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Conservation of Indigenous Cattle Breeds

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ABSTRACT

India, one of the twelve mega biodiversity countries in the world, is home to large diversified cattle genetic resources, having 190.9 M cattle and so far 43 registered native cattle breeds. These cattle breeds are specially adapted to different agro-climatic conditions of India and their genetic diversity is due to the process of domestication over the centuries. There is decrease of 4.10% in cattle population and 3.14% in cattle genetic resources of India as compared to the quinquennial livestock census. The exotic / crossbred population has been increased by 20.18% during the period of last census while population of indigenous cattle has been decreased by 8.94% during the same duration. The reasons for depletion of native breeds includes crossbreeding with exotic breeds, economically less viable, loosing utility, reduction in herd size and the large scale mechanization of agricultural operation. The native breeds need to be conserved for genetic insurance in future, scientific study, as a part of our ecosystem, cultural and ethical requirements and for energy sources in future. The indigenous breeds of cattle posses various unique characteristics such as the presence of unique genetic variation in HSP70 gene family, carry a 'thermometer gene' and presence of A2 allelic variant in cow milk, which makes them well adapted to the tropical climate.

The conservation includes the preservation along with up-gradation (improvement) of the genetic potential and management of a breed for use in future. The effective management of indigenous cattle resources includes identification, characterization, evaluation, documentation and conservation. The future strategy should be to combine genetic improvement and conservation. Establishment of regional gene banks and people's participation by involving breeders, communities, gaushalas, NGOs and other relevant stakeholders in conservation programs. For more effective conservation measures, proper coordination and integration among various agencies (ICAR, SAHD, SAUs, SVUs and Research Institutes) is highly needed. "National Consortium of Partners' comprising different stakeholders should be formulated for conservation of indigenous breed resources with a holistic approach.

Keywords: Indigenous cattle breeds, Characterizations, Conservation, Native, Indian cattle

India, one of the twelve mega biodiversity countries in the world, is home to large diversified cattle genetic resources. As per 19th Livestock Census, India has 190.9 million cattle, which is a major livestock species; represent about 37.3% of total Indian livestock population and 14.7% of total world's cattle population (Anonymous, 2012). There are so far 43 registered native cattle breeds in India broadly classified into dairy, draft and dual purpose breed depending upon their utility either in dairying or in agriculture work. There is a vast diversity in the phenotypic, utility pattern and adaptability of the cattle populations reared and adapted in varying agro-climatic conditions and production systems of India. The genetic diversity among the cattle breeds is due to the process of domestication over the centuries, mutation, selective breeding, adaptation to local environment, isolation and genetic drift (Groeneveld *et al*., 2010).

The technical aspects of conservation of animal breeds which are at the verge of extinction were considered jointly in 1980 by FAO and UNDP. The efforts in this direction in India were started with the establishment of National Bureau of Animal Genetic Resources (NBAGR) Karnal in 1984 under the ICAR (Tomar, 2004). The preservation of a breed is required when it reaches an endangered level of a population near to extinct. The preservation covers the continued maintenance of genetic variability, whereas, the conservation includes the preservation along with up-gradation (improvement) of the genetic potential and management of a breed for future use.

The different indigenous breeds of farm animals are essentially the result of evolutionary processes, they have adapted to the harsh climatic conditions with low management inputs in terms of feeds, fodder and health care, capable to convert low quality feeds and fodder more efficiently into animal products and better adapted to withstand tropical diseases. They are integral part of agriculture. These breeds are now subject to fast genetic degradation and dilution because of unplanned breeding and introduction of exotic germplasm through cross breeding (Groeneveld *et al*., 2010). As a consequence some indigenous breeds are becoming endangered and there is depletion of good native germplasm which was having unique quality of disease resistance and heat tolerance. The dilution of a breed is in terms of purity of breed. It is a decline in the availability of pure bred animals conforming to the model attributes of the breed and is very common in developing nations. Conservation of genetic diversity is essential to the long term survival of any species, particularly in the light of changing environmental conditions (Tesfa *et al.,* 2017).

Depletion of Biodiversity

It has been estimated that since domestication, over 7616 documented breed populations from 30 species of livestock have been developed globally in the last 12 thousand years (FAO, 2000). It is reported that more than 1500 breeds of livestock are at risk of extinction or are already extinct worldwide. During the first few years of this century, more than 60 breeds have disappeared with their unique genetic make-up. Indigenous cattle resources have been integral parts of the livelihoods and traditions of several communities over years and loss of a defined breed is a loss of cultural identity and heritage of that community (Belew *et al.,* 2016). Losing these breeds is like losing a global insurance policy against future threats to food security (Shah *et al.,* 2016). It is estimated that in the last hundred years about 22% of known livestock breeds have become extinct and another 27% are at varying degrees of risk (Rege and Tawah, 1999). It is further reported that approximately two breeds of poultry and livestock are lost each week (FAO, 2007). The indiscriminate crossbreeding between exotic breeds and indigenous animals has been adjudged as major cause for the losses, as well as the risk to existing breeds. According to Hanotte and Jianlin (2006), though it may be too late for many livestock and poultry breeds in Europe, optimism in the developing world about slowing down the loss of both diversity and indigenous animals is high. It is believed that continuous import of highly productive animals from developed countries is the most significant threat to domestic animal diversity in the developing world. Therefore, conservation of indigenous animal resources has been projected as a suitable method for slowing down the loss in livestock breed diversity through extinction.

Indian Cattle Wealth

The livestock census conducted in India in 1951 revealed a total cattle population of 155.3 million, which gradually increased till 1992; thereafter it declined during 1997 to 2003, but increased in 2007 and finally in 2012 cattle population was decreased to 190.90 million (Anonymous, 2012). The trend of cattle population in India during last six decades has been depicted in Fig. 1.

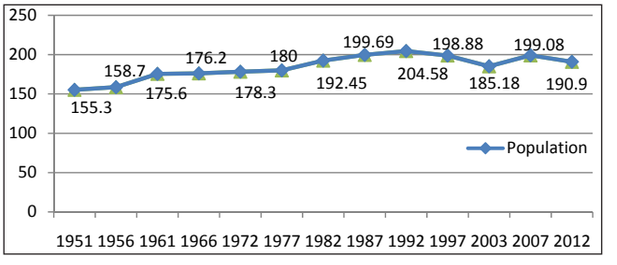

Fig. 1: Trend of cattle population (in millions) in India during last six decades

There is decrease of 4.10 % in cattle population as compared to the 2007 census (Table 1). The proportion of indigenous cattle to total cattle population is decreasing;

their percentage share is presented in Fig. 2. Madhya Pradesh state has the highest cattle as well as the indigenous cattle population followed by Uttar Pradesh, West Bengal, Maharashtra and Rajasthan, whereas; Tamil Nadu has the highest population of crossbred/ exotic cattle followed by Maharashtra, Uttar Pradesh, Bihar, Karnataka and West Bengal (Anonymous, 2012).

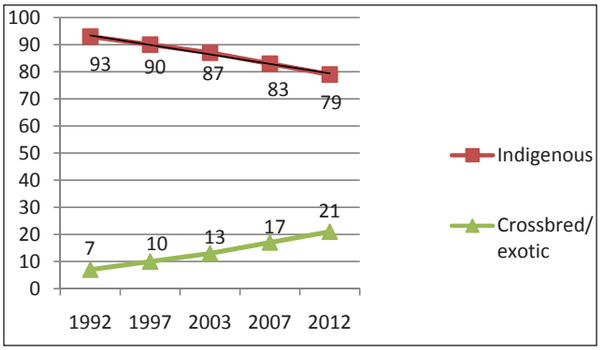

Fig. 2: Trends in the share of Indigenous and Exotic/crossbred Cattle population

Table 1: Comparison of male and female cattle population during 2007 and 2012

Type of cattle	2007 (Million)	2012 (Million)	% Change 2007-2012
Crossbred / Exotic			
Male	6.84	5.37	- 12.75%
Female	26.22	33.76	28.78 %
Total	33.06	39.73	20.18 %
Indigenous			
Male	76.78	61.95	- 19.32 %
Female	89.24	89.22	- 0.01 %
Total	166.02	151.17	-8.94%
Total Male	**83.62**	**67.32**	**- 19.49%**
Total Female	**115.46**	**122.98**	**6.51%**
Overall	**199.08**	**190.90**	**-04.10 %**

Source: 19th Livestock Census, 2012.

Indigenous Cattle Diversity and Breed Survey 2013

Department of Animal Husbandry, Dairying and Fisheries has published "ESTIMATED LIVESTOCK POPULATION BREED-WISE BASED ON BREED SURVEY-2013" in the year 2016. The whole cattle population has been categorised under Exotic/Crossbred and Indigenous/Non-descript (Anonymous, 2013).

The exotic and crossbred category is one of the high yielding categories of animals in cattle which contribute nearly 21% of the total cattle population. The Jersey and Holstein Friesian (HF) are the most important exotic dairy cattle breeds in our country. Animals which are produced by crossing exotic breeds with indigenous animals or indigenous animals which have exotic inheritance are described as Crossbred animals. In the Breed Survey, the breeds namely Jersey, crossbred Jersey, Holstein Friesian (HF) and Crossbred HF are considered under exotic and crossbred category. Crossbred Jersey has the highest share with 57.77% as compared to 38.91% of crossbred Holstein Friesian. The pure Exotic category has a share with 1.70% in Jersey and 1.62% in Holstein Friesian (Anonymous, 2013).

Animals which belong to descript (identified)/ non-descript (non-identified) breeds of indigenous origin are considered as indigenous animals. As per the survey over 79% of the cattle population is indigenous. These indigenous populations are divided into 37 recognized breeds (Table 2) in the Breed Survey as recognized by NBAGR (Anonymous, 2013) at that time. Recently NBAGR has recognized six new breeds (Table 3). Besides the pure breeds, Breed Survey also considered estimation of total number of animals in specific breeds which have more than 50% phenotypic characteristics of a particular breed under the definition of graded breed of that particular indigenous breed. The following Table 2 shows the number of animals in various indigenous breeds. The highest contribution is from non-descript category of animals which is 74.9% of the total indigenous cattle. Descript 37 cattle breed could represent only 37.92 million cattle population of the country (Anonymous, 2013). A total of 11 cattle breeds were confined to a single state / UT whereas, rest of the breeds were distributed across two or more states. The breeds which were found in maximum number of states included Sahiwal (19), Gir (15), Hariana (14), Red Sindhi (12) and Tharparkar (10). The Uttar Pradesh has reported maximum number of 12 breeds in the state. Rajasthan, Maharashtra and Kerala reported 10 breeds each whereas, Odisha and Punjab have reported 9 breeds each. The Andhra Pradesh and Madhya Pradesh census revealed that there are 8 breeds in each

Table 2: Breed-wise estimated number of animals under Indigenous cattle Breed Survey -2013

Sl. No.	Breed Name	Pure (no.)	Graded (no.)	Total (no.)	Percentage share with respect to total	Population Livestock Census-2007
1	Hariana	16,39,181	46,40,782	62,79,963	4.15	26,00,122
2	Gir	13,80,208	37,32,786	51,12,994	3.38	21,03,307
3	Sahiwal	10,92,459	37,89,835	48,82,294	3.23	4,57,405
4	Kankrej	19,45,094	10,83,185	30,28,279	2.00	38,87,152
5	Kosali	24,31,859	377	24,32,236	1.61	15,00,000
6	Khillar	11,02,359	9,11,993	20,14,352	1.33	14,23,742
7	Hallikar	12,11,242	5,96,690	18,07,932	1.20	21,96,698
8	Malvi	11,58,172	5,52,293	17,10,465	1.13	15,18,452
9	Bachaur	7,41,432	8,05,056	15,46,488	1.02	4,51,659
10	Rathi	8,65,921	3,71,588	12,37,509	0.82	9,24,087
11	Malnad Gidda	8,99,091	1,50,452	10,49,543	0.69	12,81,000
12	Tharparkar	1,97,291	5,35,182	7,32,473	0.48	5,57,679
13	Kenkatha	3,93,291	2,77,109	6,70,400	0.44	1,85,886
14	Ongole	1,15,905	5,18,621	6,34,526	0.42	2,58,240
15	Red Sindhi	59,642	4,97,744	5,57,386	0.37	5,49,432
16	Motu	4,69,320	67,438	5,36,758	0.36	7,02,347
17	Nagori	3,73,224	1,35,474	5,08,698	0.34	8,37,344
18	Red Kandhari	2,35,058	2,22,982	4,58,040	0.30	1,78,758
19	Nimari	3,41,828	1,11,805	4,53,633	0.30	3,09,859
20	Khariar	2,90,015	93,809	3,83,824	0.25	50,000
21	Deoni	1,51,236	2,00,364	3,51,600	0.23	1,66,025
22	Gaolao	1,21,538	2,01,145	3,22,683	0.21	2,22,663
23	Amritmahal	1,05,343	1,23,720	2,29,063	0.15	98,169
24	Kherigarh	75,116	1,24,135	1,99,251	0.13	1,71,414
25	Dangi	1,19,373	74,407	1,93,780	0.13	3,04,238
26	Kangayam	80,620	1,12,825	1,93,445	0.13	3,16,114
27	Binjharpuri	79,428	31,129	1,10,557	0.07	46,680
28	Ghumsuri	58,855	24,959	83,814	0.06	82,815
29	Umblacherry	39,050	33,460	72,510	0.05	2,18,315
30	Mewati	14,773	18,167	32,940	0.02	75,427
31	Ponwar	20,067	7,900	27,967	0.02	24,072
32	Siri	12,171	5,578	17,749	0.01	61,764
33	Bargur	14,154	2,153	16,307	0.01	21,312
34	Krishna Valley	3,462	10,919	14,381	0.01	2,314
35	Pulikulum	7,352	2,733	10,085	0.01	45,000
36	Punganur	2,772	56	2,828	0.00	771
37	Vechur	1,065	1,414	2,479	0.00	3,170
Indigenous Breed Cattle		1,78,48,967	2,00,70,265	3,79,19,232	25.06	2,38,33,432
Non-Descript		—	—	11,32,53,063	74.94	13,87,60,000
Total Indigenous Cattle		**1,78,48,967**	**2,00,70,265**	**15,11,72,295**	**—**	**16,60,30,000**

Source: Estimated Livestock Population Breed-wise based on Breed Survey-2013.

Table 3: New Cattle breeds registered at NBAGR, Karnal (NBAGR, 2018)

Sl. No.	Breed	Home Tract	Accession number	Estimated Population	Purpose	Reference
38	Belahi	Haryana and Chandigarh	INDIA_CATTLE_0532_ BELAHI _03038	20000-30000	Dual	Vohra *et al.*(2012)
39	Gangatiri	Uttar Pradesh and Bihar	INDIA_CATTLE_2003_ GANGATIRI_03039	364806	Dual	Singh *et al.* (2007)
40	Badri	Uttarakhand	INDIA_CATTLE_2400_ BADRI_03040	1600000	Dual	Pundir *et al.* (2013)
41	Lakhimi	Assam	INDIA_CATTLE_0200_ LAKHIMI_03041	7879806	Dual	19th Livestock Census (2012)
42	Ladakhi	Jammu & Kashmir	INDIA_CATTLE_0700_ LADAKHI_03042	54000	Dual	Pundir (2016)
43	Konkan Kapila	Maharashtra and Goa	INDIA_CATTLE_1135_ KONKANKAPILA_03043	600000	Dual	18th Livestock Census (2007)

Source: NBAGR-2018.

of these states. Among the individual breeds it shows that only 18 breeds are having their pure breeds more than 60% in number. In all other breeds major contributions is from graded population (Anonymous, 2013).

The presence of large population of milch and dual purpose breeds like Gir, Sahiwal, Hariana and Kankrej in many of the states revealed their importance for milk production. Sizable population of Hallikar and Khillar found in Southern and Western part of the country indicated that there is still need of bullocks for the different agricultural operations in that area. In 2007 Census about 138.7 million (69.7%) of total cattle population was declared as non-descript, whereas in 2012 Census about 113.25 million (59.32 %) has been declared as non-descript (Anonymous, 2012). Still, there is possibility of many homogenous populations deserving the status of breeds in this huge non-descript figure of cattle. Therefore, there is a need to explore and study the non-descript cattle populations for their description and addition as new breeds in the cattle breed list of India.

There are number of populations which still need the status of breed and study for the description of these populations (Table 4) has been completed by different agencies in the recent past.

Endangered Level (Risk) of a Breed

Endangered status of any species, according to different workers, depends on species, local circumstances like breed management system, rate of cross breeding, rate of decline and utility of breed. The FAO expert panel on preservation of Animal Genetic Resources proposed that whenever the population size of a breed reduces to 5000 breeding females, appropriate action should be initiated for its preservation. The panel observed that in case of developing countries, a breed with an effective population size of less than 2000 is to be taken as rare, with less than 500 as vulnerable and less than 100 as endangered. It also suggested that whenever the total number of animals falls below 10,000, one should start preserving semen and embryos (Mathur, 2008). The population size for normal (>25000), insecure (15000-25000), vulnerable (5000-15000), endangered (2000-5000) and critical (< 2000) status of a cattle breed under Indian conditions have been suggested by NBAGR. Tomar (2004) reported that the endangered breeds of cattle or the breeds which need attention for the conservation are Red Sindhi, Sahiwal, Tharparkar. Vechur, Punganur, Mewati, Kankatha, Kherigarh, Bargur, Siri, Krishna valley. Sharma and Niranjan (2016) postulated that Indigenous breeds / population showing low population and/or declining trends which need attention for the conservation are Vechur, Punganur, Krishna valley, Bargur, Ponwar, Binjharpuri, Red Sindhi, Sahiwal, Tharparkar and Amritmahal.

As per the latest breed survey (Anonymous, 2013) data, numbers of breeds under insecure, vulnerable, endangered

Table 4: New Indigenous breeds of cattle not registered by NBAGR

Sl. No.	Breed	Utility	Breeding Tract	Lact. Milk Yield (Kg)	Reference
1	Nari	Dual purpose	Pali and Sirohi district of Rajastahan	1200	Singh and Pundir (2013)
2	Tho-Tho	Meat and Draft	Nagaland	200	Singh and Pundir (2013)
3	Hill cattle of Tripura	Draft	Tripura	460	Singh and Pundir (2013)
4	Purnea	Draft	Purnea, Kishanganj, Katihar Dist of Bihar	300	Singh and Pundir (2013)
5	Gurezi Cattle	Draft	Gurez region of Jammu & Kashmir	—	Ganai*et.al* (2016)
6	Kasargode	Draft	Northern part of Kasargode dist. of Kerala	--	Anilkumar (2016)
7	Vadakara	Draft	Malabar region in district of Calicut and Kannur	--	Anilkumar (2016)
8	Kurichiat	Draft	Tribal area of Wayanad dist. of Kerala	--	Anilkumar (2016)
9	High Range Dwarf cattle	Draft	Tea estates of Iduddi dist. of Kerala	--	Anilkumar (2016)
10	Kuttampuzha Dwarf	Draft	Forest cow of Ernakulum dist. Kerala	--	Anilkumar (2016)
11	Cheruvally cattle	Draft	Kottayam dist. of Kerala	--	Anilkumar (2016)
12	Alambadi	Draft	Alambadi village of Dharmapuridist of TN	--	Anilkumar (2016)
13	Malaimadu	Draft	Madurai, Theni and Virudhnagar dist. of TN	--	Anilkumar (2016)
14	Jhari	Draft	Adilabad dist. of Maharashtra	--	Anilkumar (2016)

and critical category are 1, 2, 4 and 1, respectively (Table 5). Therefore, proper care must be taken to increase the population of these critical and endangered breeds. Further, pure breeding should be followed for the graded animals, to get the more pure bred population of these breeds in future.

Unique Characteristics of Indian Cattle Breeds

The indigenous breeds of cattle posses various unique characteristics, which makes them well adapted to the tropical climate. The negative impact of environmental heat stress on milk production, fertility, feed intake and growth rate of dairy animals is well known. The *Bos indicus* cattle are more thermo tolerant than the *Bos taurus* breeds due to the presence of unique genetic variation in HSP70 gene family in bovine that might be associated with regulating gene expression or protein function in response to thermal stress (Li *et al.,* 2011; Sodhi *et al*., 2013). The dwarf cows Vechur and Kasargode carry a 'thermometer gene' that allows them to better tolerate high temperature and these dwarf breeds are less susceptible to mastitis and as per Kerala Livestock Census, in the year 2012, not a single case of severe mastitis has been reported among dwarf cows(Dash *et al*., 2016). Verma and Niranjan (2014) reported that suitability of Kherigarh breed in flooded area made the live stock farmers rear this breed despite a low milk productivity of the animals. The A_1 β-casein gene is more prevalent in cow milk of exotic breeds, while the A_2 allelic variant in cow milk is predominant in Indian Zebu cattle breeds with the highest frequency of 0.987 (Mishra *et al.*, 2009) and are known as source of safe milk due to lower incidence of cardio vascular disease and Type-1 diabetes. More than of the Indian native cattle posses homozygous A_2A_2, the desirable genotype, rest of the indigenous cattle are supposed to be carrier for A_2 allele (Sharma *et al*., 2014). Conversely, the exotic cattle (*Bos taurus*) have A_2 allele in low frequency, worldwide.

Threat to Cattle Genetic Resources

The efforts have been made to improve the productivity of the indigenous cattle breeds to meet the country's milk demand by introducing exotic germplasm of superior genetic merit through cross breeding that has resulted in serious erosion for indigenous breeds. Indiscriminate use of this technology has given some negative impacts over the time. More emphasis on immediate economic return through cross breeding threatened the existence of some of the indigenous breeds that were developed by our ancestors

Table 5: List of Indigenous breeds of cattle showing endangered level

Sl. No.	Breed	Breeding Tract	Pure Breed		Graded		Total		Status of Breed
			Female	Total	Female	Total	Female	Total	
1	Vechur	Kerala	1012	1065	1182	1414	2194	2479	Critical
2	Punganur	Andhra Pradesh	1849	2772	56	56	1905	2828	Endangered
3	Krishna Valley	Karnataka	2683	3462	6189	10919	8872	14381	Endangered
4	Pulikulum	Tamil Nadu	4039	7352	1794	2733	5833	10085	Vulnerable
5	Siri	Sikkim & W.B	7933	12171	3143	5578	11076	17749	Vulnerable
6	Bargur	Tamil Nadu	11239	14154	555	2153	11794	16307	Vulnerable
7	Mewati	U.P.	11275	14773	12083	18167	23358	32940	Vulnerable
8	Ponwar	U.P.	14613	20067	6485	7900	21098	27967	Insecure

Source: Estimated Livestock Population Breed-wise based on Breed Survey-2013.

through generations (Sharma *et al.,* 2013). Unsystematic and illegitimate use of exotic germplasm over the Indian defined breeds of cattle has caused population depletion in some of the indigenous breeds of cattle (Ramesha *et al.,* 2010). Now, reorientation of their exotic inheritance with current breeding policy at local levels has become very difficult task.

There has been change in agricultural production system after 1970 due to mechanization and growing of cash crop. The agricultural production system has been completely changed, hence; there has been reduction in land holding, common grazing area and also in herd size. To keep a bull for breed improvement by small farmer with poor resources is not possible and hence he is forced to depend on the bull, available in or around the village / or the semen available, which may not be of the same breed or of good genetic merit. This caused the genetic dilution and reduced performance of progeny.

Small quantity of semen production affects the indigenous breed improvement program at field level. Out of total semen production of 88.55 million doses (2013-14) 30.06% was of exotic, 22.94% of crossbred, 11.19% of Indigenous cattle and 35.81 of buffalo bulls. Actually semen collection share during year 2012-13 was 83.64% and in year 2013-14 it was 82.57% for exotic/crossbred in total semen produced for cattle (Nivsarkar *et al.,* 2016).

The different breeds of farm animals served different purposes of the owner like milk and draught from cattle. The breeds which do not serve the purpose are neglected. Cattle breeds like Vechur and Punganur are in critical status because they didn't get recognition at proper time. The economically useful breed is automatically conserved. Mewati, Kankatha, Kherigarh and Bachaur breeds have lost their utility due to poor performance and declining economic return to the farmer. Some of indigenous breeds have lost their native tract because of geographical reorganization since the breeding tract and organized farms of some cattle breeds like Sahiwal, Red Sindhi and Tharparkar have gone in Pakistan. Lastly increase in livestock population is also causing deterioration due to inadequate inputs of feeding, health care etc.

Conservation *vis-a-vis* Genetic Improvement

Majority of cattle genetic resources are currently maintained *in situ* by farmers and pastoralists as integral component of agricultural production system. The efforts for conservation of animal genetic resources in India were started with the establishment of National Bureau of Animal Genetic Resources (NBAGR) Karnal in 1984 under the ICAR. The ICAR-NBAGR, Karnal has developed *in situ* models of conservation through providing technical inputs and incentives to the farmers/ breeders in the breeding tract of respective breed. *In situ* models were developed for the conservation of Tharparkar and Krishna valley breeds. Bulls of 3 cattle breeds have been selected and trained for semen donation under *Ex situ* conservation and more than 10000 semen doses from 3 breeds has been conserved. National Animal Gene Bank has been established at NBAGR, Karnal, with the objective of maintaining the indigenous livestock biodiversity of the country (Gandhi and Sharma, 2016). Animal Genomic resources bank has collection of

genomic DNA from 130 breeds/ population of livestock and poultry. Under the Network project on Animal Genetic resources, the characterization (phenotypic and genetic) and development of breed descriptor for 11 breeds of cattle – Deoni, Ongole. Gir, Umblacherry, Bachaur, Dangi, Amritmahal, Khillar, Gaolao, Tho-Tho and Gangatiri has been done. Besides this conservation activities have been undertaken by NBAGR for seven cattle breeds - Krishna Valley, Ponwar, Kherigarh, Kangayam, Nagori, Bargur and Ongole.

In National Livestock Policy, 2013, reorientation of breeding policy for livestock has been suggested to encourage the states to review their breeding policy for different livestock species. There is urgent need to consider region and breed specific breeding strategies and programmes to conserve the indigenous breeds. The indigenous cattle breeds should be improved by selective breeding in their native tract (Niranjan *et al.*, 2018). The production levels of defined indigenous milch cattle breeds (e.g. Gir, Kankrej, Sahiwal, Tharparkar, Rathi, Red Sindhi etc.) ranged between 2000 -2500 kg per lactation. The average 1st lactation milk yield and first lactation length of Kankrej cows maintained at germplasm unit, SDAU, Sardarkrushinagar were 2759 kg and 321 days, respectively (Patel *et al.,* 2016), which are indicative to the potential of indigenous cows. According to Mathur and Mandal (2014) study of the Frieswal crossbred (HF X Sahiwal) cows suggest that overall lactation yield oscillates around 3000-3300 kg since last 25 years, even after provision of good management condition and intensive selection over generations. Comparing the situation of crossbred vis-á-vis indigenous defined milch breeds of cattle, it is imperative to promote indigenous cattle breeds for marginal and small holder dairy farmers. For successful conservation programme, farmers need information on the value of the small holder cattle genetic resources, training, access to market, and other services, recognition of their rights, economic and legal incentives and legislative support for benefit sharing (Nyamushamba *et al.,* 2017). The states having large population of crossbreds, further crossbreeding of local cattle needs to be stopped. Most of the indigenous non-descript low producing cattle are primarily characterized by low –input production system across the country, which are deficient in quality feed and fodder resources, basic infrastructure and market facilities etc. Under this production system the non descript cattle can be improved genetically by grading up with bulls of high genetic merit of indigenous cattle such as Gir, Sahiwal, Tharparkar, Red Sindhi, Rathi, Kankrej etc.

Genetic Improvement Programmes

For strengthening the dairy sector, the Government of India has started various central sector schemes like National Programme for Bovine Breeding and Dairy Development (NPBBDD), National Dairy Plan and Dairy Entrepreneurship Scheme. NPBBDD was launched by merger of four existing schemes including Intensive Dairy Development Pogramme (IDDP) and will have two components namely National Programme for Bovine Breeding (NPBB) and National Programme for Dairy Development (NPDD) (Sharma and Niranjan, 2016). The NPBB dedicated for genetic improvement and conservation of indigenous bovine breeds. A total of 33 cattle and 7 buffalo breeds are proposed to be covered under the programme. Similarly 6 cattle breeds– Gir, Kankrej, Rathi, Tharparkar, Sahiwal and Hariana have been covered under National Dairy Plan-1 for implementation of progeny testing and pedigree selection (Niranjan *et al.*, 2018).

National Kamdhenu Breeding Centre for development and conservation of indigenous cattle (43 breeds) and buffalo (13 breeds) being setup with the objective to conserve and preserve indigenous bovine breeds; and to protect threatened bovine breeds from extinction. The core activities include establishment of nucleus herd of indigenous bovine breeds, establishment of state-of-art semen station and embryo transfer laboratories along with peripheral activities like providing AI and Veterinary facility, fodder production silage and compact feed block making, studying genomics and biology of bovines, creating milk processing facilities and strengthening, training and extension facilities. It is proposed to establish two National Kamdhenu Centers in the country one in North and other in South (Gandhi and Sharma, 2016).

National Gokul Mission has been sanctioned in XII plan with an outlay of Rs. 500 Crore with the aim to conserve and develop indigenous breeds in a scientific and focused manner (Gandhi and Sharma, 2016). The objectives of the scheme are to undertake breed improvement program for indigenous cattle breeds so as to improve the genetic makeup and increase the stock; to enhance milk production

and productivity of indigenous bovines; to upgrade non-descript cattle using elite indigenous cattle breeds like Gir, Sahiwal, Rathi, Deoni, Tharparkar, Kankrej and Red Sindhi to distribute disease free bulls of indigenous breeds having high genetic merit for natural service. It is also proposed to establish integrated indigenous cattle centers or Gokul Grams in the breeding tract of indigenous breeds. Fifty Bull Mother Farms having requisite infrastructure for management of animals will be identified in the breeding tract of a particular indigenous breed to provide bulls for natural service. Besides this, there are provisions of establishing breeder societies, incentives to farmers keeping elite animals and award/recognition of breeder societies and farmers.

Governments had decided to increase efforts for proper management and care of indigenous cattle breed in their native tract with the establishment of Cow Sanctuary under National Gokul Mission. The Country's first and unique Kamadhenu cow sanctuary has been started from 24, December, 2012 at village Salriya in Susner Taluka of Shajapur district, Madhya Pradesh. The objectives of cow sancturaryis to provide shelter to weak, disabled and stray bovine animals; conservation and augmentation of indigenous species, nourishing calves given birth by females of bovine animals in the sanctuary for 36 months and making them available to willing Gram Panchayats or farmers, and production, marketing and management of manure made of cow dung, which is very necessary for organic farming.

The Central Herd Registration Scheme started in 1963, has been continuing for Hariana, Gir, Kankrej and Ongole cattle breeds. In the scheme owners of registered animals are provided certificate and prizes/ incentives to encourage conservation of indigenous breeds and production of high quality cows. National Livestock Mission has commenced from 2014-15 with the objective of sustainable development of livestock sector, focusing on improving availability of quality feed and fodder.

All India Coordinated Research Project on Cattle, Project Directorate on Cattle (now, ICAR- Central Institute for Research on Cattle, Meerut) has taken up a genetic improvement programme of important cattle breeds in collaboration with various SAUs/ SVUs, State government and NGOs. The objective of the project is to improve the overall performance of the breed through the progeny testing and production of future young male calves using semen of proven bulls for elite mating (Gandhi *et al.,* 2013).

Strategies for Conservation

In India the status of cattle breed population is not so acute as to call for large scale *ex situ* conservation. It is necessary to evaluate and perfect these technologies at selected institutions which can be used whenever and wherever required.

For conservation, the most critical steps are to monitor the population of breeds over a time interval, identify breeds at risk, prioritize the breeds for conservation preferably for *in situ* strategy. National and State livestock census needs to be conducted on breeds and information on ecologies in which they perform. A complete data base should be generated on population of different breeds and identification of the factors threatening the extinction of breeds. Breed wise livestock census can be best utilized to monitor the population status and trends of the cattle breeds. After identifying the breeds that are at risk, breeds for conservation can be prioritized in view of financial expenditure and available infrastructure forces which restrict the number of breeds for conservation at certain time.

Three major strategies are normally followed for conservation of farm animal breeds. The first two i.e. *in situ* conservation as well as *ex situ in vivo* involves conservation of living population. The third *ex situ in vitro* (cryopreservation) encompasses conservation of living embryo, ova, semen, somatic cell or other animal tissue, DNA etc. stored cryogenically. *In situ* conservation of breeds is the most preferred method of conservation, by involving livestock keepers in the production system. The maintenance of a breed in its tract also satisfies the requirements of article 8 of the Convention of Biological Diversity, which gives first priority to *in situ* conservation (Niranjan *et al.,* 2018). Village-based breed improvement programs must be complementary to *in situ* livestock conservation objectives with the concept conservation through sustainable utilization (Alemayehu, 2013). *Ex situ in vitro* should complement in situ conservation. One of the most useful aspects of cryopreservation is its supportive role in genetic up-gradation of breeds. Realizing that no clear-cut guidelines are available within present

system of management of indigenous breeds in India, the strategy should be to combine genetic improvement and conservation. It is always recommended to preserve around 2000 doses of frozen semen each from 15-30 sires in order to maintain genetic diversity of a breed. About 300 embryos with equal number of male and females may be preserved per breed. Genomic DNA, tissues, stem cells and whole blood may also be preserved for posterity (Sharma *et al.,* 2014). Ex *situ in vivo* conservation strategy should be adopted, when in situ conservation is not at all possible.

It is suggested that research institutions of ICAR, Agricultural/Veterinary Universities and other laboratories should initiate the programmes to study and identify valuable adaptive traits of indigenous livestock at all levels (phenotypic, genotypic, DNA/RNA levels) and locate structural genes /QTLs responsible for these traits. Factors responsible for their sustainability and adaptation in their native tract should be explored. The viability of a livestock genetic resource programme is essential when it focuses on traits that increase the economic value of the breed specifically to the communities involved. Several approaches have been proposed and used to prevent or reduce the decline of livestock genetic resources, and these models can be supportive mutually for short as well as long term conservation.

It is necessary that identification, characterization, evaluation and documentation of the genetic resources are completed in next 5-10 years. A complete set of description of every breed should be generated on the basis of various profiles, including their distribution, habitat, body conformation, adaptation, production, reproductive ability and socio-economic aspects. In next 20 years, there is possibility to identify at least 30-50 new breeds of livestock. About 10 new breeds may be identified for each five year (Sharma and Niranjana, 2016).

NBAGR, as a Nodal agency, should develop a time bound action plan for breeds to be surveyed, characterized and determining conservation needs and strategies. The basic strategy will be conservation through sustainable improvement and management. This will include selection for important economic traits. A district level improvement plan, with village as a unit will have to be devised. A village level committee needs to be established that should function as Breeder's Association Unit, and be responsible for bull selection. The association / society should maintain: listing of all animals of each farmer; birth and death registers; health cover register; breeding register and monthly milk record register. All males not used in breeding, needs to be castrated and for each castration the farmer should receive a reasonable compensation. A district level monitoring committee to provide technical guidance, involving District Animal Husbandry Officer and all veterinarians in the district, should be established.

There may be situations where there is need for up-gradation of non-descript of cattle to be done. Under such circumstances grading-up of local cattle with milch breeds (Sahiwal, Gir and Red Sindhi) and dual purpose (Kankrej, Hariana and Ongole) breeds may be undertaken. However a well defined breeding plan should be developed in concurrence of futuristic need, availability of resources in different regions with avoiding problems of future degeneration of Indigenous livestock.

Sincere efforts should be made to ensure that the livestock farming should be a financially viable livestock enterprise than subsistence farming. Most creative and productive activities of individuals or groups in every society take place in communities; hence community-based conservation is receiving increasing attention from the stakeholders (Tesfa *et al.,* 2017). Farmers should get access to finance on low interest rate from Financial Institutions and Breeder's Association should made arrangements should to provide services and goods as required as well as suitable and sustainable market for the animal products. If a breed is identified as vulnerable or endangered, the farmers who maintain the animals of this breed should get appropriate compensation at the rate of profit earned through the crossbreds. The village association/ society should also arrange to take up the marketing of animal products.

Value addition of the product of indigenous cattle is new possibility for improving our conservation efforts. Efforts like identifying unique biomolecules, producing high quality products with value addition, better marketing and branding could be more important to conserve our indigenous germplasm for longer time. Recently, AMUL has started procurement of Kankrej milk from dairy farmers in North Gujarat and selling as A_2 milk at premium price. Further, it is highly desirable to generate adequate information on draft ability of indigenous

cattle which is scarcely available. The management and conservation of indigenous cattle breed is very costly and people's participation in the conservation strategy is must. Most importantly, Belew *et al.* (2016) suggested that conservation of indigenous cattle resources should be designed with a long term perspective, using a planning horizon of at least 50 years as the required genetic management to maintain diversity over a given time horizon. For more effective conservation measures, proper coordination among various agencies (ICAR, SAHD, SAUs, SVUs, and Research Institutes) is highly needed. "National Consortium of Partners" comprising different stakeholders should be formulated for conservation of indigenous breed resources with a holistic approach (Gandhi, 2016).

CONCLUSION

Although indigenous cattle breeds are best suited to their production system, the financial worth, as a whole, of these native breeds and population is not assessed properly. A National watch list should be prepared for indigenous cattle breeds at risk and those requiring conservation they should be conserved in native habitats by adopting participatory approach by involving breeders, communities, gaushalas, NGOs and other relevant stakeholders in conservation programs. Further, increasing productivity through selective breeding or upgrading would help in averting the declining trends of population of indigenous cattle breeds and their sustainable utility. For effective conservation proper coordination among various agencies and formation of "National Consortium of Partners" with a holistic approach is the need of hour.

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