



Phenotypic characterization, management and socio-economic impact of Purnathadi buffaloes

S SAJID ALI¹, S V KURALKAR², M V INGAWALE³, S P WAGHMARE⁴, S J MANWAR⁵, R S KATARIA⁶ and VIKAS VOHRA⁷

Post Graduate Institute of Veterinary and Animal Sciences, Akola Maharashtra 444 104 India

Received: 3 October 2018; Accepted: 26 March 2019

Key words: Buffalo, Phenotypic characterization, Purnathadi

About 17% of buffalo population in India belongs to the registered breeds of buffalo while 39.58% is graded of these breeds. However, 43.37% of buffalo population is non-descript (Livestock Census 2012) and needs description. Earlier some work has been done to characterize such non-descript buffalo populations from North and Central India (Vohra *et al.* 2012, 2017). There is an urgent need to evaluate phenotypic, genetic, management and socio-economic aspects of such less known buffalo populations of the country. In Maharashtra, there are three descript breed of buffalo, viz. Nagpuri, Pandharpuri and Marathwadi which together constitute about 19% of buffalo population, either as purebreds or grades of these 3 breeds, excluding extant breeds, viz. Murrah, Jafrabadi and Surti which are maintained at government farms and also by commercial livestock keepers. Out of the three major buffalo breeds of Maharashtra, Nagpuri is considered to be a unique buffalo breed and is known to have some strains or population groups within the breed, viz. Gaolao, Shahi, Elachpuri and Purnathadi (Bire *et al.* 1994, Kataria *et al.* 2007) which can be attributed to large temporal and spatial distribution of Nagpuri buffaloes in Vidharba region of Maharashtra. Out of these strains, Purnathadi - locally known as 'Bhuri buffaloes' is reported to be phenotypically distinct primarily on the basis of its brown coat colour and good milch potential. Other distinct physical traits in Purnathadi buffalo includes brown to pinkish muzzle, white patch of hairs on

fore head, white tail switch, and with or without white colour patches on extremities of leg (Bire *et al.* 1994, Gubbawar *et al.* 2012). Purnathadi animals are medium sized and have high milk fat%, good reproductive efficiency, low maintenance cost and well adopted to the harsh and hot climate of Vidarbha. In view to generate systematic information on phenotype of Purnathadi buffaloes, performance traits and socio-economic status of its keeper's under the traditional management conditions were studied across its entire breeding tract in order to characterize and evaluate the Purnathadi buffaloes.

Purnathadi, an excellent buffalo genetic resource is being maintained by the rural farmers of Vidarbha region, and its native hometract includes Akot, Akola and Telhara tehsils of Akola district; Daryapur, Anjangaon and Achalpur tehsils of Amravati district and adjoining villages of Buldhana district of Maharashtra. This germplasm receives its name from River Purna, originating in Satpuda hills and passing through Akola and Amravati district of Vidarbha region, and has evolved along its bank. The breeding tract of Purnathadi buffalo situated between 20.70° to 21.25° North latitude and 76.84° to 77.77° East longitudes. Being nearer to the tropic of cancer, the summer becomes very hot and temperature range is high, the highest temperature ever recorded is 47.9°C and the lowest during winter is 2.2°C. The average rainfall in this area is 800 mm and the average humidity is around 49.1%.

Planning genetic improvement effectively for a given genetic stock should also include the knowledge about its distribution, socio-economic status of the stakeholders, management practices and utility besides the genetics of a population. Survey was conducted in 47 villages covering four tehsil of Akola and Amravati districts (Table 1) and having the breeding tract of Purnathadi buffalo. Performance traits, management practices and the socio economic status of Purnathadi buffalo farmers (N=96) were assessed through interview approach using predesigned questionnaire developed by ICAR-NBAGR, Karnal.

Present address:¹Assistant (drssali78@gmail.com), ²Professor and Head (svkuralkar@rediffmail.com), Department of Animal Genetics and Breeding; ³Assistant Professor (drmingawale@rediffmail.com), Department of Animal Reproduction, Gynaecology and Obstetrics; ⁴Professor and Head (wps25@rediffmail.com), Teaching Veterinary Clinical Complex; ⁵Professor and Head (satishmanwar@rediffmail.com), Department of Poultry Sciences, PGIVAS, Akola. ⁶Principal Scientist (katariaranji@yahoo.co.in), ICAR-National Bureau of Animal Genetic Resources, ⁷Principal Scientist (vohravikas@gmail.com), ICAR-National Dairy Research Institute, Karnal.

Table 1. List of villages surveyed

Name of villages	No of villages	Taluka	District
Purnathadi Buffalo Unit of PGIVAS, Akola, Ugwa, Wallabh Nagar, Gandhigram, Kati, Dhonmada, Dahihanda, Sasan,	08	Akola	Akola
Akot, Wai, Panaj, Bori, Kowa, Kund, Bordi, Mohala, Asegaon Bazar, Sawra, Manchanpur, Chandikapur, Badali Satwai, Jalgaon Nahate, Adgaon Khurd, Akolkhed, Patsol, Deori, Lamkani, Mundgaon,	20	Akot	Akola
AdgaonBuzrug, Umri, Ural, Antri, Lohara, Danapur, Pathardi, Nimboli, Ghodegaon, Malegaon, Danapur, Telhara	12	Telhara	Akola
Bhandaraj, Sategaon, Khirala, Chausala, Anjangaon, Lakhad, Adgaon Khade	07	Anjangaon	Amravati

Eighteen (18) different biometric traits on 175 adult Purnathadi buffaloes (145 females and 30 males) were recorded to characterize their morphology / phenotype. The body measurements recorded were height at withers (BH); leg length (LEG); neck length (NL); neck circumference (NC); body length (BL); chest girth (CG); paunch girth (PG); face length (FL); face width (FW); ear length (EL); horn length (HL); horn circumference (HC); distance between horn (DBH); distance between hip bone (HB); distance between pin bone (PB); distance between hip and pin bone (DBHP); rump length (RL) and tail length (TL). To evade variation due to age, only adult female buffaloes (with at least one parturition) and breeding bulls (aged 3.5 years or more and used for breeding) were included in the study. All body measurements were recorded using simple tape measure in animal standing upright on a level ground and by the same person to avoid between-recorder effects. Physical characteristics (coat colour, forehead, horn, ear, muzzle, legs and udder) were also recorded. Purnathadi is preferred because of its superior milk and milk constituents thus the fresh milk samples were evaluated in lactating buffaloes (N=57) under different stages of lactation. Milk constituent traits namely, fat%, protein%, lactose, SNF and total solids were estimated using automatic lactoscan machine. The data generated for all the traits were carefully examined for completeness and correctness before tabulation. All the analysis were carried out using statistical software SPSS (version 21).

Physical and phenotypic characterization. Body coat colour in Purnathadi buffalo varied from whitish to light brown. Some of the new born calves had a complete whitish coat which changes to brown with the age (Fig. 1). The light body coat colour could be the reason for their adaptability to the extreme hot climate of the region. Muzzles were either white, pinkish or black. In 15% of buffaloes studied udder also had a pinkish colour, udder was compact and medium

sized, and had a round shape in majority of the females. Teats tips were either round (90%) or pointed (10%). Star white patch on forehead and in the lower extremities of all four legs and tail switch was a common observation. Horns were long and tapering, seen up to the shoulder and were having upward orientation at the end like hook. The physical characteristics were almost similar in male and females. Animals were docile in nature and mostly managed by the female member of the house. The typical body coat colour and unique physical characteristics differentiate these animals from the other populations of the region, viz. Elachpuri, Gaulao or Nagpuri buffaloes and makes these population eligible to be considered as separate strain or a breed of buffalo. Azikheli buffaloes of Pakistan have been reported to have similar body coat colour and appearance (Khan *et al.* 2013).

Biometrical records on 18 morphometric traits were recorded on 145 female and 30 male of adult Purnathadi buffaloes (Table 2). Significantly higher values were observed in males for BH, LEG, NL, NC, BL, FL, FW, EL, HC, and tail length while measures for CG, PG, HL and pin bone were significantly lower in males as compare to females. However the estimates for DBH, HB, DBHP and RL were similar in both the sexes. More or less similar variation pattern was reported in male and female of Chhattisgarhi buffalo (Vohra *et al.* 2017) and Azikheli buffaloes of Pakistan (Khan *et al.* 2013). In Gojri buffalo, Vohra *et al.* (2015), reported higher estimates 128.66±0.32 cm for HT, 133.33±0.35 cm BL, 195.91±0.67 cm CG, 213.91±1.34 cm PG, 48.58±0.11 cm FL, 22.33±0.09 cm FW, 28.76±0.09 cm EL, 53.58 ±0.24 cm HB, 24.29±0.29 cm PB and 90.57±1.15 cm TL. The higher estimates for BH (127.8±1.58), BL (124±2.74), FL (47.08±0.69) and DBHP (38.71±0.90) were reported for Elachpuri buffalo, another strain of Nagpuri buffalo which also share common breeding tract of Purnathadi (Ali *et al.* 1994). Nagpuri buffalo had



Fig. 1. A. Adult Purnathadi female, B. Adult Purnathadi Male, C. Purnathadi calf and D. Purnathadi buffalo unit at PGIVAS, Akola

Table 2. Mean±SE along with coefficient of variation for different body measurements (cm) in adult males and females Purnathadi buffaloes

Traits	Females (N=145)					Male (N=30)				
	Average±SEM	Min	Max	SD	CV	Average±SEM	Min	Max	SD	CV
BH	123.86±0.34	114	133	4.07	3.29	130.00±1.32	118	138	5.04	3.88
LEG	77.97±0.27	70	87	3.28	4.21	83.14±0.74	79	90	3.17	3.81
NL	60.66±0.42	50	77	5.03	8.30	67.14±1.37	58	78	6.03	8.98
NC	88.43±0.49	76	102	5.91	6.68	105.43±2.69	85	136	13.14	12.47
BL	118.65±0.47	100	133	5.65	4.76	125.05±1.60	115	136	6.37	5.09
CG	187.26±0.77	161	213	9.32	4.97	183.05±2.15	168	196	7.89	4.31
PG	205.26±0.95	174	240	11.49	5.60	191.95±2.85	169	213	11.18	5.82
FL	44.88±0.19	35	51	2.27	5.05	46.62±0.75	43	52	2.73	5.85
FW	20.75±0.12	17	25	1.49	7.17	22.62±0.35	19	29	2.11	9.32
EL	24.92±0.16	18	29	1.93	7.76	26.33±0.39	24	29	1.77	6.72
HL	57.95±0.84	39	88	10.16	17.53	52.05±2.63	39	72	9.46	18.18
HC	19.12±0.12	16	24	1.40	7.31	27.43±0.69	19	32	2.66	9.69
DBH	14.92±0.13	10	20	1.62	10.88	14.71±0.33	13	18	1.49	10.11
HB	44.87±0.35	35	58	4.27	9.53	45.38±1.01	40	52	3.61	7.96
PB	15.10±0.11	11	20	1.34	8.89	12.19±0.47	10	15	1.69	13.88
DBHP	30.14±0.16	26	38	1.91	6.35	30.33±0.44	28	35	1.53	5.04
RL	38.05±0.22	30	48	2.63	6.90	37.71±0.69	33	44	2.45	6.50
TL	81.08±0.48	67	99	5.75	7.09	84.38±1.89	69	99	7.87	9.33

BH, height at withers; BL, body length; LEG, leg length; NL, neck length; NC, neck circumference; CG, chest girth; PG, paunch girth; FL, face length; FW, face width; EL, ear length; HL, horn length; HC, horn circumference; DBH, distance between horn; HB, distance between hip bone; PB, distance between pin bone; DBHP, distance between hip and pin bone; RL, rump length; TL, tail length; N, number of adult animals; SE, standard error; SD, standard deviation and CV, coefficient of variation.

BH, BL and CG as 123.6 cm, 121.21 cm and 175.02 cm, respectively (Kataria *et al.* 2007). Apart from this body biometry, the black coat colour of Elachpuri and Nagpuri buffalo differentiate the Purnathadi buffaloes on the basis of body colour. Based on biometric traits one can say the Purnathadi buffaloes are comparable with Surti, Chhattisgarhi and Azikheli breeds of buffalo and it is medium sized buffalo than Murrah, Jafrabadi and NiliRavi. The coefficient of variation showed highest variability in horn length (17.53% and 18.18%) in females and males respectively, followed by DBH (10.88%) in female and PB (13.88%), NC (12.47%) and DBH (10.11%) in males. High variability showed least consistency of the traits amongst the individual of population which could be due to ignorance of these traits while selection in past or such traits may largely affected by the environment as compare to other body parts. Major component of the body size, i.e. BH, BL, LEG, CG and PG had low variance

confirming the high uniformity amongst the individuals of Purnathadi population. Vohra *et al.* (2017) reported very high variability in horn length (92%) and tail length (82%) in Chhattisgarhi buffaloes. Low variability amongst facial parameter may be due to the fact that these cranial measurements are associated with the cephalic bones and has limited scope for variation (Vohra *et al.* 2015).

Production and reproduction traits: Production and reproduction performance was assessed and the daily milk yield was found to range from 4 to 6 kg, peak yield had a range of 6–7 kg and total lactation milk yield ranges from 800–1000 kg with their respective averages of 5 kg, 6.5 kg and 900 kg. The lactation length and dry period ranges between 210–255 days (Avg. 235 days) and 180–255 days (Avg. 210 days) respectively. The average calving interval was observed around 450 days (range, 420 to 480 days) and age at first calving was around five and half years (range, 5 to 6 y). Regarding lactation period of Purnathadi

Table 3. Composition of Purnathadi buffalo milk

Milk composition	Order of lactation		Stage of lactation		
	First lactation (14)	Pooled lactations (57)	Early (28)	Mid (13)	Late (16)
Fat	7.74±0.34	8.18±0.22	7.66±0.28	8.52±0.46	8.79±0.43
Density	29.92±0.86	28.68±0.42	28.01±0.49	29.15±1.09	29.49±0.84
Lactose	4.36±0.07	4.26±0.05	4.23±0.07	4.35±0.09	4.24±0.11
SNF	9.27±0.17	8.86±0.09	8.78±0.12	8.88±0.20	9.01±0.19
Protein	3.89±0.13	3.68±0.07	3.55±0.09	3.64±0.16	3.93±0.10
Freezing point	-0.538±0.013	-0.523±0.007	-0.522±0.010	-0.523±0.014	-0.524±0.012
Salts	0.67±0.02	0.62±0.01	0.62±0.02	0.62±0.02	0.62±0.02

buffaloes, two types of experiences were recorded during the survey, long lactation period even up to 12–13 months with good reproductive efficiency while some livestock keepers reported fast drop of milk yield during later part of mid lactation. Baglane *et al.* (2005) also reported the range of lactation length from 261 to 355 days, with lactation milk yield varying from 615 to 1455 kg/lactation, and dry period from 134 to 302 days in Purnathadi buffalo. Lower lactation yield (465.05 ± 33.92 to 971.50 ± 92.43 kg) and peak yield (2.5 to 8.5 kg) was reported by Ambulkar *et al.* (2002). High variability in production traits indicates presence of sufficient genetic variance leaving a scope for its further genetic improvement. Production and reproduction performance of the Purnathadi buffaloes were found at par with most of the registered breeds of the buffalo available in country.

Milk composition traits were estimated and are presented in Table 3. The results revealed that pooled averages for various milk constituents of Purnathadi buffalo were $8.18 \pm 0.22\%$ milk fat, $4.26 \pm 0.05\%$ lactose, $3.68 \pm 0.07\%$ proteins and $8.86 \pm 0.09\%$ SNF. Density of milk, freezing point and salt were estimated as 28.68 ± 0.42 , -0.523 ± 0.007 and 0.62 ± 0.01 respectively. Higher values of protein (3.911), lactose (5.567) and SNF (9.491) and lower estimates for Fat% (7.112) were reported by Vohra *et al.* (2017) in less known buffalo population of Chhattisgarh in India. Varrichio *et al.* (2007) reported average milk fat% as 8.3% in Italian buffalo, which can reach up to 15% under favourable conditions. In Indian buffaloes, the average fat% ranges between 6.5 to 8.5% in different breeds and comparatively higher fat content was recorded in the Bhadawari buffaloes than the most of the other buffalo breeds (Nivsarkar *et al.* 2000). From these results, it can be inferred that Purnathadi buffalo milk contains comparatively higher fat percentage, which makes it preferred buffalo for milk production. Analysis of variance revealed significantly higher values of SNF and salt in first lactation milk at 5% level of significance. Early, mid and late stages of lactation had shown non-significant difference on the traits studied. However, higher values for milk constituents (except salts content) were found during late lactation in Purnathadi buffaloes.

Socio-economic status of livestock keepers: Survey revealed Purnathadi buffaloes were maintained by all the communities especially of Muslims, Bari, Kumbi, Mali, Gaowli and Dhangar (Table 4). The average family size of Purnathadi keepers was seven. About 35.42, 50 and 14.58% respondents had small (≤ 5), medium (> 5 to 10) and large (> 10) family sizes, respectively. Around 90% buffalo keepers were literate and among educated group, 16.67% were graduates. None of them received training on animal husbandry practices nor received any loan or grant for maintaining buffaloes. About 73% farmers had well-constructed residential house and 100% farmers had electricity and sanitation in their homes. The average farm land holding was recorded as 7.27 acre whereas 25% of the keepers were landless, 20.83% marginal, 16.67% small,

Table 4. Socio-economic status of Purnathadi buffalo farmers

Parameter	Category	Respondents	Percentage
Communities maintaining germplasm	Muslims	24	25.00
	Maratha/Kunbi	20	20.83
	Bari	16	16.67
	Mali	14	14.58
	Dhangar /Gaowli	12	12.50
	Others (SC, Teli, etc)	10	10.42
	Total	96	100.00
Family size (Average: 7.17)	Small (≤ 5)	34	35.42
	Medium (> 5 to 10)	48	50.00
	Large (> 10)	17	14.58
	Total	96	100.00
Education	Illiterate	10	10.41
	School/High School Education	70	72.92
	Graduation	16	16.67
	Total	96	100.00
Source of income	Solely livestock farming	18	18.75
	Livestock with agriculture	65	67.71
	Livestock with other Business / Job / Labour work	13	13.54
	Total	96	100.00
Land holding (in acres) (Average: 7.27)	Landless	24	25.00
	Marginal (less than 2.5 acres)	20	20.83
	Small (2.5–5 acres)	16	16.67
	Semi-medium (5–10 acres)	10	10.41
	Medium (10–25 acres)	22	22.91
	Large (above 25 acres)	04	04.16
	Total	96	100.00
Residential Housing/Facilities	Kaccha	26	27.08
	Pakka	70	72.92
	Total	96	100.00
Electricity supply	Available	96	100
	Non available	00	00
	Total	96	100.00
Sanitation (Toilet, drainage etc)	Available	96	100
	Non available	00	00
	Total	96	100.00
Training skills	For buffalo farming	00	00
	Any livestock farming	00	00
	Without training	96	100
	Total	96	100.00
Source of capital	Bank loan	00	00
	Own capital	96	100
	Total	96	100.00

10.41% semi-medium, and 22.91% medium. About 4.16% were large farmers based on land holding capacity. About 18.75% farmers were solely involved in the buffalo farming and 67.71% were allied to agriculture while 13.54% were having some additional jobs or businesses along with supplementary buffalo farming.

The average number of buffaloes per household studies was 4.01 with average total number of livestock was 6.54. The buffalo sheds were not well constructed, i.e. *Kaccha*

Table 5. Livestock housing and management practices of Purnathadi farmers.

Parameter	Category	Respondents	Percentage
Buffalo shed	Kaccha	50	52.09
	Pakka	38	39.58
	No Sheds	08	08.33
Total	96	100	
Location of buffalo sheds	Part of house	18	18.75
	Inside house	32	33.33
	Boundary		
	Separate	46	47.92
Total	96	100.00	
Grazing practice	Grazing	56	58.33
	Non-grazing	40	41.67
Total	96	100	
Fodder availability	Purchased	24	25.00
	Farm Grown	20	20.83
	Both (Farm grown + Purchased)	52	54.17
Total	96	100	
Concentrate feeding	Yes (Rate of feeding Varies)	96	100.00
	No	00	00.00
	Total	96	100.00
Involvement of females	Yes	66	68.75
	No	30	31.25
Total	96	100	
Sanitation and cleanliness of shed	Very Good	19	21.59
	Good	29	32.96
	Poor	40	45.45
Total	88	100	
Livestock keeping preference	Buffalo	96	100.00
	Cattle	54	56.25
	Goat	20	20.83

in 52.09%, *Pakka* in 39.58% cases where as 8.33% had no sheds (Table 5). In more than 50% cases, the buffalo shed is either a part of residential house or inside the house boundary; only 48% farmer had separate buffalo sheds as shown in Table 5. Sanitation and cleanliness of the animal shed was not up to the mark in almost 50% cases. Females have larger participation (68%) in maintaining buffaloes and in dairy operations. About 54.17% farmers offer the farm grown green fodder along with some purchased feed whereas 25% famers totally dependent on purchased green fodder. The concentrate supplementation was practiced by almost all the farmer @2–4 kg according to the milk yield of the animal, i.e. concentrate @ 1 kg per 2 kg milk including maintenance ration. More than 50% famers release their animals for free grazing in open fields daily and rest maintained as stall fed and offers hay, *karbi*, *kutti* and *chuni* along with green fodder and concentrate.

The market price of the buffaloes varies according to the size, milk yield and pregnancy status. The average price of Purnathadi buffalo ranges between ₹25,000 to 40,000 for female and ₹20,000 to 35,000 for breeding bulls. Farmers were seldom maintaining breeding bulls due to availability of Murrah and Nagpuri semen for artificial insemination. Farmers, those maintaining the Purnathadi

germplasm are majorly depend on free grazing which curtails feeding expenditures. Stall fed animals were maintained only along with other breeds of buffaloes. Prize of buffalo milk in rural areas was ₹40/kg whereas it is ₹50–60/kg in semi urban and urban areas. Shortage of greens during half of the year, increasing cost of dry forage and concentrate and marginal profit due to low milk prices in rural areas is a prime reason forcing livestock keepers to shift from buffalo farming to other occupations. Non availability of frozen semen of Purnathadi buffalo for AI by government agencies and very low preference towards maintenance of breeding bull by the farmers is a major constraint in the genetic improvement and conservation of Purnathadi buffaloes.

SUMMARY

A survey was conducted in breeding tract of Purnathadi buffalo with the aim to record its physical, phenotypic and performance traits as well as management practices and the socio economic status were assessed. Purnathadi is a medium sized buffalo, docile in nature with a typical whitish to brown coat colour. Physical and morphometric traits are not only important to identify the group of animals but because of their relationship with performance traits. The studied population of Purnathadi buffalo breed was homogeneous and possessed distinct physical characters those could form the base for identification. Purnathadi buffaloes were preferred by the small and marginal farmers due to low animal cost, high fat% in milk, good reproductive performance and low maintenance cost on feeding and management, however, non-availability of frozen semen and low preference towards maintenance of breeding bull is a major limitation for genetic improvement and conservation of Purnathadi buffaloes. Further, detailed studies for its complete characterization and genetic comparison with other breeds of the region are necessary to register and recognize Purnathadi as separate breed of buffalo, so that breeding plan for conservation and genetic improvement could be designed. This shall increase the interest and confidence of its keepers towards their own germplasm, the Purnathadi buffalo.

ACKNOWLEDGEMENTS

Authors wish to thank Director, NBAGR to include Purnathadi buffalo under their project and the Associate Dean, PGIVAS, Akola to provide necessary support to carry out the work. Sincere gratitude to the state animal husbandry officers and field veterinarians for rendering necessary help and to all the livestock keepers who allowed milk samples and measurements of their buffaloes.

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