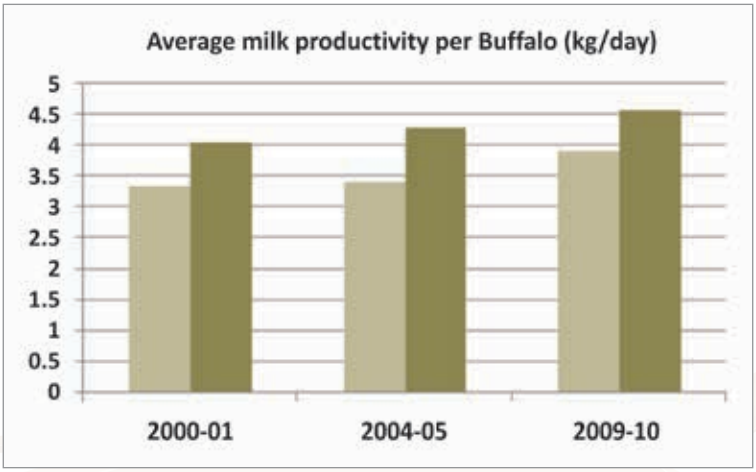
CATTLE GENETIC RESOURCES OF BIHAR

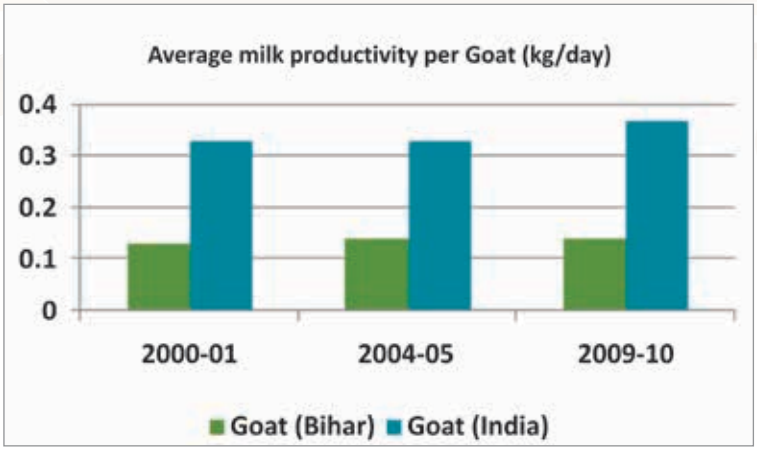
Total mammalian and avian genetic resources of the state are 303.42 and 114.20 lakhs respectively. Among the domestic mammalian livestock species cattle constitutes 41.4%, which is the largest single livestock species of the state. Bihar possesses 6.3% cattle of the country. The total cattle population of Bihar (125.59 lakhs) consists of 105.83 lakhs indigenous and 19.76 lakhs crossbred cattle. During 2003-07 the annual growth rate in indigenous cattle, crossbred cattle and total cattle was recorded as 2.86%, 11.6% and 4.02%, respectively.

During 2009-10, the state of Bihar contributed 61.24 lakh metric ton of milk to the 1164.25 lakh metric ton of total milk produced in India. The total milk produced in Bihar (2009-10) was shared by cross bred (10.74 lakh metric ton), Indigenous cattle (20.23 lakh metric ton), buffaloes (28.07 lakh metric ton) and goat (2.19 lakh metric ton). Average productivity of indigenous cows, cross bred cow, buffalo and goat in Bihar is 6.19, 2.91, 3.92, and 0.14 kg of milk per day. Thus the milk productivity of cross bred cattle, buffalo and goat is below the national average (6.87, 4.57 and 0.37 kg of milk per day). It is also important to mention that indigenous cows are contributing more than one third of milk produced in the state and share of cattle species to the total milk production of Bihar is about 50.6%. The per capita daily availability of milk in Bihar is 175g against the national average of 273g (BAHS, 2012). Therefore, it is important to improve the milk production/productivity by structured genetic improvement programmes separately for indigenous cattle, buffalo, cross bred cattle and goat besides the suitable strategies for the availability of adequate feed and fodder and health management.


Milk production (000' tones) - Trends in Bihar
2500
2000
1500
1000
500
0
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
Indigenous cow
Crossbred cow
Buffalo
Goat


Average milk productivity per Cattle (kg/day)
8
6
4
2
0
2000-01
2004-05
2009-10
Indigenous cow (Bihar)
Indigenous cow (India)
Crossbred cow (Bihar)
Crossbred cow (India)


Average milk productivity per Buffalo (kg/day)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2000-01
2004-05
2009-10



GEOGRAPHICAL DISTRIBUTION OF PURNEA CATTLE

The name of the population has been derived from its place of origin i.e. Purnea district of Bihar. The Purnea cattle are mainly distributed in the Purnea Commissionary of Bihar (Fig. 1) which includes Purnea, Araria, Katihar and Kishnan Ganj districts. Purnea cattle are also found in tarai area of neighbouring country, Nepal. All most all the communities of the area are rearing the breed. Important information regarding breeding tract has been compiled in the Table 1.

Fig-1. Geographical distribution of Purnea cattle in Bihar

Table 1: Important information regarding the breeding tract of Purnea cattle

Parameter	Araria	Katihar	Purnia	Kishan Ganj	Bihar state
Latitude	25°56'30" to 26°35'15" N	25°42'- 26°22'N	25°13'- 27°7' N	25°20'- 26°30' N	24°-20'-10" ~ 27°-31'-15" N
Longitude	87°02'30" to 87°42'45" E	87°10'-88°05' E	86°59'-87°52' E	87°7'-88°19' E	82°-19'-50" ~ 88°-17'-40" E
Total area (Sq Km)	2,830	3,057	3,229	1,884	94,163
Total population (2011)	2,806,200	3,068,149	3,273,127	1,690,948	10,38,04,637
Male	1,460,878	1,601,158	1,695,829	868,845	5,41,85,347
Female	1,345,322	1,466,991	1,577,298	822,103	4,96,19,290
Density of Population (per Sq Km.)	992	1,004	1,014	898	1,102
Sex Ratio (♀/'000 ♂)	921	956	930	946	916
Male Literacy rate (%)	64.15	60.99	61.09	65.56	73.39
Female Literacy rate (%)	45.18	45.37	43.19	47.98	53.33
Rate of Literacy (%)	55.10	53.56	52.49	57.04	63.82
Soil description	Recent alluvium and calcareous soil	Alluvial soil	Alluvial soil	Light Sandy soil	1.Swamp Soil - West Champaran district. 2.Terai Soil - Northern region along Nepal border. 3.Gangetic Alluvium - Bihar plains
Major Rivers	Kosi, Suware, Koli and Keli	Ganga, Mahananda Kosi/ Koshi, Righa	Kosi, Panwar, Mahananda, Koska, Ganga	Mahananda, Kankai, Mechi, Donk, Ratua	Ganga, Sone, Gandak and Damodar
Maximum Temperature (°C) (May)	40	43	45.5	41	35-45
Minimum Temperature (°C) (January)	7	8	8.8	5	2–10

Average Annual Rainfall (mm) 2000-2010	1195.3	1297.8	1411.5	2250	1052.6
Major rain months			**July-September**		
Average Humidity			**70% & above**		
Area under forest, Hectares (%) (2008-09)	838 (0.3)	1785 (0.6)	113	354 (0.2)	621635 (6.6)
Barren/Un-cultivated land Hectares (%)	5009 (1.8)	22109 (7.6)	12329 (3.9)	11198 (5.9)	431770 (4.6)
Permanent Pasture area Hectares (%)	230 (0.1)	131 (0.0)	50 (0.0)	421 (0.2)	15869 (0.2)
Net area sown/ Agricultural land Hectares (%)	185474 (68.3)	161158 (55.3)	195255 (62.2)	118957 (62.9)	5554083 (59.3)
Cropping Intensity	1.45	1.61	1.32	1.32	1.38
Total irrigated area (Ha) (2008-09)	112612	144098	151137	44877	4691620
Major cultivated crops	Paddy, Wheat, Maize, Millet, Cereals and Vegetables	Paddy, maize, wheat, vegetables, and pulses	Paddy, potatoes, wheat, sugarcane	Wheat, soyabean, maize, jowar, paddy, mustard	Paddy, wheat, lentils, sugarcane, jute

Table 2: Bovine statistics in the breeding tract

Parameter	Araria	Katihar	Purnia	Kishan Ganj	Bihar state
Crossbred cattle ('000)	1.6	7.7	0.1	8.2	1274
Indigenous cattle ('000)	462	392	259	397	9455
Buffalo ('000)	197	71	45	184	5743
Crossbred cattle (CB) density/sq. km	1	3	0	3	14
Indigenous cattle density /sq. km	163	128	137	123	100
Buffalo /sq. km	70	23	24	57	61
Adult CB cattle unit male('000)	0.14	0.42	0	1.14	125
Adult CB cattle unit female ('000)	0.96	5.38	0.08	4.47	797.9
Adult CB cattle unit total('000)	1.1	5.8	0.1	5.6	922.8
Adult Ind. cattle unit male('000)	155	108	98	116	3468
Adult Ind. cattle unit female ('000)	177	175	95	180	3847

Adult Ind. cattle unit total('000)	332	283	193	295	7315
Adult Buffalo unit male('000)	41	14	16	40	553
Adult Buffalo unit male('000)	96	40	16	81	3559
Adult Buffalo unit male('000)	137	53	31	121	4112
Milk Production ('000 tonnes)	35.72	21.25	17.86	51.15	4847.59
Milk density Lit/day/sq.km.	35	19	26	43	141
Per capita milk availability (g/d)	42.8	22.6	35.1	51.2	148.8
Total AI done	972	3328	4680	1256	718256

SURVEY OF PURNEA CATTLE

Visits were made to different villages of its breeding tract to collect the information on Purnea cattle. The villages were selected in consultation with Bihar Veterinary College, Patna and State Animal Husbandry Department, Bihar. Identified villages included Mahendrapur, Chattia and Bhatgawama of Purnia block, Damgarha and Bhotia villages of Dhamdaha block (Purnia diatrict) and Bochi, Rampur and Manikpur villages of Araria district. Information on the morphological traits (body length, height at wither, heart girth, paunch girth, horn length, ear length, face length and tail length without switch) were collected on 205 animals of different age and sex groups. Information on physical and performance traits and management practices was obtained through interview of cattle owners on a pre-designed questionnaire recommended for the purpose. The data on phenotypic and morphometric traits were analysed as per standard statistical procedures described by Snedecor and Cochren (1989).

STATUS OF PURNEA CATTLE

The bovine statistics in the breeding tract of Purnea cattle has been presented in Table 2. The population status of the Purnea cattle is normal but showed a declining trend especially in last two decades (Singh, 2009). In the current census of livestock, 2007, the population

of Purnea cattle has been reported to be 1,47,988 of which 1,39,488 are in Bihar and 8,500 in Jharkhand state. The artificial insemination programme in the area is providing an opportunity to breed the animals with the semen of Hariana, Sahiwal, Red Sindhi, Tharparkar indigenous breeds and Jersey and Holstein Friesian (HF) crossbreds. This is diluting the breed especially nearby cities and towns. Therefore, there is a need to develop breeding Purnea bulls of high genetic merit, which may be used on cows of farmers' herds either through Artificial Insemination (AI) or natural mating.

PHYSICAL CHARACTERISTICS

The animals are of small size and compact body. The coat colour of Purnea cattle ranges from light to deep red and some greyish white animals are also seen especially nearby district headquarters (Fig. 2). Therefore, it would be more appropriate to call the breed as Purnea rather than Red Purnea.

The head profile is straight in almost all the females but slightly budged fore head is seen in males. The face is small and triangular in appearance (Fig. 3). Eyes are black and bright.

The colour of eyelid, muzzle and tail switch are mostly black. The body is short. The horns are also short, set in a crescent shape and point forward. The ears are horizontal in orientation. The limbs are short and thin (Fig. 4). Majority of animals of Purnea cattle possess small but well defined hump, which is better developed in males. The dewlap size is small to medium (Fig. 2).

Fig-2. Coat colour variation in Purnea cattle

Fig-3. Face of Purnea Cattle

The udders are small in size and bowl in shape (Fig. 5). The teats are funnel shaped with pointed tips ranging from 2.5 to 4 cm in length (Fig. 6). The milk vein is poorly developed. The temperament of animal is docile.

MORPHO-METRIC MEASUREMENTS: The body length, chest girth, height at withers, paunch girth, face length, tail length with and without

Fig-4. Limbs of Purnea Cattle

Fig-5. Fore udder of Purnea Cattle

Fig-6. Rear udder of Purnea Cattle

switch, horn length and ear length are measured in 205 animals belonging to different age/ sex groups. The body measurements are presented in the Table 3. The body length, height at withers and chest girth of Purnea cattle is less than Bachaur cattle reported by Anonymous (2004) and Gangatiri cattle reported by Singh *et al* (2007). This indicates that Purnea is the smallest breed of cattle found in Bihar. The morphometry of Purnea cattle is higher than the Malnad Gidda cattle which is considered as a dwarf cattle of Karnataka as reported by Singh *et al* (2008).

Table 3. Biometry (in cm) of Purnea Cattle (Mean ± S.E.)

Trait	Cows	Bullocks	Young Stock Male (1-3 years)	Young Stock Female (1-3 years)	Calves (<1 year)
Body Length	101.2±0.56 (84-114) N=88	104.2±1.61 (94-117) N=16	83.76±1.86 (69-102) N=21	86.97±1.03 (62-105) N=58	65.36±2.07 (50-82) N=22
Chest Girth	131.6±0.99 (110-154) N=85	135.86±3.00 (115-156) N=14	103.05±2.62 (84-128) N=21	108.38±1.60 (78-134) N=58	76.91±3.03 (51-105) N=22
Height	103.31±0.58 (79-112) N=88	108.38±2.43 (82-128) N=16	90.05±1.64 (76-105) N=21	92.21±0.95 (71-110) N=58	73.27±2.25 (50-90) N=22
Paunch Girth	136.4±1.26 (112-165) N=84	137.9±3.14 (122-158) N=14	104.67±2.76 (84-130) N=21	110.9±1.89 (73-142) N=58	75.32±3.24 (52-109) N=22
Face Length	38.25±0.33 (18-47) N=87	41.31±0.66 (39-48) N=16	32±0.98 (21-41) N=21	33.12±0.43 (24-40) N=58	23.36±1.03 (16-30) N=22
Tail Length Without Switch	69.97±0.75 (55-86) N=71	73.53±1.37 (64-84) N=15	53.37±2.0 (40-72) N=19	57.75±1.10 (38-79) N=56	38.90±1.86 (26-52) N=20
Tail Length With Switch	92.14±1.10 (67-113) N=71	98.13±1.94 (85-110) N=15	72.26±3.06 (50-96) N=19	76.55±1.34 (45-105) N=56	47.75±2.57 (30-65) N=20
Horn Length	6.85±0.38 (1-18) N=86	8±1.32 (2-23) N=16	2.5±0.56 (1-5) N=10	2.63±0.25 (1-7) N=38	--
Ear Length	20.01±0.18 (11-26) N=87	20.94±0.50 (18-25) N=16	18.14±0.30 (16-21) N=21	18.34±0.21 (13-22) N=58	14.95±0.55 (12-19) N=22

N refers to number of observations; figures in parenthesis indicate range.

PERFORMANCE TRAITS

The age at sexual maturity in males is about 2.5 to 3.0 years and age at first calving of cows ranges from 3 to 4 years of age. The average daily milk yield of cows is 0.5 to 2.0 kg with about 4.5% of fat. The milking of cows is done only to meet the requirement of the family and not for sale. The lactation length varies between 5 to 8 months and calving interval 15-24 months. The bullocks of the Purnea are in good demand. Due to low cost of Purnea

bullocks, they come within range of purchasing power of small/marginal farmers for different agricultural operations.

MANAGEMENT PRACTICES

***Herd Size*:** The herd size varies between 3 to 25. Mostly the farmers are keeping about 5-10 animals (Fig. 7).

Fig-7. Herd of Purnea cattle

Housing management: During day the animals are either sent for grazing or kept in open space. The feeding trough is made of cement and earthen material for providing them chaffed dry/ green fodder (Fig. 8a). The animals are kept in shelters made nearby the farmers' houses during night (Fig. 8b). The roof of animal houses is generally made up of thatched/ tin. The floor is katcha type. Drainage system is not provided in the animal houses. The half wall is found in most of the animal houses, which is generally made up of mud/ bamboo chips.

Fig-8a. Open housing during day

Fig- 8b. Closed housing during night

Fig- 8 (a-b). Type of housing

Feeding management: The animals are kept under zero or very low input system of management. The animals are sent for grazing during noon to evening hours. The grazing hours are generally 8-11 a.m. to 4-5 p.m. The bullocks and calves under 6 months of age are not sent for grazing. In the evening they are tied in closed houses nearby the farmers' houses. Grass and dry fodder (mainly paddy straw) is offered to animals by the farmers in the morning and/or evening. The dry and green fodder is offered after chaffing with chaff cutter or locally made sharp knives (Fig. 9 a-e). Little amount of concentrate including maize, bajra and wheat (250 to 500g/d) is also offered to the animals by few farmers.

a. Menger

b. Storage of dry fodder

c. Green fodder

d. Chaffing of dry fodder

e. Feeding with dry and green fodder

Fig-9 (a-e). Feeding management

***Calf management*:** The calves (Fig. 10 a-c) are fed from udder of their dams. The farmers feed the calves with the colostrum in the first fortnight of the calving. The removal of placenta is in its natural way and manual removal of placenta is not reported by the farmers. The majority of the farmers do not practice the de-worming of the calves. However, no severe incidence of gastro-intestinal infestation is reported by the farmers.

Fig.-10 (a-c). Purnea Calves

BREEDING MANAGEMENT

Breeding Policy of state: The state of Bihar has made its breeding policy for genetic improvement of cattle and Buffalo. All the distrcts of Bihar have been classified into nine groups (Clusters) for making area specific breeding policy. The breeding tract of Purnea cattle is covered in two clusters. The districts of Araria, Kishan ganj and Purnia have been classified as harsh climate zone with poor resources in the North Eastern parts of Bihar. The breeding policy of this area states genetic improvement of cattle by using the Red Sindhi and Gir breeds of cattle. In this cluster no crossbreeding will be taken up. For buffaloes, Mehsana and Murrah breeds will be used in this cluster. The district Katihar has been classified as harsh climate zone with relatively better resources in the North Eastern parts of Bihar. As per state breeding policy of this cluster, genetic improvement of cattle will be taken up by using the Red Sindhi and Gir breeds of cattle. In this cluster crossbreeding will be taken up by using Jersey breed and maximum exotic inheritance will be 50%, however the crossbreeding will be a low priority for this cluster. For buffaloes, Mehsana breed will be used in this cluster.

Breeding management of Purnea cattle: In the remote villages adequate numbers of Purnea breeding bulls are available for the breeding purposes through natural mating (Fig. 11 a-c). However, in the area near by AI centres/ towns, the breed has been upgraded with the use of semen of exotic and indigenous milch cattle breed's bull. At the veterinary hospitals there is good demand of semen of indigenous breeds but the supply is not adequate enough to fulfill the demands of farmers. The farmer's preference order for breeding the cows is found to be Sahiwal, Red Sindhi, Hariana and Tharparkar bulls' semen. The veterinarian of the area also informed that the proportion of AI through indigenous breed

may go upto 80%, if the supply of semen of these breeds is maintained through out the year. In such circumstances the pure specimen of the

Fig-11 (a-c). Purnea Bulls

breed are available in the interior villages and the dilution in the breed purity is seen in the areas nearby towns. The farmers are well aware of signs of estrous and right time of AI in the cows.

Castration of males: The castration of males is practiced at the age of 6 months to two years of age.

Prophylactic measures and Disease control: The animal of this population possess resistance to various infectious/communicable diseases and ecto-parasitic infestations. The vaccination cover to the animals is hardly 10-15% for Haemorrhagic Septicaemia (HS) and 5% for Foot & Mouth Disease (FMD) but animals are reported to be more resistant to these diseases as compared to crossbreds. It was also informed that animals are comparatively more resistant to the FMD and if it happened, mouth lesions are less than foot lesions and animals recovered with in 3-4 days. H.S. is also less and there is less mortality among affected animals as compared to the other groups of cattle and buffaloes.

Utility: The Purnea animals are playing a significant role in the rural livelihood of small and marginal farmers in terms of draft, milk and manure. The bullocks are well suited to agricultural operations and rural transport in the area (Fig. 12). The bullocks can plough 0.3 to 0.6 acres of land in a day and can pull 4 quintals of load at the speed of 4 kmph. The bullocks are available at less price (Rs.5 to 10 thousand) as compared to Shahabadi or Bachaur bullocks (Rs 15 to 25 thousand), therefore, suited to the small and marginal farmers. The dung of animals is used for fuel and manure purposes. Small amount of milk produced by the cows fulfill the requirement of the family. Since the animals are well suited to the climate of the area and comparatively resistant to diseases and tolerant to the heat, the management of animals becomes cheaper to the farmers.

Fig-12. Draft utility of Purnea Cattle (Carting)

MOLECULAR CHARACTERIZATION

Blood samples were acquired from 50 random and unrelated Purnea animals from the breeding region following the guidelines of MoDAD (Measurement of Domestic Animal Diversity) programme (FAO 1995). To ensure unrelatedness of animals due to nonexistence of pedigreed account under field situations, animals were selected from distinct villages after interviewing the owners in detail. Blood samples (5-6 ml) were collected in vacutainer containing ethylene diamine tetra acetic acid (EDTA). Genomic DNA was extracted from whole blood using Phenol-Chloroform protocol (Sambrook *et al*. 1989).

PCR amplification and genotyping: A panel of 23 bovine-specific microsatellite markers (Table 4) selected from the recommended list of

the Food and Agricultural Organization (FAO 1998) and the International Society for Animal Genetics (ISAG) was used in this study for estimating within breed genetic variability in Purnea cattle. PCR was performed with 50-100 ng genomic DNA in a 25 µl reaction volume. 200µM of each dNTP, 50pMol of each primer and 0.5 units of Taq DNA polymerase was used for reaction. The reaction cycle was accomplished by denaturation for 1 min at 94°C; 30 cycles of 94°C for 1 min, precise annealing temperature of primer for 1 min, 72°C for 1 min and finally extension at 72°C for 5 min. The PCR products were then checked on 1.8% agarose gel followed by genotyping on ABI-3100 DNA sequencer. Genotypes were assigned using GeneMapper software package (Applied Biosystems, Foster city, CA, USA).

Table 4: Characteristics of 23 microsatellite loci used in study

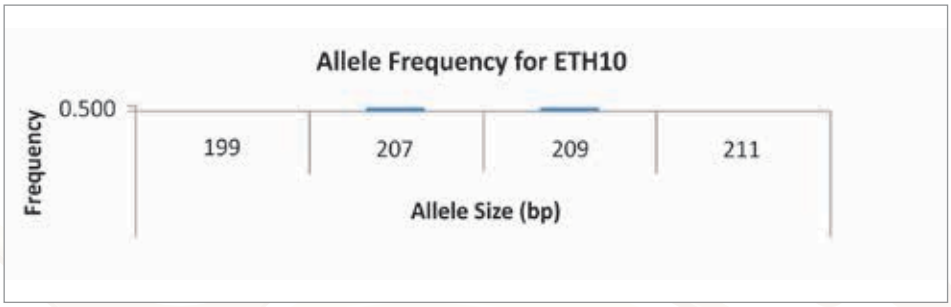
Sr. No	Primers	Primer No.	Primer Sequences (5'-3')	No. of bases	Forward label	Annea. Temp °C	Product Size (bp)
1.	BM1824	Primer 1 Primer 2	gagcaaggtgtttttccaatc cattctccaactgcttccttg	21 21	VIC	58	176-196
2.	CSSM008	Primer 1 Primer 2	cttggtgttactagccctggg gatatatttgccagagattctgca	21 24	VIC	55	182-200
3.	CSSM033	Primer 1 Primer 2	cactgtgaatgcatgtgtgtgagc cccatgataagagtgcagatgact	24 24	NED	58	144-188
4.	CSSM66	Primer 1 Primer 2	acacaaatcctttctgccagctga aatttaatgcactgaggagcttgg	24 24	FAM	60	167-207
5.	ETH10	Primer 1 Primer 2	gttcaggactggccctgctaaca cctccagcccactttctcttctc	23 23	NED	58	185-221
6.	ETH3	Primer 1 Primer 2	gaacctgcctctcctgcattgg actctgcctgtggccaagtagg	22 22	VIC	64	90-124
7.	ETH225	Primer 1 Primer 2	gatcaccttgccactatttcct acatgacagccagctgctact	22 21	NED	57	134-162
8.	HEL1	Primer 1 Primer 2	caacagctatttaacaagga aggctacagtccatgggatt	20 20	PET	59	102-120
9.	HEL9	Primer 1 Primer 2	cccattcagtcttcagaggt cacatccatgttctcaccac	20 20	FAM	59	140-182

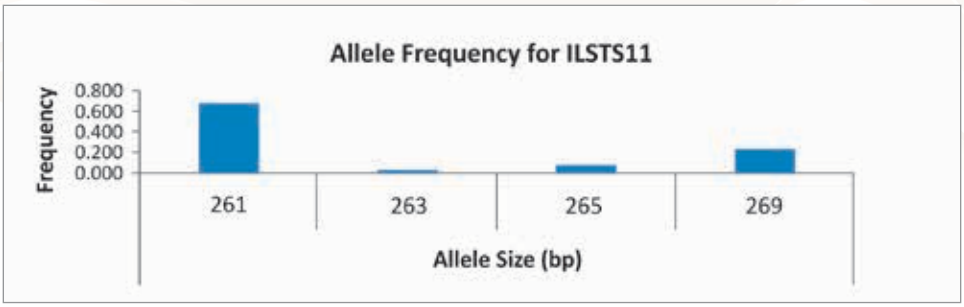
10.	HEL5	Primer 1 Primer 2	gcaggatcacttgttaggga agacgttagtgtacattaac	20 20	VIC	55	137-195
11.	ILSTS005	Primer 1 Primer 2	ggaagcaatgaaatctatagcc tgttctgtgagtttgtaagc	22 20	NED	55	160-210
12.	ILSTS006	Primer 1 Primer 2	tgtctgtatttctgctgtgg acacggaagcgatctaaacg	20 20	FAM	58	275-303
13.	ILSTS011	Primer 1 Primer 2	gcttgctacatggaaagtgc ctaaaatgcagagccctacc	20 20	NED	58	249-273
14	ILSTS034	Primer 1 Primer 2	aagggtctaagtccactggc gacctggtttagcagagagc	20 20	VIC	59	138-212
15.	ILSTS033	Primer 1 Primer 2	tattagagtggctcagtgcc atgcagacagttttagaggg	20 20	PET	55	131-163
16.	INRA005	Primer 1 Primer 2	caatctgcatgaagtataaatat cttcaggcataccctacacc	23 20	FAM	54	130-148
17.	INRA035	Primer 1 Primer 2	atcctttgcagcctccacattg ttgtgctttatgacactatccg	22 22	FAM	54	80-142
18.	INRA063	Primer 1 Primer 2	atttgcacaagctaaatctaacc aaaccacagaaatgcttggaag	23 22	PET	54	162-190
19.	MM12	Primer 1 Primer 2	caagacaggtgtttcaatct atcgactctggggatgatgt	20 20	PET	52	88-133
20.	MM8	Primer 1 Primer 2	cccaaggacagaaaagact ctcaagataagaccacacc	19 19	NED	55	114-144
21.	TGLA122	Primer 1 Primer 2	ccctcctccaggtaaatcagc aatcacatggcaaataagtacatac	21 25	VIC	58	133-179
22.	TGLA227	Primer 1 Primer 2	cgaattccaaatctgttaatttgct acagacagaaactcaatgaaagca	25 24	PET	55	67-119
23.	TGLA53	Primer 1 Primer 2	gctttcagaaatagtttgcattca atcttcacatgatattacagcaga	24 24	FAM	58	142-184

Molecular genetic analysis: The microsatellite data were analyzed using software GenAlEx 6.2 (Peakall and Smouse 2008) to calculate allele frequencies, observed (No) and effective number of alleles (Ne), observed (Ho) and expected heterozygosity (He) and heterozygote deficit (F_{IS}) in the whole population. Across the 23 microsatellites scrutinized, a total of 204 distinct alleles were identified in Purnea. The allele frequency data revealed a reasonable amount of polymorphism in Purnea cattle. The number of observed alleles oscillated between 4 (ETH10, ILSTS11, BM1824) and 15 (TGLA53, MM12) with an overall mean number of alleles (MNA) per

locus of 8.870±0.72. FAO has specified a minimum of four distinct alleles per locus for proficient judgment of genetic differences between breeds. All the 23 microsatellites employed in this study corresponded with this delineated principle and thus signified ample polymorphism and their suitability for evaluating genetic variation within breed and exploring genetic differences between breeds. The observed number of alleles for all the loci exceeded the effective number of alleles which varied from 1.871 (TGLA227) to 8.0 (HEL09) with a mean of 4.179±0.384 (Table 5). The mean observed number of alleles in this study for Purnea cattle population was similar in magnitude to Binjharpuri (8.8, Sharma *et al*. 2011). Higher mean number of alleles per locus has been reported in some other indigenous cattle breeds/ populations viz. Tharparker-9, Rathi-9.6 (Sodhi *et al*. 2008), Ghumsuri-9.4 (Sharma et al. 2011), Kumaun hill cattle-9.7 (Pandey *et al*. 2010) and Motu-10.04 (Pandey *et al*. 2011). However, lower mean number of alleles per locus was also reported in other Indian cattle breeds like Kherigarh-6.24 (Pandey *et al*. 2006a), and Bachaur-6.30 (Sharma *et al*. 2007).

The observed heterozygosity averaged over the 23 loci was 0.688±0.037 which was lower than the expected heterozygosity (Table 5). The average expected heterozygosity (Nei 1973) within the Purnea population diverged

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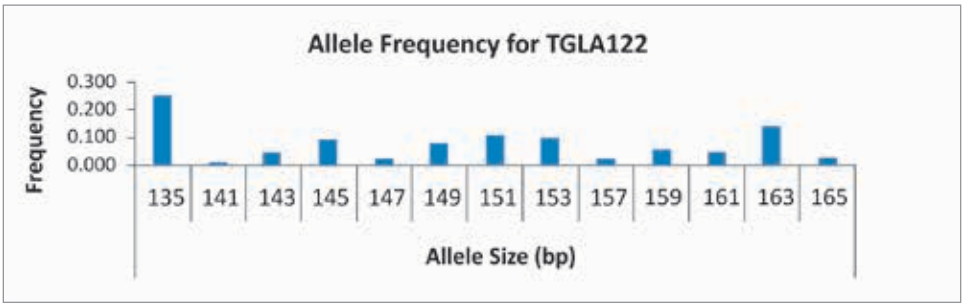
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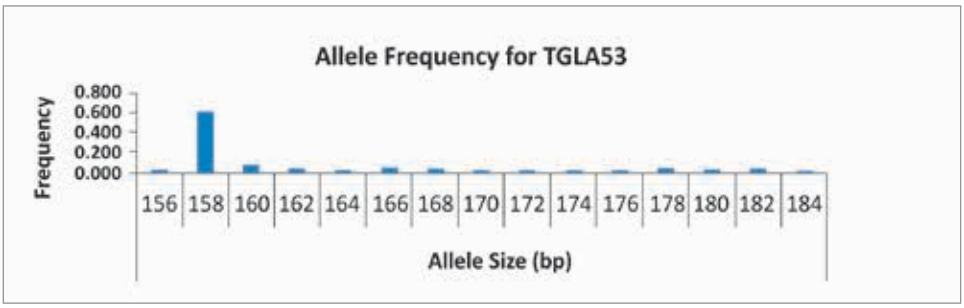
161
163
165
Allele Size (bp)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174
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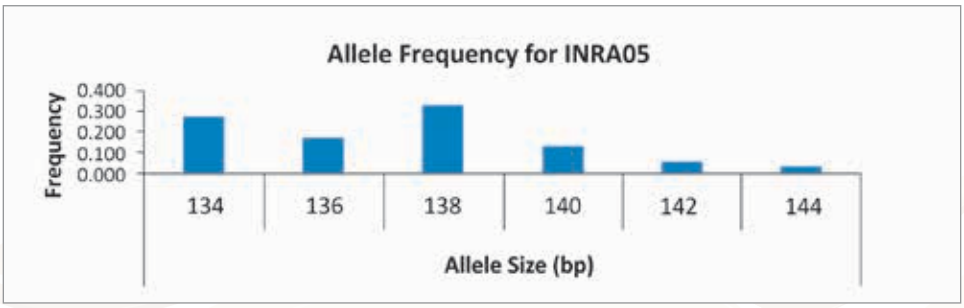
180
182
184
Allele Size (bp)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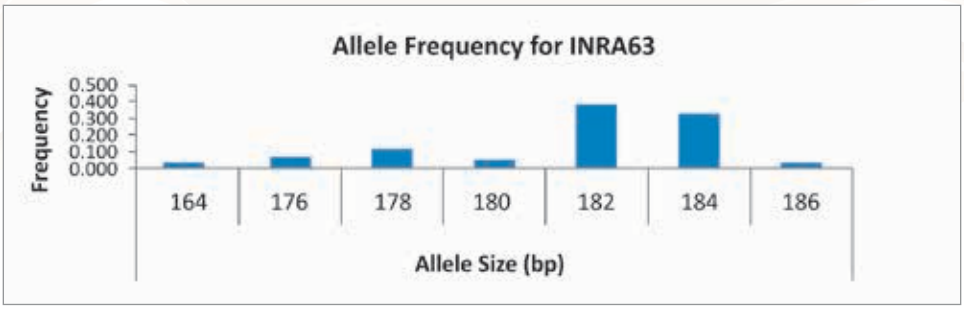
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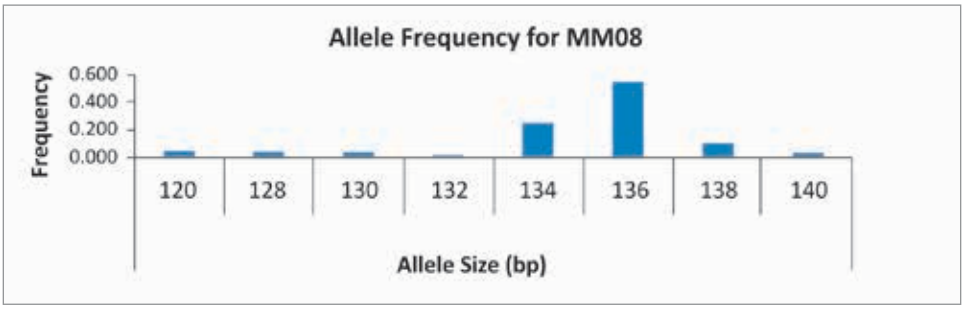
176
178
180
182
184
186
Allele Size (bp)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130
132
134
136
138
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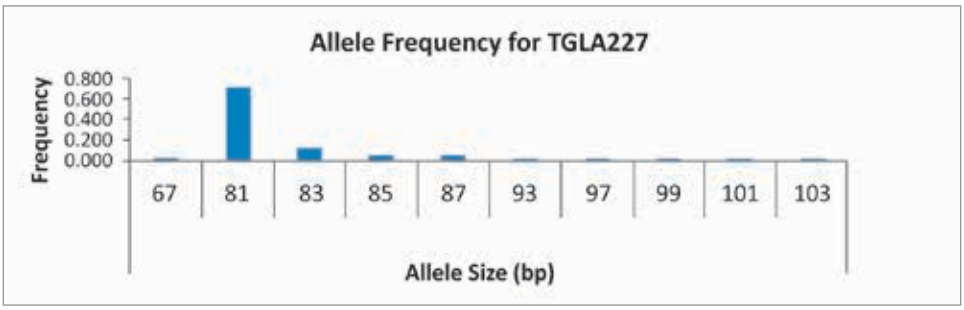
Allele Size (bp)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101
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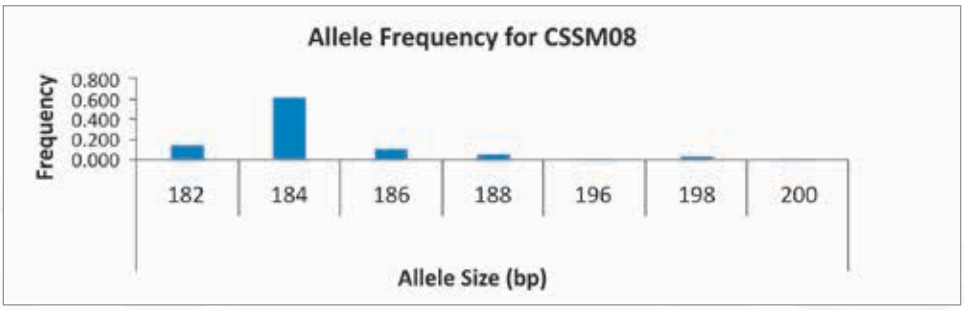
Allele Size (bp)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184
186
188
196
198
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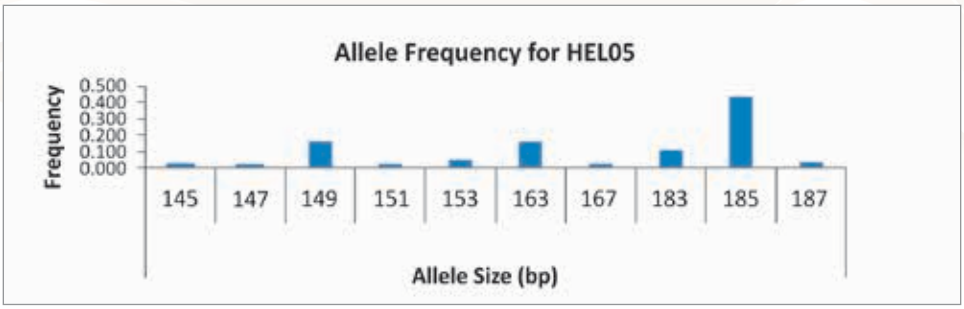
Allele Size (bp)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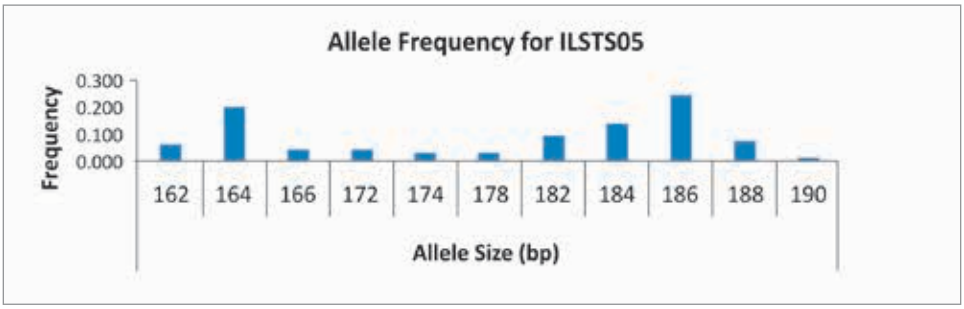
149
151
153
163
167
183
185
187
Allele Size (bp)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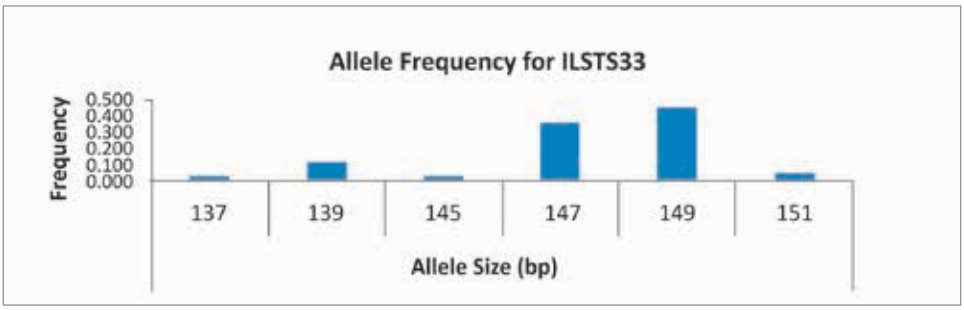
172
174
178
182
184
186
188
190
Allele Size (bp)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149
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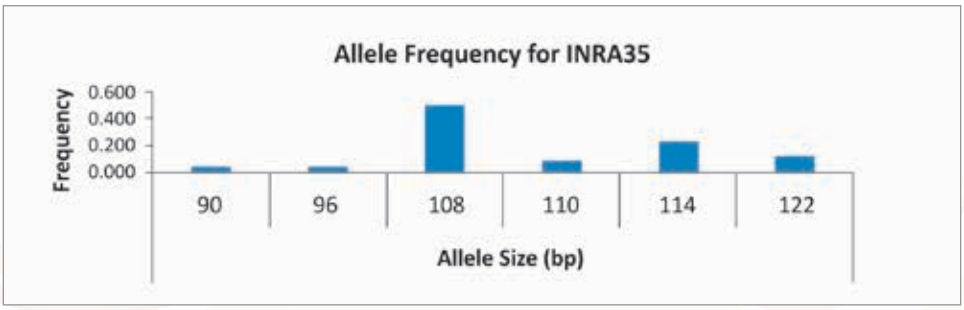
Allele Size (bp)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110
114
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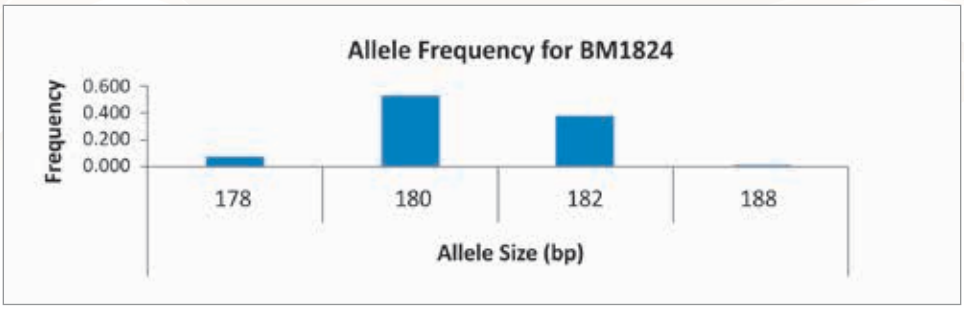
Allele Size (bp)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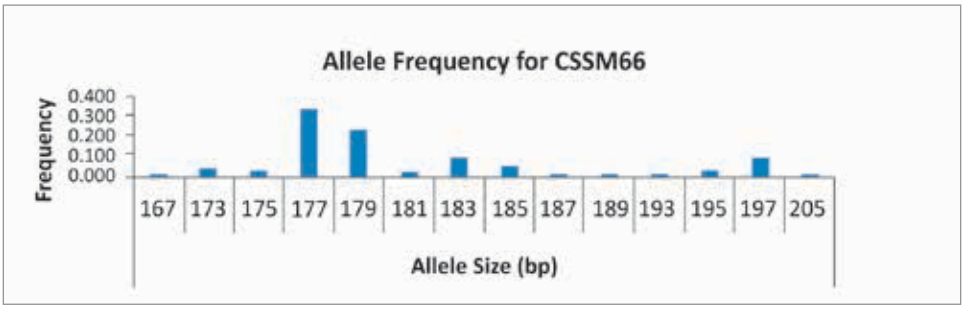
180
182
188
Allele Size (bp)


Allele Frequency for CSSM66
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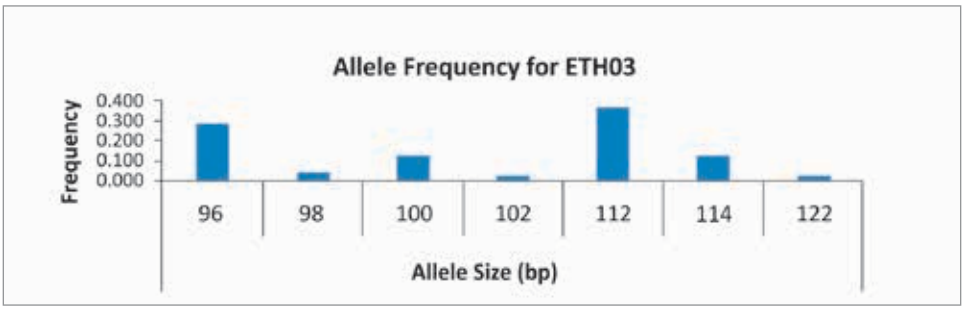
Allele Size (bp)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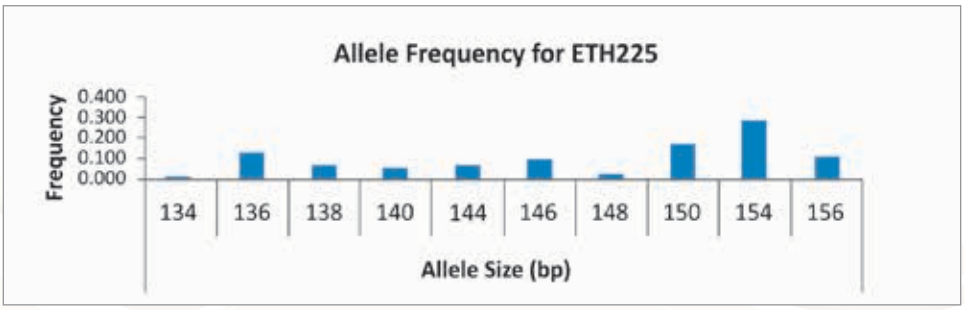
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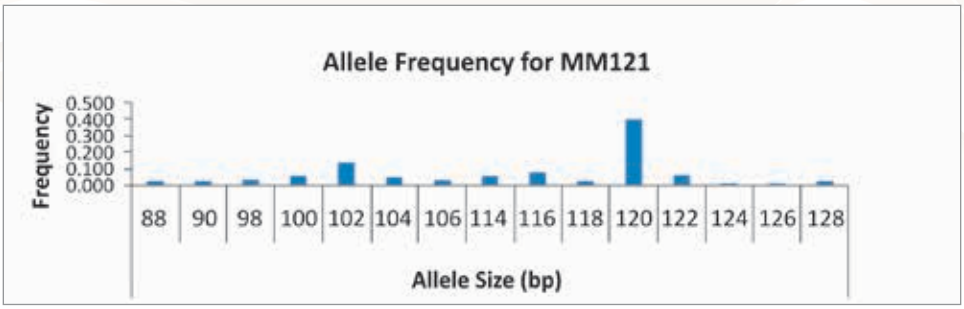
Allele Frequency for MM121
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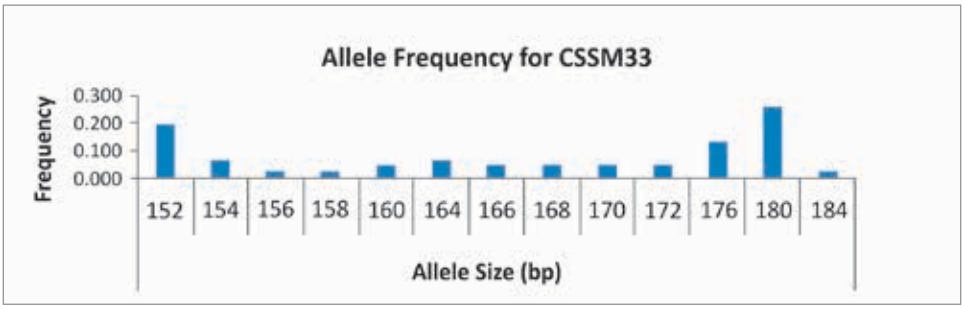
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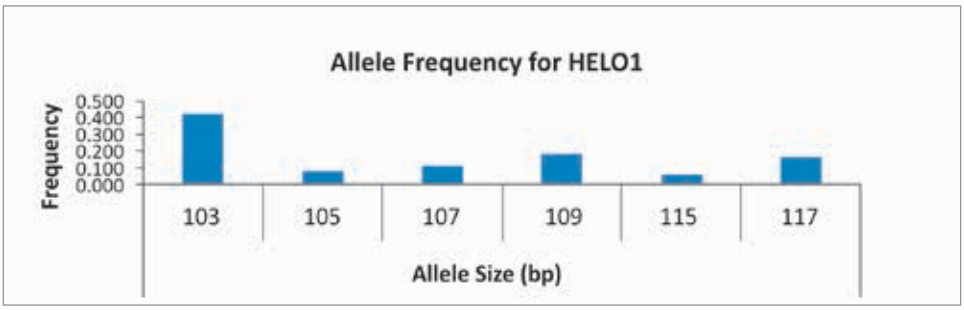
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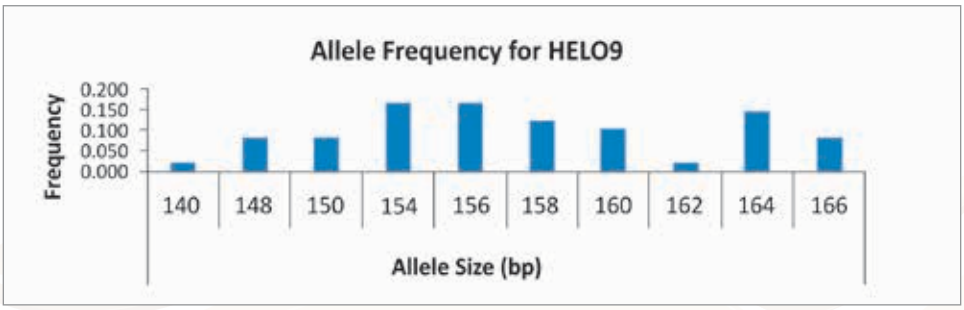
Allele Size (bp)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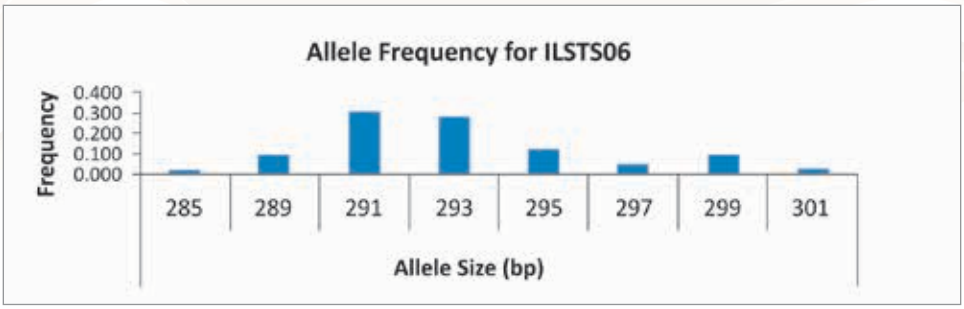
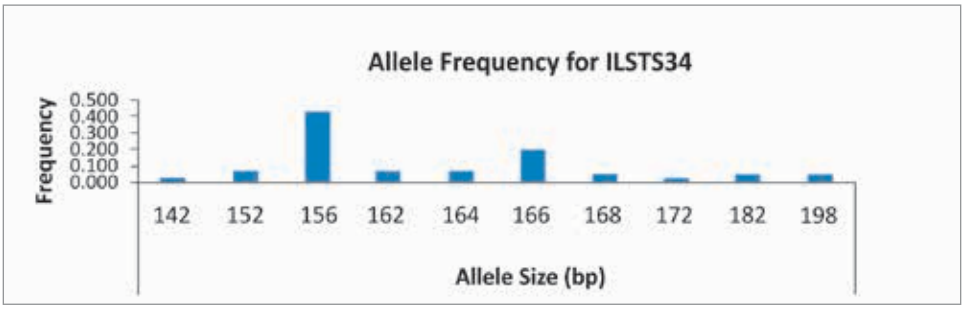




from 0.466 (TGLA227) to 0.875 (HEL09) with an overall mean of 0.714±0.025. Purnea cattle, thus, encompassed considerable measure of genetic variation derived from its gene diversity as estimated against the genetic variation described in several breeds scrutinized worldwide. Fairly comparable levels of heterozygosity were reported in seven Italian cattle breeds 0.6 – 0.68 (Del Bo *et al*. 2001) and five Swiss cattle breeds 0.60-0.69 (Schmid *et al*. 1999). Heterozygosity of similar magnitude has also been reported in Tharparker cattle of India (Ho = 0.64, He = 0.72) by Sodhi *et al*. (2008) and Orissa cattle populations (Ho = 0.62-0.66, He = 0.70-0.75) by Pandey *et al*. and Sharma *et al*. (2011). The average observed heterozygosity estimation in this study 0.688±0.037 is marginally higher than illustrated in Kenkatha (Ho = 0.540) by Pandey *et al*. (2006b), Bachaur (Ho = 0.534) by Sharma *et al*. (2007), Deoni (0.59) by Mukesh *et al*. (2004) and in exotic cattle: Brown Swiss (0.563) by Schmid *et al*. (1999) and twelve west/central African cattle breeds 0.506-0.697 (Ibeagha-Awemu *et al*. 2004). However, much lower heterozygosities (0.42 and 0.53) and reductions in number of alleles than

Purnea have been recounted in two Indian zebu cattle breeds viz Sahiwal and Hariana (Mukesh *et al*. 2004) whose populations are on a rapid decline in India.

Table 5: Measures of genetic variation in Purnea cattle of Bihar

Locus	N	No	Ne	Ho	He	F
ETH10	46	4	2.673	0.891	0.626	-0.424
ILSTS11	45	4	1.928	0.422	0.481	0.123
TGLA122	45	13	7.627	0.844	0.869	0.028
TGLA53	44	15	2.557	0.545	0.609	0.104
INRA05	43	6	4.251	0.581	0.765	0.240
INRA63	43	7	3.446	0.837	0.710	-0.179
MM08	43	8	2.703	0.605	0.630	0.040
TGLA227	43	10	1.871	0.302	0.466	0.351
CSSM08	31	7	2.409	0.581	0.585	0.007
HEL05	32	10	3.901	0.844	0.744	-0.135
ILSTS05	32	11	6.715	0.844	0.851	0.009
ILSTS33	32	6	2.864	0.531	0.651	0.184
INRA35	29	6	3.081	0.621	0.675	0.081
BM1824	47	4	2.297	0.404	0.565	0.284
CSSM66	47	14	5.084	0.745	0.803	0.073
ETH03	47	7	3.899	0.979	0.744	-0.316
ETH225	47	10	6.258	0.851	0.840	-0.013
MM12	47	15	4.909	0.787	0.796	0.011
CSSM33	23	13	7.007	0.826	0.857	0.036
HEL01	19	6	3.903	0.684	0.744	0.080
HEL09	24	10	8.000	0.833	0.875	0.048
ILSTS06	21	8	4.691	0.619	0.787	0.213
ILSTS34	23	10	4.054	0.652	0.753	0.134
Mean	37.087	8.870	4.179	0.688	0.714	0.043
SE	2.094	0.720	0.384	0.037	0.025	0.037

N=Sample Size, No= observed no. of alleles; Ne = effective no. of alleles; Ho = observed heterozygosity; He = expected heterozygosity; F/F_{IS} = heterozygote deficiency

Within-population inbreeding estimate f(F_{IS}) was significantly positive as derived from table wide randomizations ($P< 0.05$). The f-estimates ranged between -0.424 and 0.351 with an average of 0.043. Thus on an average a shortfall (4.3%) of heterozygotes existed in the Purnea population. Eighteen out of 23 microsatellite markers, contributed to this observed heterozygote shortage. The F_{IS} values obtained in present study were lower than several other Indian cattle breeds and this was expected owing to more number of alleles and higher heterozygosity values. Higher heterozygote deficiency than the Purnea cattle (0.043) has been observed in several Indian cattle like Kumaun Hill cattle and Ghumsuri (F_{IS} = 0.08, Pandey *et al.* 2010, Sharma *et al.* 2011), Binjharpuri (F_{IS} =0.10, Sharma *et al.* 2011), Motu (F_{IS} = 0.113, Pandey *et al.* 2011), Sahiwal (F_{IS} = 0.32) by Mukesh *et al* (2004), Bachaur (F_{IS} = 0.22) by Sharma *et al* (2007) and Gangatiri (F_{IS} = 0.31) by Sharma *et al* (2006).

Numerous factors viz., inbreeding, locus under selection (genetic hitchhiking), null alleles (non amplifying alleles) and occurrence of population sub structure (Wahlund effect) have been established as responsible for insufficiency of heterozygotes in a population (Nei 1987). Non-accessibility of adequate quantity of breeding bulls in the population could be the predictable basis for the ascertained deficiency of heterozygotes. Null alleles are largely unlikely to be segregating at all the loci. Likewise prospective Wahlund effects (localities with subpopulations) may not account significantly for the observed heterozygote deficit. The inbreeding detected in this population may be a manifestation of declining population size, coupled with lack of sufficient number of breeding males in the breeding region.

Relationship of Purnea cattle with other local and descript cattle populations of the region: An attempt was made to specifically quantify the genetic status and diversity of Purnea cattle with lesser known indigenous cattle populations of Bihar and adjoining region (Fig. 13) and their relationship with established breeds of the same region (Bachaur and Siri) using 21 microsatellite markers. Blood samples from 243 animals were collected (Bachaur-50, Gangatiri-50, Shahabadi-48, Purnea-47 and Siri-48) from different villages of breeding tract, while avoiding closely related individuals. Samples of the populations included in this study represented animals of the original autochthonous phenotype.

Nei's standard genetic distances (Nei 1987) among populations were computed and a pair wise matrix of the genetic distances was then used to obtain a Neighbor-joining (NJ) tree which was visualized using

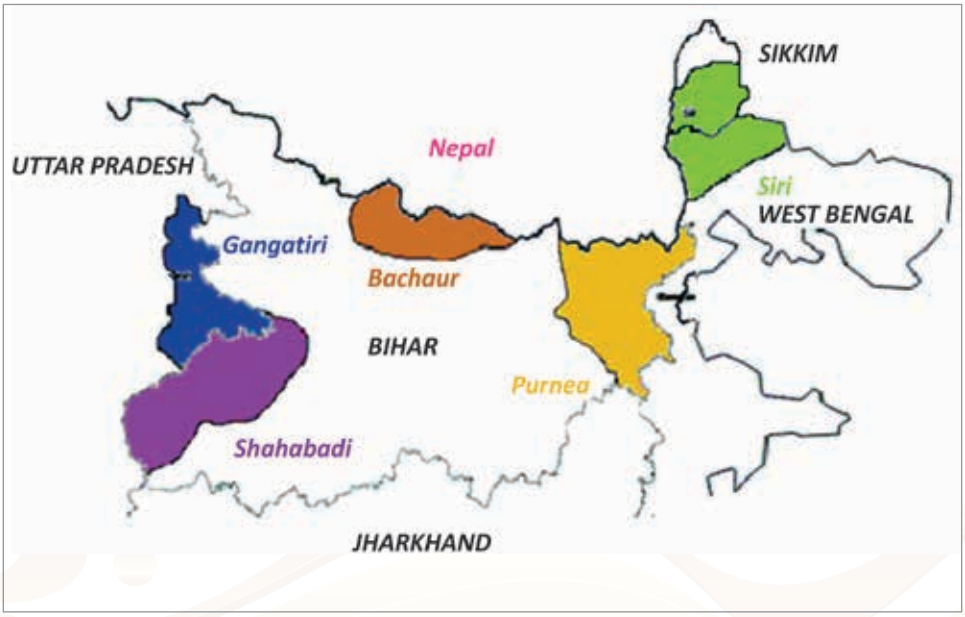


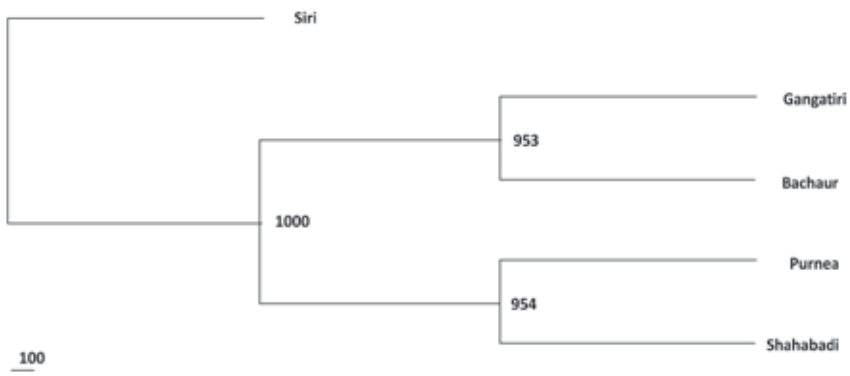
Fig-13. Geographic localization of analysed cattle breeds/populations

the software TreeView (Page 1996). Bootstraps of 1000 replicates were performed in order to test the robustness of tree topology using the Phylip software (Tuimala 2005). Multivariate analysis of microsatellite allele frequencies (Principal Component analysis, PCA) was applied to reveal the underlying evolutionary history and admixture among populations. An alternative model-based Bayesian clustering analysis was used to infer how many clusters or subpopulations (K) were most appropriate for interpreting the data without prior information on the number of locations at which the individuals were sampled as implemented in STRUCTURE v2.2 (Pritchard *et al*. 2000). Analysis was performed with a burn-in length of 50,000 followed by 30,000 MCMC (Marcov Chain Monte Carlo) iterations for each K= 1 to 7 with 5 replicate runs for each K. Optimal K value was selected after analyzing the result files with STRUCTURE Harvester (Earl Dent *et al*. 2012).

Pair-wise genetic differentiations quantified by F_{ST} estimates identified Bachaur and Gangatiri (0.008) as the closest populations while the most differentiated were Purnea and Siri (0.044). Similar results were obtained with Nei's genetic distance matrix. The highest genetic distance was found between Purnea and Siri (0.292), while Bachaur and Gangatiri were closest to each other (0.037) (Fig. 14). In accordance to these observations highest gene flow was among the Bachaur and Gangatiri (Nm= 32.809) populations and least between Purnea and Siri (Nm= 5.408). Overall Nm value also indicated high rate of genetic flow between the populations (10.230±1.922).

Visualization of breed relationship was done by constructing Neighbor joining tree on the basis of Nei's genetic distance (Fig. 14). As expected, the Siri was most distinct and separated first, while remaining populations formed two groups with clustering of Gangatiri and Bachaur on one node and Purnea and Shahabadi on second with more than 95% bootstrap value.

This grouping pattern was further supported by PCA analysis. Since phylogenetic reconstruction may not take into account the effects of admixture between breeds, PCA was performed to further investigate possible genetic relationship between recognized breeds and local populations. First three dimension of the PCA (PC1=40.35; PC2=30.72;



	Bachaur	Gangatiri	Shahabadi	Purnea	Siri
Bachaur	0.000				
Gangitri	0.037	0.000			
Shahabadi	0.191	0.183	0.000		
Purnea	0.189	0.197	0.203	0.000	
Siri	0.154	0.136	0.239	0.292	0.000

Fig-14. Genetic relationship among cattle populations using Nei's distance.

(The number in the branch indicates the percentage occurrence in 1000 bootstrap replicates. Table shows Nei's genetic distance between populations and breeds analyzed.)

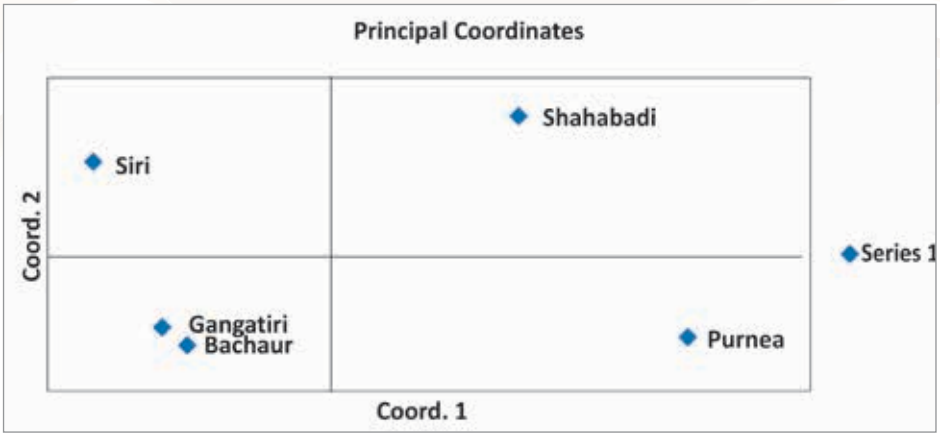


Fig-15. Principal Coordinates Analysis (PCA) via Covariance matrix with data standardization

PC3=22.74) accounted for 93.81% of total variation. In the multivariate space defined by PCA, Bachaur and Gangatiri were much closer (Fig. 15).

It confirmed distinctiveness of Siri as well as lesser known cattle populations of Purnea, and Shahabadi. Among methods not assuming predefined structure, tree-based methods use genetic distance between individuals and tree construction algorithm such as UPGMA or Neighbour-joining to group them in clusters. Similarly, multivariate analyses can help in defining clusters of individuals. However these graphical methods are loosely connected to statistical procedures allowing the identification of homogeneous clusters of individuals.

An alternative approach to delineate clusters of individuals on the basis of their genotypes at multiple loci was also performed using a Bayesian approach employed in software STRUCTURE. It works by grouping individuals into clusters (K) such that Hardy-Weinberg equilibrium is maximized within clusters. Likely value of K which best captured the

variation present in the data was four based on modal value of K versus ΔK distribution following Evano *et al.* 2005. Siri, Purnea and Shahabadi were grouped in their own clusters. However, Bachaur and Gangatiri animals were intermingled in one cluster (Fig. 16).

It is important to mention that breeding tract of Gangatiri and Shahabadi are much closer than Bachaur and Gangatiri geographically. Closeness of Bachaur and Gangatiri instead of Gangatiri and Shahabadi may be due to attempt in field to upgrade local populations with the use of semen of

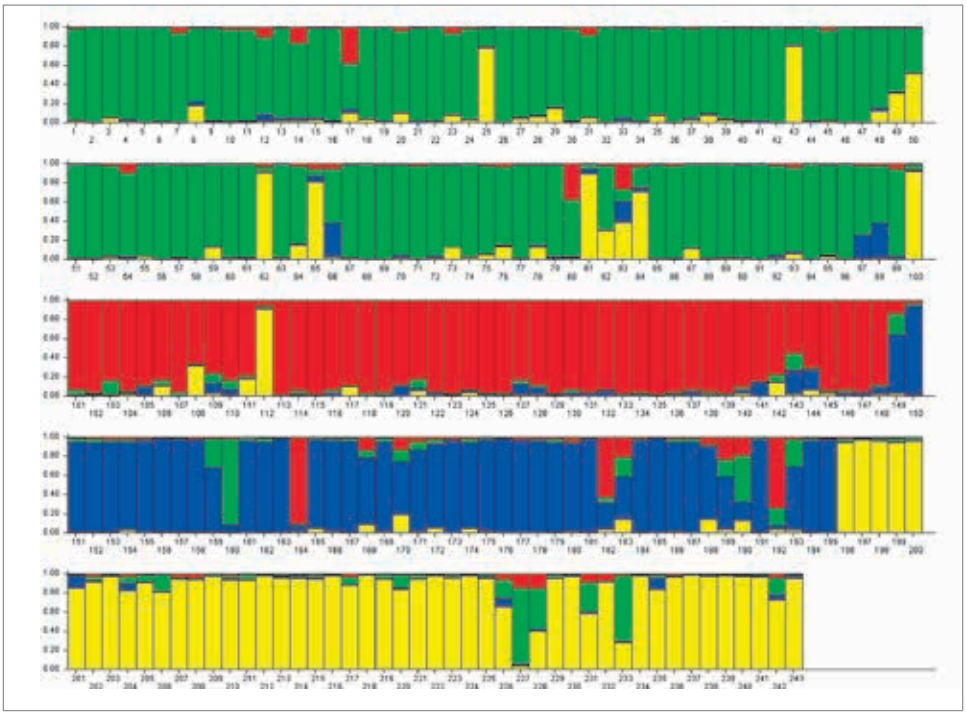


Fig-16. Clustering assignment of 243 animals representing five East Indian cattle populations using STRUCTURE at K=4 arranged by Q values

(Each individual cattle is represented on the graph by a vertical bar divided into K colored segments corresponding to K genetic clusters. The length of each colored segment is proportional to the individual's membership in the cluster of corresponding colour. Shahabadi (Red), Purnea (Blue) and Siri cattle (Yellow) form separate cluster. Bachaur and Gangatiri (Green) cluster in one group.)

indigenous milch (Hariana, Sahiwal, Red Sindhi, Tharparkar) cattle breeds. Secondly the breeding tract of Gangatiri and Shahabadi are separated by river Ganges, which may act as a geographic barrier. Based on present study Siri cattle appeared to be distinct from all other neighboring breeds and populations of eastern region of India. As per literature this was expected also because Bhutan is said to be the real home tract of this breed (Nivsarkar *et al*. 2000). It was distributed from that area to the various parts of Sikkim and Darjeeling region of West Bengal. Presumably Siri cattle had some blood from the cattle in Tibet too. Small cattle with similar black and white markings have been found in Sikong Province of China, which occupies a portion of the Tibetan highlands northeast of Bhutan.

CONCLUSIONS AND RECOMMENDATIONS

The significant level of variability in Purnea cattle is indicative of a valuable reservoir of genetic diversity in this population. This fact coupled with the evident environmental acclimatization emphasizes the instant inevitability for registration of Purnea population as a cattle breed, genetic improvement and its sustainable utilization. It is distinctively indispensable at this point of time to initiate planned and organized breeding, as F_{IS} is indicative of heterozygote deficiency in the population and to check declining trend in the population of the breed. To make a start, breed society needs to be formed, which should be educated and supported for the comprehensive safeguarding and improvement of the breed to make it economically sustainable in the moderating agricultural

scenario of the country. Availability of proven males as well as frozen semen of the breed should also be ensured in the breeding tract.

Points to ponder...

- A detailed survey of the entire breeding tract of Purnea cattle is needed so as to characterize and evaluate this cattle population as well as to develop all the parameters of breed descriptors on the basis of adequate number of observations. The State Animal Husbandry Department in coordination with academic Veterinary Institution(s) may take up this task.

- This cattle population may be registered by State Animal Husbandry department of Bihar with National Bureau of Animal Genetic Resources, Karnal so as to include it as a separate cattle breed of India.

- The Veterinary Institutions/ development agencies working in native tract of Purnea cattle should prepare list of elite Purnea cows. The bull calves born to these elite cows of the breeding tract may be selected and reared at farmers' door/ any organized livestock farm. Subsequently such bulls may be used in the breeding tract on available Purnea cows either through AI or natural service or both. In accordance with the state breeding policy, use of exotic bull semen may be banned in breeding tract of Purnea and upgrading with Red Sindhi/ Gir breeds of cattle may be restricted to resourceful farmers' cows.

- One livestock farm of Purnea cattle may be established in the breeding tract preferably in the Purnea district with the following objectives:
    - To act as nucleus herd of Purnea cattle.
    - To identify elite bull calves from the field, rear them and supply them in field for breeding purpose. Top bulls may also be taken up in AI programme of the state.
    - To act as demonstration unit for the farmers and train the farmers for cattle husbandry practices.
- A Purnea cattle breed society may be established for the development of the breed and protection of farmers'/ animal keepers' rights in the breeding tract. Majority of the elite females maintained under rural management conditions throughout the breeding tract should be registered by the breed society. The breed society may also take up certain programmes of genetic improvement, conservation and health management etc.

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REFERENCES

Anonymous. 2004. Survey and Characterization of Bachaur cattle in its native tract. Final report submitted by Bihar Veterinary College Patna under Network Project on Animal Genetic Resources (ICAR).

BAHS. 2012. Basic Animal Husbandry Statistics. Published by Department of Animal Husbandry Dairying and Fisheries, Ministry of Agriculture, Government of India.

Bradley D G, Machugh D G, Loftus R T, Sow R S, Hoste C H and Cunningham E P. 1994. Zebu-taurine variation in Y chromosome DNA: a sensitive assay for introgression in West African trypnotolerant cattle populations. *Animal Genetics* **25:** 7-12.

Del Bo L, Polli M, Longeri M, Ceriotti G, Looft C, Barre-Dirie A, Dolf G and Zanotti M. 2001. Genetic diversity among some cattle breeds in the alpine area. *Journal of Animal Breeding and Genetics* **118**, 317-325.

Earl Dent A and vonHoldt Bridgett M. 2012. STRUCTURE HARVESTER: a website and program for visualizing STRUCTURE output and implementing the Evanno method. *Conservation Genetics Resources* **4(2)**:359-361.

Edwards C, Dolf G, Lofft C, Loftus R and Bradley D. 2000. Relationship between the endangered Pustertaler-Sprinzen and three related European cattle breeds as analyzed with 20 microsatellite loci. *Animal Geneics* **31,** 329-332.

Evano G, Regnaut S and Goudet J. 2005. Detecting the number of clusters of individuals using the software structure: A simulation study. *Mol Ecol* **14**:2611-2620.

FAO. 1995. Global project for the maintenance of domestic animal genetic diversity (MoDAD)-Draft project formulation report, FAO, Rome, Italy.

FAO. 1998. Food and Agriculture Organization, Rome, repost. http://dad.fao.org/en/refer/library/ guideline/workgrp.pdf

Ibeagha-Awemu E M, Jann O C, Weimann C and Erhardt G. 2004. Genetic diversity, introgression and relationship among West/Central African cattle breeds. *Genetics Seection and Evolution*. **36**: 673-690.

Kim KS, Yeo J S, and Choi C B. 2002. Genetic diversity of north-east Asian cattle based on microsatellite data. *Animal Geneics* **33:** 201-204.

MacHugh D E, Shriver M D, Loftus R T, Cunningham P and Bradley D G. 1997. Microsatellite DNA variation and evolution, domestication and phylogeography of taurine and zebu cattle (*Bos taurus and Bos indicus*). *Genetics* **146:** 1071-1086.

Metta M, Kanginakudru S, Gudiseva N and Nagaraju J. 2004. Genetic characterization of the Indian cattle breeds, Ongole and Deoni (*Bos indicus*), using microsatellite markers – a preliminary study. *BMC Genetics* **5**: 5-16.

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)**: 416-424.

Nei M. 1973. Analysis of gene diversity in subdivided populations. *Proceedings of National Academic Sciences of USA* **70:** 3321-3323.

Nei M. 1987. Molecular evolutionary genetics. Columbia University Press, New York USA.

Nivsarkar A E, Vij P K and Tantia M S. 2000. Animal genetic resources of India: Cattle and buffalo, ICAR, India.

Page R D M. 1996. TreeView: An application to display phylogenetic trees on personal computers. *Comp App in Biosci* **12**:357-358.

Pandey A K, Sharma R, Singh L V, Maitra A and Mishra B P. 2010. Estimation of genetic variability parameters in Kumaun hill cattle (Kumauni cattle) by STR markers. *Indian Journal of Animal Sciences* **81 (2)**: 194–195.

Pandey A K, Sharma R, Singh L V, Maitra A and Mishra B P. 2011. Microsatellite based genetic characterization of Motu cattle. *Indian Journal of Animal Sciences* **81(5)**: 519–20.

Pandey A K, Sharma R, Singh Y, Prakash B and Ahlawat S P S. 2006a. Genetic diversity studies of Kherigarh cattle based on microsatellite markers. *Journal of Genetics* **85(2)**: 117-122.

Pandey A K, Sharma R, Singh Y, Prakash B, and Ahlawat S P S. 2006b. Evaluation of Genetic Variation in Kenkatha cattle by microsatellite markers. *Asian–Australasian Journal of Animal Science* **19(12):** 1685-1690.

Peakall R and Smouse P E. 2008. A heterogeneity test for fine-scale genetic structure. *Molecular Ecology Notes* **17:** 3389-3400.

Pritchard J, Stephensa M and Donnelly P. 2000. Inference of Population Structure Using Multilocus Genotype Data. *Genetics* **155**:945-959.

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.

Sharma R, Pandey A K, Maitra A, Singh L V and Mishra B P. 2011. Diversity analysis of Binjharpuri breed of cattle. *Indian Veterinary Journal* **88(2)**: 23-24.

Sharma R, Pandey A K, Singh L V, Maitra A and Mishra B P. 2011. Genetic variability in Ghumsuri cattle through microsatellite DNA profiling. *Indian Veterinary Journal* **88(3):** 27-28.

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 revelant in mechanized Era. *Korean Journal of Genetics* **29(3):** 369-378.

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.

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 P K, Gaur G K, Pundir R K and Singh Avtar. 2007. Characterization and evaluation of Gangatiri cattle breed in its native tract. *Indian Journal of Animal Sciences* **77:** 66-70.

Singh P K, Pundir R K, Manjunath V K, Rudresh B H and Govindaiah M G. 2008. Features and status of miniature indigenous germplasm of cattle-Malnad Gidda. *The Indian Journal of Animal Sciences* **78(10):** 1123-1126.

Singh S R. 2009. Status of animal genetic resources in Bihar- An insight. Conservation of threatened breeds of livestock and poultry. First edition. Bihar Agricultural Management and Extension Training Institute, Patna.

Snedecor G W and Cochren W G. 1989. Statistical methods. Sixth edition, Oxford and IBH Publising Co., Calcutta.

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:**124-136.

Tuimala J. 2005. A primer to phylogenetic analysis using phylip package. CSC-Scientific Computing Ltd. ISBN 952-5520-02-1.

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