



Prioritizing districts in India for buffalo development

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ABSTRACT

Prioritization of districts for buffalo development in India was done taking into account the buffalo growth rate (r), density (d) and number per 1,000 human beings (PTH). Priority Index for buffalo (PI-B) was worked out by giving equal weight to the 3 variables. Analysis was done for 19 states with 311 districts for the period 1966 to 2007, taking 1966 as the base year and apportioning the subsequent data to the base year. The 19 states covered 90.53% of the geographical area having 98.7% of the total buffalo population. Zones I to IV were demarcated each having 25% of the total buffalo population based on decreasing order growth rate, density, PTH and PI-B. Based on the Priority Index, 25% of the buffaloes with highest index (Z- I) were reared in 31 districts in 6.74% of the geographical area of the country by 9.37% of human beings. This zone had an overall growth rate of 2.70% p.a., buffalo density 124 and 245 buffalo PTH. Zone II with next 25% of buffaloes were located in 51 districts in 14.6% area of the country where 14.8% of human beings reside. This zone had an overall growth rate of 2.15% p.a., buffalo density 57 and 154 buffalo PTH. Zone III with next 25% of buffaloes were located in 67 districts in 19.7% area of the country where 22.4% of human beings reside. This zone had an overall growth rate of 1.86% p.a., buffalo density 42 and 102 buffalo PTH. Zone IV with next 23.7% of buffaloes were located in 162 districts in 49.5% area of the country where 49.4% of human beings reside. This zone had an overall growth rate of 0.54% p.a., buffalo density 16 and 44 buffalo PTH. GIS maps were also prepared for visualization of the location of different zones based on growth rate, density, PTH and Priority Index for buffalo.

Key words: Buffalo density, Buffalo distribution, Buffalo growth rate, Buffalo per 1000 human, Buffalo zoning, Priority index

Buffalo, an important source of livelihood in rural and peri-urban areas across the country, provides livelihood opportunities to millions of farmers. Buffaloes are primarily reared for milk production but in recent years have also emerged as one of the important meat animals earning foreign exchange for the country. The buffalo has been the pillar of success of Operation Flood Programme bringing White Revolution in India and making India the leading producer of milk in the world, 127.9 million tonnes in 2011–12 (DAHDF 2013). Buffalo milk production in 2010–11 was 62.35 million tonnes, which was 51.17% of the total milk produced. The per capita milk availability has reached to 290 g / day (2011–12), which is more than the world average of 284 g / day. The buffalo is also an important source of meat for domestic consumption as well as for export purpose, and meat production in 2010–11 was 0.80 million tonnes, which is 16.53% of the total meat produced (BAHS 2012). In 2012–13, total 1,107,506 MT of buffalo meat was exported valued at ₹ 17,413 crore (APEDA 2014).

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Suresh *et al.* (2012) reported that buffalo meat accounts for about 23% total production, its contribution in meat export accounts for more than 85%, mostly in frozen form. Buffalo is also an important source of draught power providing about 10% of the total draught power of the work animals. It also produces 0.52 million metric tonnes of skin and hides (CIRB 2013).

There has been a consistent increase in buffalo population from 43.40 million in 1951 to 105 million in 2007. Educated unemployed rural youth are increasingly taking to dairying as a vocation especially in the peri-urban areas because of preference of urban consumers for fresh milk over packaged milk. Buffaloes are considered as an efficient converter of low grade, fibrous feeds into high value milk, containing about 7% fat, which is much higher than the cow milk (Bardhan *et al.* 2006) and hence, it is a preferred dairy animal. However, the growth in buffalo population, its distribution and the dependence of human being on buffalo is not uniform across the country. There are areas with very high growth rate of buffalo together with vast areas where its population has actually declined. Prioritizing districts will help in demarcating zones with differential needs in respect of breed improvement, fodder production, developing market linkage, identifying

catchment areas for milk procurement and establishment of milk and meat processing plants etc. This paper attempts to demarcate the areas based on priority index which will help in formulating buffalo development programmes with differential focus required by different regions for optimal utilization of resources.

MATERIALS AND METHODS

District-wise livestock census data for 1966 and 1972 were taken from District Level Database Documentation of 19 states of India covering 90.53% of the geographical area of the country (ICRISAT 2012) and for 2007, it was taken from 18th livestock census 2007 (DAHD 2007). The district-wise livestock census data for Bihar was taken from Bihar Statistical Abstract 2012 and aligned with DAHD total for the state. Data for districts formed after 1966 were given back to their parent district (311) and apportioning per cent was based on geographical area of the parent district transferred to the new district.

The human census for years 2001 and 2011 were downloaded from the Census of India website (Census of India 2013). The census data of 19 states were regrouped into 311 districts of 1966 by merging the data into their parent districts based on the geographical area. The human population in 2007 was estimated by taking into account the growth rate between 2001 and 2011. The estimated 2007 human population was used to calculate number of livestock per thousand human beings (PTH).

The growth rate (% p.a.) of livestock was calculated using MS Excel as:

$r = ((\text{POWER}((A/P), 1/t)) - 1) * 100$; where, r, growth rate in % p.a.; A, final population; P, initial population; t, no. of years. Livestock density (d, number per sq km) was calculated as, $d = \text{Livestock population} / \text{geographical area (sq km)}$. Number of livestock per thousand human population (PTH) was calculated as, $\text{PTH} = \text{Livestock population (2007)} * 1,000 / \text{estimated human population (2007)}$.

Priority Index (PI) for buffalo was calculated by taking into account the 3 variables, growth rate (r), livestock density (d) and livestock per thousand human beings (PTH). The growth rate for the period 1966–2007 was normalized by the highest growth rate (Barmer, 4.30% p.a.) among the 311 districts. Similarly, the livestock density was normalized by the highest density (Bulandshahar, 294 / sq km) and the PTH was normalized by the highest PTH (Mahendragarh, 595 buffalo PTH). The normalized r, d and PTH were added to get the priority index for buffalo.

Priority Index, $PI = \Sigma (r/4.30, d/294, PTH/595)$

Zones (I to IV) were demarcated for growth rate, density, PTH and PI, each having 25% of the buffalo population in decreasing order of the indicators.

RESULTS AND DISCUSSION

Buffalo population were analyzed taking 1966 as the base year for the 19 states in which there were 311 districts. The states under study covered 90.53% of the geographical

area of the country and had 98.7% of the total buffalo population in India in 2007. The study was undertaken to identify regions taking into account growth rate (r), density (d), PTH and Priority Index (PI) of buffalo. Based on r, d, PTH and PI the buffalo population was divided into 4 zones each having 25% of buffaloes.

Need for Priority Index: The priorities in livestock sector of a region differ from others because of the socio-economic, agro-climatic conditions, farming system, level of agricultural development, cultural factors and preferences of people of the region, among others. Based on the factors mentioned above, preference of a particular livestock species differs from one region to another. Identifying this priority will help in concentrating efforts of the developmental agencies for maximum impact of the available resources and chalking out developmental plans based on the specific needs of a particular region. In buffaloes, the general perception indicated that north-western part of India forms the buffalo heartland and the primary focus of buffalo development programmes should focus on regions including Punjab, Haryana, western Uttar Pradesh and adjoining areas. But a consolidated list with districts prioritized for buffalo development programmes across the states for whole of India is lacking. Moreover, there is need to identify the criteria for constructing a priority index for buffaloes.

Criteria for Priority Index: For developing priority index, 3 indicators namely, growth rate over 4 decades (1966–2007), density of buffaloes and buffalo ownership (defined in terms of number of buffaloes per 1,000 human beings, PTH) were taken into consideration. Buffalo growth rate

Table 1. Classification of buffalo population based on growth rate, density and PTH

	Zone I	Zone II	Zone III	Zone IV
Growth rate				
Buffalo population (%)	25.11	24.96	25.22	23.39
Growth rate of buffalo (% p.a.)	3.01	2.27	1.73	0.42
No. of buffalo PTH	163	126	121	48
Buffalo density (no/sq km)	57	55	39	20
No of districts	46	51	68	146
Geog. area of the country (%)	14.74	15.08	21.26	39.45
Buffalo density				
Buffalo population (%)	25.09	24.76	25.26	23.57
Growth rate of buffalo (% p.a.)	2.18	2.10	1.86	0.83
No. of buffalo PTH	211	124	113	47
Buffalo density (no/sq km)	148	81	47	14
No of districts	35	49	63	164
Geog. area of the country (%)	5.63	10.12	17.89	56.89
Buffalo ownership (PTH)				
Buffalo population (%)	25.21	24.80	25.07	23.59
Growth rate of buffalo (% p.a.)	2.32	2.00	1.84	0.82
No. of buffalo PTH	276	179	116	39
Buffalo density (no/sq km)	92	63	37	17
No of districts	35	55	77	144
Geog. area of the country (%)	9.07	13.05	22.61	45.80

gives current trend of acceptability or otherwise of buffaloes in the region in terms of increasing or decreasing rate of its population. Buffalo density (d) indicated the historical importance a region gives to buffaloes. Buffalo ownership (PTH) indicated how intricately buffaloes are associated with the livelihood of people. Higher the PTH, more dependence can be expected on buffaloes of the human beings. The 3 indicators were given equal weight to calculate the Priority Index of buffaloes for districts in India.

Based on the growth rate, density and PTH, 4 zones were demarcated, each having 25% of the buffalo population of the country (Table 1). Based on growth rate, the first 25% of the buffaloes (Zone I) were reared in 14.7% of the geographical area of the country by 14.1% of human beings. Taking density into account, it was revealed that the first 25% of the buffaloes were reared in only 5.63% area by 10.9% of human beings whereas, on the basis of PTH it was 9.1% area by 8.4% of human beings.

Similarly, the Zone II with next 25% of buffaloes when growth rate, density and PTH were taken into consideration, were reared respectively, in 15.1, 10.1 and 13.1% area of

the country. The next 25% of the buffaloes (Zone III) were located in an area of 21.3, 17.9 and 22.6%, respectively of the country when growth rate, density and PTH were considered. The last quarter of buffaloes (23.5%, Zone IV) were reared respectively, in 39.5, 56.9 and 45.8% area of the country when growth rate, density and PTH were considered.

Buffalo Priority Index for districts: Based on the 3 indicators mentioned above, each having equal weight, Priority Index for buffalo for districts were calculated and they were classified into 4 zones (Table 2) each having 25% of the buffalo population. It was revealed that the first 25% of the buffaloes (Zone I) were located in 6.7% area of the country in 31 districts (1966 base year) or 52 districts as prevalent in 2011. This zone had an overall growth rate of 2.70% p.a., density 124/sq km and 245 PTH.

The next 25% of the buffaloes (Zone II) were reared in 51 districts (1966 base year) or 78 districts in 2011 in a geographical area of 14.6% of the country. This zone had an overall growth rate of 2.15% p.a., density 57/sq km and 154 PTH. In Zone III, having next 25% of the buffaloes were reared in 67 districts (1966 base year) or 115 districts in 2011, in 19.7% area of the country. This zone had an overall growth rate of 1.86% p.a., density 42/sq km and 102 PTH. Zone IV with 23.7% of buffalo population were reared in 49.5% area of the country located in 162 districts (1966 base year) or 298 districts in 2011. This zone had an overall growth rate of 0.54% p.a., density 16/sq km and 44 PTH.

Buffalo and social indicators: The study revealed that regions with high buffalo Priority Index had lower gender ratio in human beings, indicating an inverse relationship (Table 2). The gender ratio in Zone I to IV was respectively, 895, 926, 931 and 961. The human density was high when the Priority Index was high (506, Zone I). In Zone II, it was 368 and in Zone III 414 which declined to 364 in Zone IV. Female literacy in Zone I to IV was respectively, 54.0, 50.9, 51.0 and 61.5%. The correlation coefficient of Priority Index with gender ratio and female literacy were negative (Table 3).

Table 2. Classification of buffalo population based on buffalo Priority Index

	Zone I	Zone II	Zone III	Zone IV
Buffalo population (%)	25.09	24.85	25.04	23.69
Growth rate of buffalo (% p.a.)	2.70	2.15	1.86	0.54
No. of buffalo PTH	245	154	102	44
Buffalo density (no/sq km)	124	57	42	16
No. of districts	31	51	67	162
Geog. area of the country (%)	6.74	14.63	19.69	49.47
Human population (%)	9.37	14.80	22.38	49.43
Human density (no/sq km)	506	368	414	364
Gender ratio (No. of female / no. of male)	895	926	931	961
Total literacy (%)	66.45	62.95	62.76	70.87
Male literacy (%)	70.59	68.04	67.42	73.80
Female literacy (%)	54.04	50.97	51.02	61.46
Urbanization (2001) (%)	24.42	20.49	18.24	27.61

Table 3. Correlation matrix of buffalo Priority Index with other indicators

	Buff priority index	Buffalo gr. Rate (1966–2007)	Buffalo density	Buffalo PTH	Human density	Gender ratio	Literacy %- total	Literacy %-male	Literacy %-female	Urbanization %
Buff Priority Index	1.000									
Buffalo gr. rate (1966–2007)	0.929	1.000								
Buffalo density	0.711	0.445	1.000							
Buffalo PTH	0.783	0.562	0.703	1.000						
Human density	-0.136	-0.182	0.089	-0.137	1.000					
Gender ratio	-0.556	-0.518	-0.473	-0.302	-0.126	1.000				
Literacy%- total	-0.397	-0.434	-0.152	-0.278	0.160	0.205	1.000			
Literacy%-male	-0.357	-0.397	-0.167	-0.204	0.121	0.263	0.963	1.000		
Literacy%-female	-0.479	-0.522	-0.190	-0.326	0.179	0.302	0.974	0.919	1.000	
Urbanization%	-0.137	-0.148	0.014	-0.134	0.388	-0.131	0.523	0.444	0.501	1.000

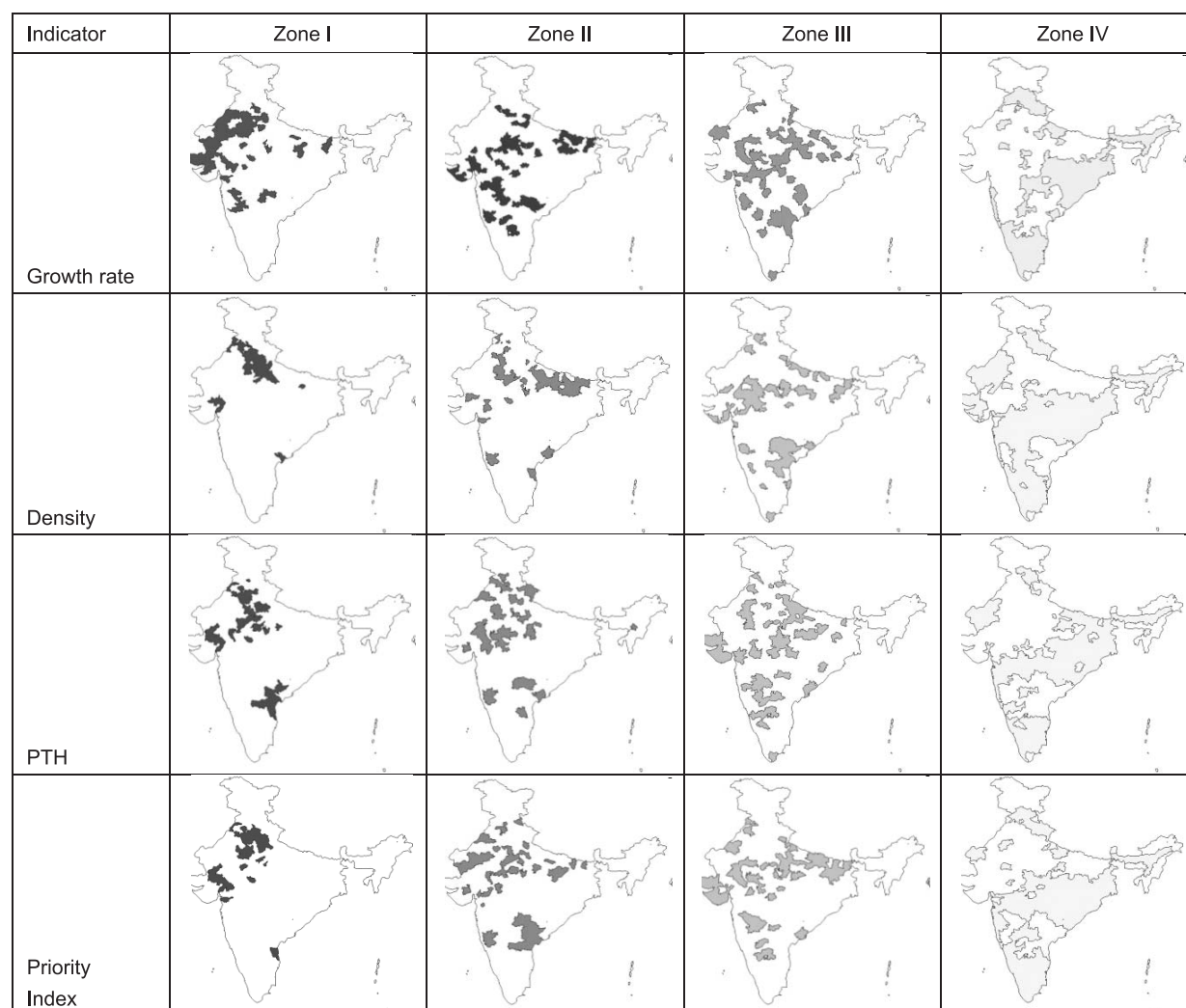


Fig. 1. Distribution of buffalo in Zone I to IV based on decreasing growth rate, density, PTH and Priority Index (Zone I to III each has 25% and Zone IV 23.4% of country's buffalo population).

Correlation matrix (Table 3) indicated that the Priority Index was strongly correlated with buffalo growth rate, density and PTH. The PI is negatively correlated with the social indicators like gender ratio (-0.56) and female literacy (-0.48). Thus, in the regions where there is high priority of buffaloes the social indicators are weak with respect to women. It is possible that increasing female literacy in regions with high Priority Index may enhance the acceptance of scientific management practices and increase the productivity of buffaloes. There is also need to look into factors which causes low gender ratio in areas with high buffalo Priority Index.

Buffalo distribution on map: The 4 zones demarcated based on growth rate, density, PTH and Priority Index were projected on the map of India (Fig. 1). The figure presents a clear visualization and comparative distribution of the buffaloes across the country, which otherwise would be difficult to locate in tables.

The different zones identified based on the different indicators like r , d , PTH and PI have differential needs.

Based on buffalo density, 25% of the country's buffalo are concentrated in only 5.63% of the geographical area (Fig. 1) representing a narrow band in north-west India and a little pocket in Gujarat. This represents the heartland of buffalo but when we look at the growth rate over 40 years and the dependence of human on buffalo (PTH), the geographical spread differs from that of the density indicating new areas, where promise lies and where people are beginning to appreciate the importance of buffaloes in their livelihood. The map indicates, a higher growth rate of buffaloes in western dry regions of India contrary to the perception that buffalo or water buffalo is a water loving animal and wallowing is an essential requisite for it. Gupta *et al.* (2007) have also reported high growth rates in the populations of buffalo in Rajasthan during 1983–2003. This region is also traditionally deficient in feed and fodder and suffers from vagaries of monsoon. There is need to study the reasons for the proliferation of buffaloes in dry western part of India and plan for a long term intervention to sustain it. For example, the hinterland of this dry region could be

focussed for intensive fodder development programmes to supply dried baled fodder to the western dry regions. When we look at the dependence of human on buffalo (PTH), it is located in a girdle adjoining Rajasthan and the coastal Andhra region (Fig.1, Zone I). Is it because the success of milk cooperatives providing regular uptake of milk at reasonable price or there are other reasons?

The first priority areas (Fig. 1, Zone I) is the region where people appreciate the importance of buffaloes and are well versed with the rearing and management practices of buffaloes. The primary focus of the development agencies here should be to develop it a nucleus of the buffalo germplasm in India. Pedigreed buffalo bulls and their semen should be made available and the artificial insemination programme should be intensively implemented for further breed improvement of the respective buffalo breeds prevalent in that region. The promise of accelerated buffalo development lies in Zone II and III (Fig. 1). Zone II lies in close proximity of Zone I and diffusion of technologies related to buffalo improvement can be easily achieved. Putting resources by the development agencies in breed improvement, intensification of fodder production through supply of quality seeds of fodder crops and grasses, providing quality veterinary care, organizing programmes for scientific rearing of buffaloes together with strengthening the milk cooperatives among others will help improve the productivity of buffaloes. Zone III also needs attention on the above interventions but with a greater focus. In Zone IV, buffalo generally is not a preferred animal. Nevertheless, even in this zone the pockets with high growth rate of buffalo, density and PTH may be identified and developmental programmes may be initiated.

The study has important implication for the policy makers and the implementing agencies for the country as a whole and at the state level for judicious allocation of resources and concentrating their efforts for increased impact of the buffalo development programmes impacting the livelihood opportunities of people.

REFERENCES

- APEDA. 2014. http://agriexchange.apeda.gov.in/index/Product_description_32head.aspx?gcode=0401 (Accessed on 18.01.2014)
- Bardhan D, Srivastava R S L and Dabas Y P S. 2006. Resource use efficiency in milk production from crossbred cows in Terai area of Uttaranchal with special reference to nutrition and health of animals. *Indian Journal of Animal Health* **45** (1): 47–54.
- BAHS. 2012. *Basic Animal Husbandry Statistics*. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. New Delhi.
- Census of India. 2013. <http://www.censusindia.gov.in>.
- CIRB 2013. *Annual Report*. Central Institute for Research on Buffaloes. Hissar-125001, India.
- DAHDF. 2013. *Annual Report 2012–13*. Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India. New Delhi.
- Gupta D C, Suresh A and Singh V K. 2007. Livestock growth and major production systems in different agro- climatic zones of Rajasthan. *Indian Journal of Animal Sciences* **77**: 494– 99.
- ICRISAT 2012. *District Level Database Documentation 19 States of India*. <http://vdsa.icrisat.ac.in/> (Accessed on 31.08.2013).
- Suresh A, Kavita B and Chaudhary R K. 2012. India's meat export: Structure, composition and future prospects. *Indian Journal of Animal Sciences* **82** (7): 749–56.