POLICY PAPER 82

Breeding Policy for Cattle and Buffalo in India

NATIONAL ACADEMY OF AGRICULTURAL SCIENCES, NEW DELHI

October 2016

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Preface

Born out of major considerations of sustainability and nutritional security in Indian Agriculture, domestic animal population has emerged as a key factor for agriculture production. A sound breeding policy for these animals is the hallmark for enhancing the production and productivity of major livestock species in India, *viz.,* cattle and buffalo in conjunction with balanced nutrition, health protection, bio-security and efficient management. This becomes crucial considering the importance of livestock for smallholder and landless farmers for their livelihood. India producing over 140 million tonnes of milk from Cows, Buffaloes and Goats, stands at first place in the world. According to the 19th Livestock Census (2012), India has the largest livestock population (512.05 m) including 56% of world's buffalo population (109 m) and 14.7% of cattle population (191.9 m).

Considering the increasing importance of livestock production, particularly milk and meat for providing high biological value protein to our population, the National Academy of Agricultural Sciences (NAAS) organized a Brainstorming Session (BSS) on 'Breeding Policy for Cattle and Buffalo in India' on July 12, 2014, with Dr. M.L. Madan, formerly Deputy Director General (Animal Science), ICAR; Vice Chancellor, Dr. Punjabrao Deshmukh Agriculture University & Vice-Chancellor, U.P. Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan, and Prof. M.P. Yadav, Ex-Vice Chancellor, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut and Ex Director, Indian Veterinary Research Institute, Izatnagar as Conveners; and. Dr. R.S. Khanna, Dr. Arjava Sharma, Dr. B.K. Joshi and Dr. P.K. Singh as Co-Conveners.

The BSS was attended by eminent scientists and experts in the discipline of animal breeding and other related disciplines of animal reproduction, production, health and dairy Industry. The deliberations were enriched by lively participation and in-depth discussions on the issues highlighted during the BSS. Besides the main focus of breeding policy, the BSS also discussed all important issues and inputs that are required to support the breeding policy.

The Policy Paper is the outcome of the above deliberations and provides for a road map for policy implementation by the stakeholders both nationally and in States. I acknowledge the contributions made by the Conveners, Co-conveners, participants, reviewers and the Editors of the Policy Paper.

S. Ayyappan
President

Breeding Policy for Cattle and Buffalo in India

1. PREAMBLE

Potentiating the agricultural production and developing a sound 'Breeding Policy' for the major livestock species, namely, cattle and buffalo, in a sustainable mode, implies a thorough understanding of the livestock (LS) production system and the environment under which it operates.

Indian agriculture, and what surrounds and influences it, is in for profound change. The rural and urban populations are under tremendous strain born out of diverse reasons mostly rooting to food, agriculture and economy. Lately, the most vital agriculture component for food and nutritional security and economic profitability among the population, with or without land, has been identified to be the "*livestock*", which is greatly impacted by the demography, environment, disease, technology and economic changes. Therefore, major imperatives for livestock policy will involve consideration of many of these factors, which are discussed below in order of priority. Policy makers, scientists, livestock keepers and society at large need to look at these issues and take up the challenge to improve the Indian Livestock by selecting the best of the cattle and buffaloes by the best method of genetic selection.

1.1. Breeding Challenges and Goals

1.1.1. The important challenge, which has received little or no attention of both Royal Commission on Agriculture (1928) in India and National Commission on Agriculture (1976), has been the problem of cattle numbers and how to feed them given the available feed and fodder resources. When a breeding policy statement for large ruminants (cattle and buffaloes) is to be made, the stake holders (state and central government's, district authority, farmers' cooperative and individual farmers) need to be identified and provided a goal with specific objectives and a statement of assets. The cardinal principles for shared responsibility need to be defined and identified for each stake holder.

1.1.2. The primary stake holder to ensure economic growth seems to be the government. The goal of the government is to ensure improvement of livestock sector for enhanced economic returns to the farmers / livestock keepers, so as to improve their life style and provide them a regular livelihood option within the possible economic frame work existing at the time. The goal has not been quantified for each stake holder and hence investment required cannot be quantified. The second important stake holder is the resource poor animal keeper.

The total population of cattle and buffaloes that need to be improved, including the infrastructure for their management, needs to be identified with quantifiable feed and fodder resources.

1.1.3. The inputs for improved technologies, and programme (Health care, Reproductive cover, Artificial Insemination services) including all other technical services like vaccinations against diseases, diagnostics medication and a calendar for total health care and management need to be identified and provided for.

1.1.4. Bulk of livestock farmers (the secondary stake holder) are resource poor, and have no access to credit or market, but they are expected to take all important decisions regarding Breeding and Feeding on the advices of Project Management, etc. A viable breeding program cannot be implemented unless the main investor (GoI) pays a proportionate cost to the farmer.

1.1.5. It is necessary that any breeding policy frame work should be able to meet out the required inputs in the area of implementation so that deliverables are available in the targeted time. Since these programmes have to work within time frame, the investor needs to specify a timeline (say 5 – 15 years).

1.1.6. Feed and fodder are the bed rock of any breeding plan because these play a central role in providing proper nutrition to livestock. The feeding of a diet (balanced in all nutrients), and at a level that meets the production objective considering the animal's physiological state, is imperative for achieving high and sustained livestock productivity and the required genetic gains which need to be pre-fixed.

1.1.7. During the last couple of decades both production and consumption of animal products, such as milk, meat and egg has substantially increased and, therefore, an assessment of feed and fodder for the present LS population and likely growth in the livestock and poultry population is most urgent if a successful and implementable breeding policy is to be developed.

1.2. Feed and Fodder challenges

1.2.1. Availability of feed and fodder is a major constraint in promotion of animal husbandry in the country. The rise in demand for animal protein is difficult to meet with the present livestock farming system. India is facing shortage of dry fodder, concentrate and green fodder to the tune of about 11 %, 35 % and 45 %, respectively. It has been estimated that only 880 million tons of dry fodder was available including greens, which can meet only 35-40% of the demand. On dry matter basis, deficiency of dry fodder, green fodder and concentrate was estimated to be 40 %, 36 % and 57 %, respectively in 2007 (DAHDF, 2014).

1.2.2. This clearly indicates that most of the livestock remain underfed. They cannot thus perform optimally. Most of the dry matter is available in the form of agricultural by-products and dried grass collected from community wastelands and forests, which are of inferior quality.

1.2.3. The concentrates required for feeding the livestock are also in acute shortage to the extent of about 57 %. As a result, even the high yielding animals, which are presumably well-fed are suffering from nutritional imbalance and producing 26-51% below the attainable yield.

1.2.4. With regard to the cultivation of forage crops, hardly 3-4% of the cultivable area is being utilized in selected pockets. If we take feed conversion ratios of approximately 2, 4 and 9 for poultry, pigs and cattle, respectively and also consider carcass percentage; a high demand for feed already exists. There is thus an urgent challenge to generate real time and time-period data on fodder production, feed grain production, land availability for grassland and other pasture grounds etc. particularly in light of the rising demands.

1.2.5. This major feed problem gets confounded due to increase in the number of cattle and buffaloes. The population of cattle and buffaloes has increased by 129 % and 243 % between 1951 and 2012, respectively. Due to increase in number of cattle and buffaloes and lack of nutritional availability, population of unproductive cattle and buffaloes has increased, particularly among cattle. It is because of the large number of unproductive (besides stray) animals, that there has been further severe shortage of feed and fodder resources. The continued increase in the LS population has serious implications on the limited natural resources of the country. The burden of large number of unproductive population, stray animals (over 52.87 lakh) adds to the feed scarcity, productivity loss, environmental degradation and greenhouse gas (GHG) emission. The fact remains that if feed availability cannot be ensured in a well-designed breeding programme, no genetic gains can be obtained as a result of selection.

1.2.6. With the availability of branded / unbranded commercial livestock feeds sold in the market there will be a growing need to check the quality vis-à-vis the approved standards prescribed by the Bureau of Indian Standards (BIS) and efficient action mechanism / National Authority as per law to prevent sale of sub-standard livestock feeds.

1.3. Land holding and social challenges

1.3.1. Due to shrinking land holding, fatigue of the production system, acute nutrient mining from soil, scarce water resource, the production system in grain crops sector is having limited factor return and annual production increase.

1.3.2. Today's youth, generally prefers job avenues in professions other than agriculture. To address this issue, the youth need to be motivated to business prepositions in livestock enterprises as one of the option where regular returns are available.

1.3.3. Currently consumer spending capacity is attracting greater use of value added animal products of milk, meat, eggs and special meat and dairy preparations, both in urban as well as in rural situation.

1.3.4. The income gap between the rich and the poor across rural and urban populations is increasing, creating hurdles for technology absorption particularly among resource poor rural population who hold the maximum livestock critical for livelihood, poverty alleviation and food security.

1.3.5. Powerful shifts are occurring in crop production towards alternate agriculture, spearheaded by livestock (dairying, piggery, poultry, fisheries and ancillary industries) operations.

1.4. Scenario for livestock in 2030

1.4.1. The breeding Policy for large ruminants needs to be examined and analyzed in relation to the component breeds and their relative role in the socio-economics of the region. There is a need to invoke "Foresight Technology" to seek perspective from the future rather than extending the present. This involves working with distinguishing tools – challenge questions and scenario development. A group of following questions and their corresponding scenario needs to be explored:

- *The scenario for livestock in 2030 can be envisaged as a sector constrained with fragmented land holding, depleted soil nutrients, and low productivity with water scarce agriculture.*
- *With population increase, human and animal differential growth, leading to variation in human and animal numbers, ratio variation (between species / breeds), a brand new order of modified species and an entirely new competitive animal production system has taken place.*
- *A large population of unproductive and stray animals will further burden the limited feed resource and carrying capacity of the land mass if proper breeding and selection technologies are not implemented.*
- *"Resource" crunch for extensive livestock production and "Technology" crunch for intensive livestock production need to be deliberated.*
- *Peri-urban livestock activity shifting to rural base due to skyrocketing of land prices in peri-urban areas and accompanying risks of pollution and spread of diseases among animal and human populations are other limiting factors.*

- *Rural livestock production to serve as a viable economic agriculture option, with corresponding environmental issues and demands.*
- *Limited human willingness or participation in livestock activity among rural animal / land holding population.*
- *Per animal production/economics of milk and/or meat a more potent consideration for livestock farming than any love for breed or animal. Value addition and marketing becoming as key for profitability of animal produce.*

The livestock sector has far reaching implications for the rural poverty, rural employment, women empowerment, youth involvement, female and child nutrition, protein hunger, soil quality management and production system sustainability as well as ecosystem stability. Further, as the livestock is mostly owned by resource poor and poverty affected population, inclusiveness in growth and development and empowerment, amongst poor people is possible at a faster pace through livestock only.

2. STATUS OF LIVESTOCK IN AGRICULTURE GROWTH AND NATIONAL ECONOMY

2.1. Livestock Growth and Economy

Livestock contribution to the agricultural GDP has been increasing consistently. In fact, since 1970, the growth in the national livestock sector has always been higher than the growth in the crop sector. This was the case even during the heydays of green revolution (1970s and 1980s); when the policy emphasis and financial allocation were highly tilted towards crop sector. The compound annual growth rate for the livestock sector is presented in Table 1.

Table 1: Average Annual Growth Rates of National GDP, Agricultural and Allied Sectors

Year	Crop Sector	Livestock	Forestry	Fisheries	Agriculture	GDP
1950-60	3.1	1.4	0.3	5.8	2.6	3.68
1960-70	1.7	0.4	3.3	4.0	1.7	3.29
1970-80	1.8	3.9	-0.6	2.9	2.0	3.45
1980-90	2.2	4.9	-0.3	5.6	2.8	5.17
1990-00	3.0	3.8	0.9	5.3	3.2	6.05
2000-07	2.7	3.7	1.2	2.9	2.9	6.88

Source: State of Agriculture: NAAS-2009

2.2. The ‘State of Agriculture’ document (NAAS 2009) states that: “Rapid growth in livestock sector has led not only to boost agricultural growth but also to reduce rural poverty and promote rural equity. The distribution of livestock is more egalitarian than that of land. The smallholders and landless rural population together control 75 percent of the livestock resources. Livestock is thus an important source of livelihood for smallholders and the landless and the sector’s rapid growth benefits the poorest households the most. Evidence shows that livestock contributes nearly half of the total income of the smallholders.” It further documents, “Livestock sector also seems to promote gender and social equity. About 70 percent of the total workers engaged in the livestock sector are women. The participation of women in other activities including agriculture is low compared to that of animal husbandry. Further, a majority of workers engaged in livestock sector belong to socially and economically backward communities. Scheduled Tribes, Scheduled Castes and other Backward Castes together constitute about 70 percent of the persons employed in livestock sector.”

The growth and development of livestock sector in the country has not been uniform across recent decades. There exists a distinct disparity among states. The leading livestock producing states like Punjab, Andhra Pradesh, Haryana, Rajasthan and Gujarat have a high level of animal productivity which contributes significantly to agricultural output and rural poverty reduction. The share of livestock’s output to total agricultural GDP output is as high as 35 % to 40 % in some of these states, which does not include the contribution of draft animal power (DAP) and meat fully as a large number of animals are slaughtered outside registered slaughter houses, particularly on festive occasions. Another group of states including Kerala, Gujarat, Maharashtra and Uttar Pradesh have an intermediate level of livestock development and productivity. In yet another group of states (Orissa, Bihar) the livestock sector continues to be mainly subsistence driven and livelihood based,

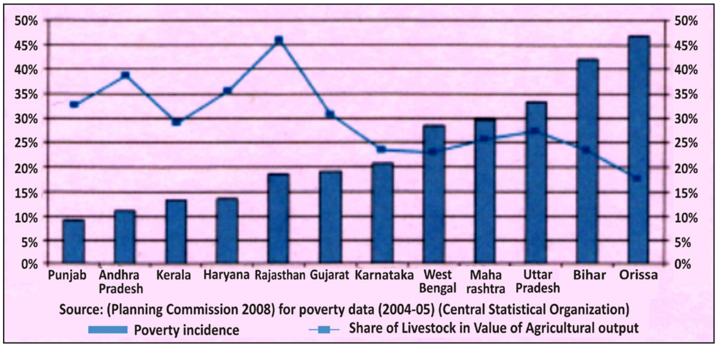

Figure 1: Rural Poverty and Share of Livestock Sector in Agricultural Output Value in Selected States in India

characterized by low levels of animal productivity and low contribution to overall agricultural GDP. Poverty is significantly higher in these states as compared to the states in the first category (Fig. 1).

3. CATTLE AND BUFFALO - POPULATION, BREEDS, PRODUCTION AND PRODUCTIVITY

3.1. Population

3.1.1. The 19th Livestock Census (DAHDF, 2012) indicates that though the total Livestock population has decreased by about 3.33% over the previous 2007 census, the number of milch animals (in-milk and dry) in cows and buffalo has increased from 111.09 million to118.59 million - an increase of 6.75%. The number of animals in milk in cows and buffalo has also increased from 77.04 million to 80.52 million showing a growth of 4.51%.

3.1.2. In 19th Livestock Census, 37.28 % were cattle, 21.23 % buffaloes, 12.71 % sheep, 26.40 % goats and 2.01 % pigs. The corresponding figures as per the 18th Census were 37.58 %, 19.89 %, 13.50 %, 26.53 % and 2.10 %. The female cattle (cows) population has increased by 6.52% over the previous census (2007) and the total number of female cattle in 2012 was 122.9 million numbers. The female buffalo population has increased by 7.99% over the previous census and the total number of female buffalo was 92.5 million numbers in 2012. The exotic / crossbred milch cattle increased from 14.40 million to 19.42 million, an increase of 34.78%. Indigenous milch cattle increased from 48.04 million to 48.12 million, an increase of 0.17%. The milch buffaloes increased from 48.64 million to 51.05 million, showing an increase of 4.95% over previous census.

3.1.3. The apparent reduction in total numbers in 2012 census is obviously in terms of males, since their use and utility has considerably got reduced mainly due to economics of rearing male animals with limited returns to the farmer and also tractors taking over the farm operations more efficiently. Because of use of bullocks for a limited number of days in the year, the male claves are not managed properly and thus there is a lot of wastage of DAP. DAP may be used directly for various mechanical purposes or converted into electricity and used for household and rural industrial purposes. The dung available from such holdings could be used for making biogas, and biogas slurry could be used as a nutrient source for raising fish, production of single cell proteins and nutritionally enriched water for strategic irrigation of crops.

Increasing the milk productivity from bovine population is the greatest challenge. The average milk yield currently is about 2.27 kg in indigenous cattle, about 6.97 kg in crossbred and about 4.71 kg in buffaloes (Table - 2). The average milk yield from cow / buffalo needs to be substantively and sustainably increased. The breeding policy, therefore, has to necessarily take into consideration the notable features of the sector enumerated above and to develop policy imperatives nationally as well as on a regional basis.

Table 2: Population Statistics (in thousands) and Average Productivity of Cattle, Buffalo and Goats

	Indigenous cattle		Crossbred cattle		Buffalo		Goats	
	2007	2012	2007	2012	2007	2012	2007	2012
Total population	166015	151172	33060	39732	105343	108702	140537	135173
Female	89236	89224	26216	33760	85745	92599	99744	97556
Male	76779	61949	6844	5971	19597	16103	40793	37617
Breedable female	54088	55417	15665	21268	52820	53856	62489	71011
Average production/ animal (kg/day) *	2.06	2.27	6.39	6.97	4.39	4.71	0.36	0.42

* BAHS (2015)

3.1.4. The exotic / crossbred milch-cattle increased to 39.73 million in 2012 and contributing to 21 % of cattle population, where as the total indigenous population of 151.17 million, contributes to about 79 % of cattle population.

3.1.5. In the Breed Survey (Census 2013), the indigenous descript population is composed of 37 breeds which also include the graded animals (pure indigenous, 17.85 million animals and graded descript population 20.07 millions animals) making a total of 37.92 million descript animals. The remaining non-descript animals population of

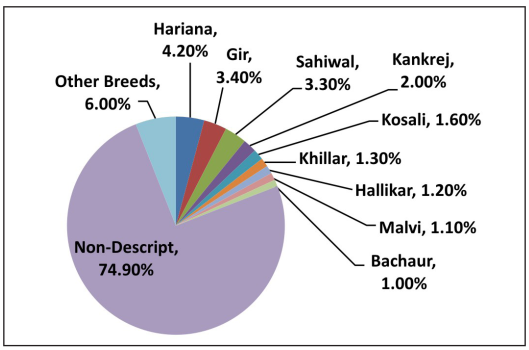

Figure 2: Percentage contribution of various major Indigenous Breeds (Pure, Graded and Non-descript) [DAHDF, 2013]

113.25 million constitutes 74.90 % of total cattle population (Fig. 2). As per DAHDF (2013), 15 cattle breeds are confined to a single state, whereas, rest of the breeds are distributed across two or more states/UTs. The cattle breeds having larger area of distribution include Sahiwal (19 states/UTs), Gir (15 states/UTs), Hariana (14 states/UTs), Red Sindhi (12 states/UTs) and Tharparkar (10 states/UTs).

3.1.6. In spite of large total cattle population and breeds in the country, only 7 major cattle breeds each have a population status of more than 10 lakh animals and a single breed is present in more than one state. The States of Uttar Pradesh and Madhya Pradesh reportedly have 8 breeds each; Rajasthan, Bihar and Jharkhand 7 breeds each; Tamil Nadu, Maharashtra and Karnataka 6 breeds each. There is a large population of dual purpose breeds (Fig. 2), like Kankrej (19.45 lakh pure and 10.83 lakh graded), Hariana (16.39 lakh pure and 46.41 lakh graded), Gir (13.80 lakh pure and 37.33 lakh graded), Malvi (11.58 lakh pure and 5.52 lakh graded), which have a significant number of higher milk yielding cows (DAHDF, 2013).

3.2. Cattle and Buffalo Population

3.2.1. The first livestock census conducted in India in 1951 revealed a total cattle population of 155.3 million, which gradually increased and stands at 190.90 million in 2012 (Fig. 3).

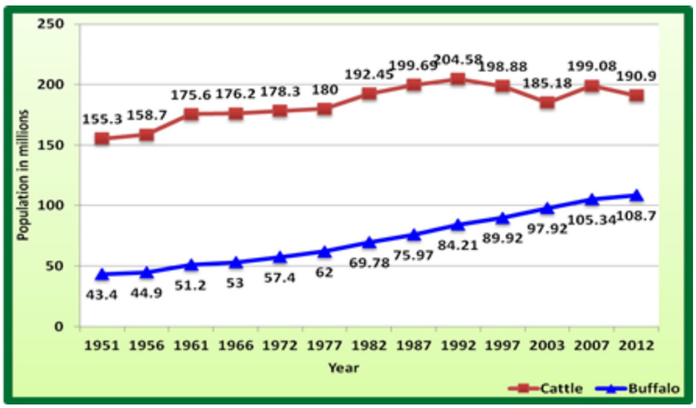

Figure 3: Trend of Cattle and Buffalo Population in India

3.2.2. Exotic / crossbred animals introduced into Indian cattle population has not only increased the cattle biodiversity of India, but has also been instrumental for considerable increase in milk productivity from cattle. By using male germplasm of a number of exotic dairy breeds, new high yielding cross bred strains such as Karan Fries, Sunandani and Virindavani have been evolved through inter-breeding and selection of cross breeds, mostly half-bred. Crossbreeding in cattle was adopted for improving the milk productivity of indigenous cattle by using high milk productive exotic breeds like Holstein Friesian, Jersey and Brown Swiss. Some of the States of India have increased the proportion of exotic / crossbreds to more than 50 %. These States include Pondicherry (95.9 %), Kerala (94.2 %), Punjab (85.0 %) and Tamil Nadu (72.1 %). Some other states have also moderately increased the crossbred cattle population above the national proportion like the states of Haryana (55.1 %), Karnataka (30.6 %) and Maharashtra (23.6 %). On the other hand some of the highly cattle populated states could develop less than 5 % of their total cattle population as crossbreds *e.g*. Assam (4.8 %), Madhya Pradesh (4.3 %), Chhattisgarh (1.8 %) and Jharkhand (2.9 %) (DAHDF, 2012).

3.2.3. The crossbred /exotic cattle are by and large distributed in larger area of the country. The main breeds in this category include Holstein Friesian (HF) and Jersey (Table 3; Fig. 4). However, exotic as well as crossbreds of some other breeds like Brown Swiss (BS) have also been reported, though comparatively less in number. Some of the synthetic strains / breeds developed by using exotic germplasm have shown problems of adaptation to hot-arid / hot-humid climate needing protection from direct solar radiation, disease susceptibility and infertility effecting productivity, particularly among cross-breed males. Forty percent of Holstein cross-breed males have poor libido and semen quality, especially freezability. This is a serious impediment in genetic improvement in cross-breeds through selection. The first cross animals (F1) when interbred show a decline in milk production. Various explanations and solutions to the problems have been suggested (as detailed under 4.2).

Table 3: Exotic cattle breeds and their crossbred population (DAHDF, 2013)

Genetic Group	Breed	Population (in lakh)
Exotic	Jersey	6.76
	HF	6.44
	Total	**13.20**
Crossbred	Jersey	229.54
	HF	154.58
	Total	**384.12**
Total Exotic and Crossbred		**397.32**

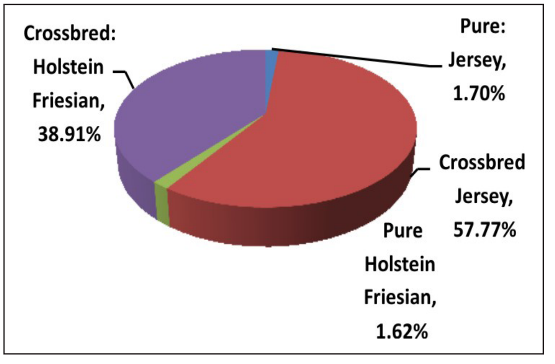

Figure 4: Percentage Share of various breeds in exotic/crossbred cattle

3.2.4. More recently it has been reported that the exotic dairy breeds have a higher frequency of A1 allele at the β casein locus, which causes variation in amino acid histidine (CAT) in A1 and proline (CCT) in A2 milk. Variant of A1 beta casein gene produces beta casomorphin 7 (BCM7), a bioactive peptide in human during digestion in GI tract and is supposedly claimed to be associated with a number of health problems, though to-date there is no study to conclusively prove this. In India the work carried out at National Bureau of Animal Genetic Resources (NBAGR) has indicated that the allele frequency of A2 in 15 breeds of Zebu cattle was 98.7% and that among all the buffaloes tested (8 breeds) all were A2 type. Another study conducted at National Dairy Research Institute revealed that while all Tharparkar and Sahiwal breed animals were A2 type, among the cross-bred (Karan Fries and Karan Swiss) the allele frequency (A2) was 79-89%.

Though several BCM-7 studies have shown metabolic association to digestive and assimilatory biochemical functions, there is no cause and effect relation with any disease. In the scientific report of European Food Safety Association (2009), an extensive review of scientific literature on A1 and A2 milk has been done. In this report a cause-effect relationship between the oral in-take of BCM-7 or related peptides and etiology and course of any suggested non-communicable diseases could not be established. Consequently, a formal risk assessment of food derived peptides such as BCM-7 has not been suggested in their final recommendation.

The White Paper issued by NBAGR (2014) states "evidence for a clear link between A1 beta-casein and a disease state has not been demonstrated". However, further research on these aspects of crossbred and native animals and the amino acid composition of milk is required. As a cautionary measure; it may be appropriate to monitor the status of A1 / A2 alleles in our dairy bulls and also screen all semen for A1 / A2 alleles.

3.3. Cattle and Buffalo Production

India continues to be the largest producer of milk in the world. Several measures have been initiated by the Government to increase the productivity of livestock, which has resulted in increasing the milk production significantly from the level of 102.6 million tonnes at the end of the Tenth Plan (2006-07) to 127.9 million tonnes at the end of the Eleventh Plan (2011-12). Milk production during 2012-13 and 2013-14 is 132.4 million tonnes and over ~~140~~ 137.7 million tonnes respectively with an annual growth rate of 3.54 % and 3.97 %, respectively. The per capita availability of milk was around 307 grams per day in 2013-14.

3.3.1. Cattle Production

The overall productivity of indigenous cattle in the country (BAHS, 2015) has been estimated as 2.36 kg/day (2012-13). Punjab is at the top in the productivity of indigenous cattle (6.52 kg/day) and Haryana is at second rank with the productivity of 5.07 kg/day from indigenous cattle. This may be due to better management of indigenous cows and availability of good breeds like Sahiwal and Hariana in these states. The indigenous cattle of Rajasthan and Gujarat are also having good productivity (3.67 and 3.95 kg/day) due to the presence of good indigenous milch breeds in these areas, which include Gir, Kankrej, Rathi, Sahiwal and Tharparkar.

The productivity of indigenous cattle in other regions of India by and large varies from 0.77 to 2.87 kg/day. Majority of indigenous cattle are having low productivity, which need to be genetically improved. The feeding and health management is another aspect to be taken care of for increasing the productivity. Though in majority of the states, Indian cattle breeds are draft type, yet a slight increase in their productivity may significantly increase the total milk production of the country as well as the livelihood standards of livestock keepers.

The overall productivity of crossbred cattle in India is 7.02 kg/day during 2012-13 with a range of 4.05 to 11.00 kg/day. Considering the productivity of crossbred cattle in the country across the states, Punjab (11.00 kg/day), Meghalaya (8.98 kg/day), Kerala (9.11 kg/day), Gujarat (8.81 kg/day), Haryana (8.17 kg/day) are the leading states. The productivity of crossbred cattle in these states is perhaps due to better feeding and health management. In fact, despite the fact that crossbred and exotic cattle require good and higher level of management, feeding and health care, these animals are having a much high acceptance among the resourceful animal keepers / farmers.

3.3.2. Buffalo Production

The Indian buffaloes are mostly riverine type (2*n*=50). However, some swamp type (2*n*=48) buffaloes are available in north-eastern region of the country. As per 2012

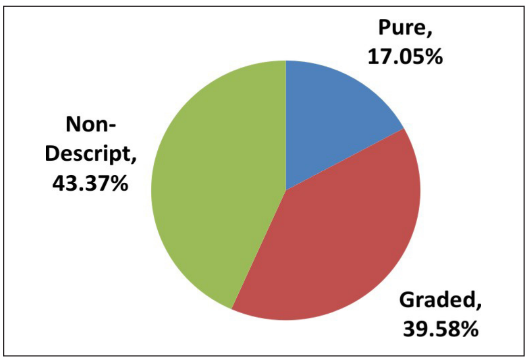

Figure 5: Percentage contribution of various breeds of buffalo including non-descript

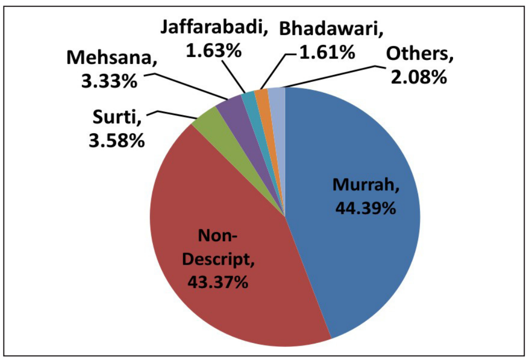

Figure 6: Distribution of total buffalo population breed wise

census, the country had 108.7 million buffaloes (21.23 % of livestock population), which is more than 50 % of the world's population. Buffaloes are the "dairy animal of 21st century" in India and presently they contribute about 51 % of the total milk produced.

3.4. The buffalo population has increased to about 150 % in last six decades (43.4 millions in 1951 to 108.7 million in 2012). As per Livestock Census, Indian buffalo population consists of 17.05 % pure bred, 39.58 % graded and 43.37 % non-descript animal (Fig. 5). The entire Indian population belongs to indigenous germ plasm and most of the animals are Murrah or Murrah type (44.39%). The diversity of Indian buffalo reflects in terms of 13 breeds registered by NBAGR, Karnal. The buffalo population varies from 3386 animals of Chilika to 482 lakh of Murrah buffalo (117 lakh pure and 365 lakh graded). Population of some of the breeds like Mehsana (36 lakh), Surti (38.9 lakh) and Jaffarabadi (17.7 lakh) are sizable (Fig. 6) where as population size of some breeds like Chilika, Manda, Kujang are very small to the extent of few thousands only (DAHDF, 2007). As per DAHDF (2013), 5 buffalo breeds are confined to a single state, whereas, rest of the breeds are distributed across two or more states/UTs. The buffalo breeds having larger area of distribution include Murrah (22 states/UTs), Jaffarabadi (12 states/UTs), Surti (12 states/UTs), and Mehsana (10 states/UTs).

3.5. Buffalo Milk – The Lost Advantage

Most of the time our focus in the country has been to process milk and manufacture milk products bringing in the concept of difficulties as we handle "buffalo milk", in spite of the fact that around 51 % of the available milk in the country is from buffalo. All the available techniques, processes and procedures have not been enough to exploit this special milk with distinct compositional advantage in terms of its fat, protein and SNF. Our research and educational institutes have spent considerable time to enlist the differences between buffalo milk from that of cow milk but exploiting the excellence has eluded our R and D. The education as well as the R and D focus has never been to innovate upon the strength of our country. The large volume of over 50 million tons of milk, the largest distinct commodity, has never been addressed to develop a niche product line and / or market franchise.

It is high time that when we are endowed with competitive global environment, buffalo milk should be pushed as "**buffalo milk**" to hold its own in terms of its advantage in fat, protein quality, Mozzarella cheese and product manufacture nationally and globally. A technological fusion will bring in much higher remuneration to the producer as well as the industry. The coagulated milk products have a ready world market. The conflicting situation needs to be redeemed to work for buffalo excellence and not waste the milk volume and quality advantage. The regional breeding programs which often are Murrah based need to be delineated and followed (Madan, 2010; DAHDF, 2013).

3.6. The Male Squandering

3.6.1. Traditionally, due to the limited use of buffalo male calf to the animal owners, their existence is an abject picture of neglect resulting into male wasting. The existing female buffaloes in the country are supposed to have around 30 million calves annually out of which male / female birth ratio would give a frequency of about 15.0 million to each of these sexes (Tables 2). In fact, the latest available census analysis (2012) shows over 20.2 million female buffalo calves less than one year of age and only 10.8 million males (below 2 years of age) in the comparative age group implying systematic neglect of the male calves. There is further erosion of male animal numbers and by 3 years of age the numbers are drastically reduced to about third. This clearly indicates that over 15 million calves are annually wasted (neglected and / or allowed to die).

3.6.2. Even if we are able to bring up just 50 % of the 10.8 million male calves, say 5 - 6 million, in 16th month post birth, we would have excellent buffalo meat available with great potential for profits and export earnings. The added 4.0 million tons of quality meat for export, will propel the demand growth of this sector to an almost 80 % increase in growth and export earnings. The available models of male buffalo calf rearing have taken the economic returns from this animal beyond all previous calculations over and above the returns from milk alone. Farmers in several states have caught on the idea and we see that more and more people opting for buffalo production by choice and resulting into a setback to cattle production.

3.6. Buffalo Meat Advantage

3.6.1. Buffalo is referred as backbone of Indian dairying and meat exports. Out of the total buffalo population of 108.7 million, about 9.02 million (mostly infertile and / or low producing) are slaughtered annually producing buffalo meat (Carcass wt.) of 1.10 million tonnes. Buffalo meat (boneless meat) production potential is around 2.00 million tonnes. There are about 12 modern abattoirs cum meat processing plants leading to an export of 462780 MT of meat. Buffalo meat was exported to 60-75 countries in the past years and the value of the meat exported in 2009 was 48,400 million rupees, which has reached a figure of 80,000 million rupees in recent years. Buffalo meat with lower intramuscular fat, cholesterol and calories; higher units of essential amino acids, biological value, iron content, and residue free status would make it one of the healthiest meat for consumption. Buffalo meat is excellent for producing a variety of meat products including, emulsion products, smoked and cured products, restructured products and traditional meat products (Madan, 2010; DAHDF, 2013).

3.7. Draught Animal Power

3.7.1. Though there are large number of draft cattle breeds like Kankarej, Hallikar, Ongole and Khillar found in southern and western parts of the country with a sizable population, but their use as a draft animal has drastically reduced in agriculture operations. The trend witnessed in 2012 census has sharply dipped further as evidenced in the reports from several states limiting the dependence of these draught animals as a work animal for ploughing the land. This observation is further supported by the data on tractors, which are rapidly increasing almost in all parts of the country. Perusal of the data (Agricultural Research Data Book, 2013, IASRI, ICAR, p-204) shows that the State-wise annual sale of tractors increased from 2,17,456 in the year 2001-02 to 5,90,672 in 2012-13, a near 272% increase. Nearly 4 to 6 lakh tractors are being added in the system annually, thus drastically reducing the role of cattle. Further, though the role of the draught animal in the rural economy of the country need not and cannot be under emphasized, the fact remains that the contribution of animal energy has significantly decreased from 43.9 % to 5.8 % and human energy from 36.7 % to 7.9 % (Box 1) (IASRI, 2013a, b).

Box 1: Energy Use in Agricultural Operations in India

The total energy use in production of principal crops in India has increased 4.5 times between 1970 and 2005 for productivity increase from 837 to 1583 kg/ha.

Total energy: 4.5 times (4184 to 19000 MJ/ha)

Fertilizer: 16.4 to 29.7 per cent **Human:** 36.7 to 7.9 per cent

Electricity: 0.19 to 38.1 per cent **Animal**: 43.9 to 5.8 per cent

Box: Source-wise energy consumption in Indian agriculture - NAAS-SOA, 2009, pp 131, ICAR Data Book (IASRI) 2013, pp 213

3.7.2. Draught animal power contribution, as one of the power resources to total power availability for agriculture in India, was 45.26 % (1971-72), which reduced to 9.38 % by 2007-08 (IASRI, 2013), and has further gone down due to increased mechanization of agriculture operations and change of human labour attributes.

3.7.3. It is scientifically established through a series of tests under different climatic conditions that crossbred males are having nearly equal capacity for draught activity and compare well to animals from most of the indigenous dairy breeds. Though crossbred males have lowered performance under sustained activity in hot and humid conditions, but the fact that ploughing and local transport activity involves work with breaks under actual field operation / conditions, eliminates any serious negativity of field performance from crossbred animals, particularly in terms of the draught animal scenario.

3.8. Gaushalas

3.8.1. In India more than 5000 *Gaushalas* are maintaining cattle herd of size varying from 50 to more than thousands (estimated around 20 lakh animals). Some of these animals are of descript breeds, most are non-descript, with no scientific breeding records or breeding plan for improvement). *Gaushalas*, mostly private trusts or charitable organizations, are providing semi intensive production system and utilizing the products and also the by-products for revenue generation. These *gaushalas* are partially funded by government, NGOs or through public contributions. Some states have a very high number of these institutions (*e.g*, Haryana, 256) mostly born on donated lands and run on charity contributions / donations. Large infrastructure and the animals possessed by these *gaushalas* constitute a huge resource of indigenous cattle population and have attracted attention as a resource for cattle breed improvement and conservation (Singh, 2013). Though some of these have good herds, such as Sahiwal and Hariana cattle, but the management and the animal rearing practices (breeding, nutrition, health control, etc.) leave much to be desired in most of these *gaushalas*. Concepts that this vast population could be used in bull production or animal improvement programs get grounded when the genetic merit, management control and the social dictates within the *gaushalas* are considered.

4. PAST ANIMAL BREEDING STRATEGIES AND PROGRAMS

4.1. Genetic improvement and genetic selection

Since the beginning of planned development in India, undertaking genetic improvement of Indian cattle and buffalo breeds have been at the centre of the objective of all the programmes. The Key Village Scheme (KVS), the Intensive Cattle Development Programme (ICDP) have been major programmes covering / intending to cover a very large population of cattle and buffaloes. Their failure to achieve the genetic improvement has many causes and deficiencies (Joshi *et al*, 2005). None of these programmes have been found faulting as far as planning has been concerned. It was due to the deficiencies in execution of the programmes at the field level that hindered in achieving the aims and objectives.

4.2. Cross Breeding of Cattle in India

Crossbreeding programmes have extensively been reviewed and commented upon by several committees of the Ministry of Agriculture, Department of Animal Husbandry and Dairying and critically analyzed by Acharya (1970 and 2011), Acharya and Puneet (2013 a,b), Bhat *et al*. (1978), Joshi *et al*. (2005), Khanna and Bhat (1971), Gandhi (2013), Singh and Pundir (2013). Some salient features of cross breeding are enumerated below:

4.2.1. Most of the cross breeding experiments in the tropics comprised of crossing indigenous cattle (*Bos indicus*) with the better developed European dairy breeds (*Bos~~s~~ ~~T~~taurus)*. This cross involves two segregating populations where males from one population having higher gene frequency for production are being crossed with females having low gene frequency for that trait. A crossbred population when further mated would then show segregation and linkage between blocks of genes affecting production traits, which would then generate a series of genotypes with different proportions of inheritance from either parent population.

4.2.2. Crossbreeding of cattle in India started as early as 1857 when the 'Taylor breed' of cattle was said to have been evolved near Patna using crosses of *Taurus* bulls (Ayrshire bulls from U.K) by Mr. Taylor, an Englishman, the then commissioner of Patna division. Since then the crossbreeding work on organised pattern with various Euro-American breeds (Holstein, Ayrshire, Jersey, Guernsey, Red-Dane, and Brown-Swiss) has been going on. The information on the crosses generated has been analysed and results reported by a number of workers. Mostly two-breed crosses were produced barring a few planned experiments which envisaged production of three-breed crosses also.

4.2.3. In a somewhat planned cross breeding conducted with cattle (*Bos taurus* × *Bos indicus*) at Military dairy farms in India (8 Military Dairy Farms: Ambala, Bareilly, Dehra Dun, Jabalpur, Jalandhar, Lucknow, Meerut and Mhow), it has been generally observed that with an increase in exotic inheritance, the advance made in production in later crosses has fallen short of theoretical expectations. As a result of forward and backward crossing, a series of different genotypes having varying levels of exotic inheritance were generated. The breeding policy in operation prior to 1952 was that of criss-cross breeding. Since 1953 a policy of backcrossing with Sahiwal bulls was introduced with a view to reduce the exotic inheritance gradually. The results revealed that in cattle when two breeds of diverse origin, different in their production levels, one of superior merit and the other relatively inferior, are crossed in a scheme of forward crossing; there is no linear increase in production level with the increase in the level of inheritance of the superior parent. Thus, it cannot be assumed that by grading up a total replacement of genes can be obtained, at least in cattle (Khanna and Bhat, 1971, and Bhat *et al*., 1978).

4.2.4. The situation becomes more complex when backcrossing with the better parent is continued in order to generate genotypes with a higher proportion of exotic inheritance namely ¾, 7/8, 15/16, 31/32 and 63/64. In fact, the very validity of calling a certain grade 3/8, ½, 5/8 or ¾ etc. is questioned because individual within that grade may not in reality have that level of exotic inheritance.

4.2.5. The data maintained at military dairy farms from 1930 to 1980 were extensively investigated. The results suggested that the Holstein inheritance between 1/2 and 3/4 was-most suitable for growth, reproduction and milk production but further increase in milk yield in higher grades fell short of theoretical expectations (Bhat *et al*., 1978). Various factors like undesirable genetic effects and lack of adaptability to tropical environment have been attributed to poor performance of higher grades.

4.2.6. At National Dairy Research Institute, Karnal, crossbreeding of Sindhi with Brown Swiss was initiated in 1963 to evolve a new dairy breed. Semen of bulls with a progeny test index between 6,000 and 7,000 kg of milk was used. The inter-se mating in these crosses was practiced for three generations and crossbreds named as ‘Karan Swiss’. The first lactation yield was higher in F1 crosses than in F2. This was mainly due to non-selection of F1 crossbred sires. In another pilot experiment to produce half-breds; 3/4th and 3/4th with two exotic breeds, the mortality between birth and 6 months was higher in 3/4 grades (8.4 % - 13.3 %) than half-breds (2.4 % - 7.7 %). Similarly, the age at first conception was lower in half-breds (18.4 - 21.1 months) than 3/4th with two exotic breeds (22.8 - 25.1 months). Milk yield (305 days) in first lactation was 3,392, 2,755 and 2,714 kg respectively in Friesian half-breds, Brown Swiss half-breds and Jersey half-breds. The yield in 3/4 Friesian crosses (3,049 kg) was higher than 3/4 grades with two exotic breeds (2,376 kg for FJT and 2,705 kg for FBT). These results suggested that 3/4th with two exotic breeds were not superior to 3/4 straight breeds for most of the traits.

All-India Coordinated Research Project (AICRP) on Cattle was initiated in 1969 as a major project to evolve new dairy breeds in tropics. A number of half-breds, *viz*. ½ F, ½ L(FL), ½ B. ½ L (BL), ½ J. ½L (JL) and 3/4th with two exotic breeds, *viz*. ½F, ¼ B, ¼ L (FBL), ½B, ¼ F, ¼ L (BFL), ½F, ¼J. ¼ L (FJL) and ½ J. ¼ F. ¼ L (JFL) have been produced at six different agro-climatic locations. Friesian half-breds excelled in growth, production and reproduction, with all the local breeds (Acharya, 1970; Acharya and Puneet, 2013 a, b).

4.2.7. The 3/4th with two exotic breeds had lower body weights than half-breds at most of the units. The birth weight in 3/4th was higher. None of the 3/4th excelled Friesian half-breds in milk yield. The differences among the 3/4th grades were negligible. The Jersey inheritance in 3/4th contributed lower mature weights and higher reproductive efficiency. The percent fat in milk was highest in Jersey half-breds (4.9 %) while there were no differences among the other half and 3/4 grades.

4.2.8. The Indian Council of Agricultural Research (ICAR) initiated a large crossbreeding programme of crossing low yielding non-descript animals in hilly and heavy rainfall areas with Jersey in 1955 at several locations in different states. A number of grades with exotic inheritance of 1/2, 5/8, 3/4 and 7/8 Jersey inheritance were produced. Inter se breeding was practiced in 1/4, 1/2, 3/4 grades. All the animals in the scheme were identified and milk recorded revealed that milk yield of half-breds was 1,512 kg, local cows 692 kg, and of 3/4 Jersey 1,935 kg. The Brown Swiss half-breds from local cows in Kerala gave a first lactation yield of 1,958 kg as against 716 kg in local cows. The 3/4th gave a higher yield of 2,499 kg. These results suggested that crossbreeding of non-descript cows with exotic breeds led to significant improvement in all the economic traits. Milk in cross bred cows increased to 200-300 % in different grades as compared to local cattle. Grades with more than 50 % exotic inheritance were difficult to be maintained, at the then available feed, health management and disease control programs. There was no significant difference in milk production of 1/2 and 3/4 grades. In addition to improvement in milk production in crossbreds there was an improvement in reproductive performance as reflected by reduction in age at first calving and inter-calving period. These results suggested that crossbreds with milk yield up to 2,000 kg could be sustained with feeding and management practices followed by the farmers under village conditions. Exotic inheritance between 1/2 and 3/4 was optimum for maximum production depending upon the level of animal husbandry practices, availability of inputs and climatic conditions (Acharya, 1970; Acharya and Puneet, 2013 a,b).

4.2.9. In support of the field based programmes like the KVS and the ICDP, the governments and the ICAR set up State and Central cattle and buffalo breeding farms for crossbreeding of indigenous cattle, undertook progeny testing of bulls of identified cattle breeds, buffaloes and crossbreds of Indian and exotic breeds. The project undertaken by the Kerala Livestock Development Board has been able to provide a documented result in the Progeny Testing Programme. Several batches of bulls have been recorded as progeny tested. This has lead to the improvement in lactation yield of Sunandini breed from 1408 ± 484 kg to 1829 ± 564 kg over the lifetime of the project. Surely this increase is very inadequate. Results based on progeny testing have also identified some outstanding crossbred bulls at PDC, Meerut (Singh and Pundir, 2013) and NDRI Karnal (Joshi, 2004), and buffalo bulls under AICRP on Buffalo (Sethi, 2003).

4.2.10. Establishing a new breed through crossbreeding has been always a matter of scrutiny and controversy. It has been considered that inter-breeding crossbreds leads to a decline in their performance. This is because interbreeding amongst the crossbred progeny breaks down the heterotic gene combinations and this leads to decline in their performance. The decline in performance has been largely due to lack of selection in F_1 that can result in some decline in the mean in F_2. It is well known that neither the Indian cattle population nor the exotic bulls come from highly inbred populations. Both the populations are random bred. Therefore, the crossbreeding between two breeds leads to gene segregation when the F_2 crossbreds are interbred. This interbreeding, on one hand results in breakdown of heterotic gene combinations, and on the other results in large variability in F_2 (Bhat *et al.*, 1978).

4.3. Cross breeding conclusions

4.3.1. From the narrative given above, cross breeding of indigenous cattle with exotic dairy cattle breeds has been, over varying degrees, carried out for nearly past hundred years in organized farms and under field conditions in different agro-ecological zone of the country. The results of the cross breeding, when analysed to answer questions raised, have not been fully answered because of the incompleteness of the available genetic variability data. Since there are millions of crossbred animals born in the country there is need to have a definite policy for breeding with exotic breeds and breeding among the F_1 generation animals of the crossbreds. The performance of crossbred (F_1) and their interbreds (F_2) has been evaluated extensively in military dairy farms and in classical experiments carried out in the ICAR. The F_2 inter breeds had variable performance when compared to their F_1 records. Besides the lowered milk production, there was a major issue of male infertility (40 % or more). This probably shows that interbreeding among the interspecies crossbred (F2) over years does result in decline in performance probably due to lack of selection in crossbred bulls in relation to the exotic bulls used in creating F_1's. Certain degree of loss of heterosis (to the extent it exists) and epistasis and linkage dis-equilibrium is also responsible for this decline. The inter breeding of crosses with adequate selection of sires on the basis of their progeny performance will lead to further improvement in the performance of crossbreds over the indigenous cattle involved in crossbreeding and it will be possible to evolve a new high yielding dairy breed from the crossbred base. It is reported that evolving a new breed from the crossbred base is most feasible approach if there is: (i) proper identification of the animals, (ii) proper performance recording, (iii) thorough selection process, and (iv) availability of large crossbred population (Acharya and Puneet, 2013 a,b; Khanna, 2006).

4.3.2. In spite of large volume of data generated, the analysis to determine components of genetic variance are not very accurate as they are not based on contemporary comparisons among all the requisite groups involving exotic and indigenous breeds *viz*, the purebred exotic and indigenous, the reciprocal F_1's, ¾ breds and 5/8's and their interbreds. However, recent information on the Holstein Friesians (HF) crosses with more than 50% of exotic inheritance, back crossed with high genetic merit pure exotic Holstein Friesian semen and evaluated in terms of life time production, are known to have more milk production, longer herd and productive life and more number of completed lactations. Life time milk production, and number of lactations completed have been found to be much higher among crossbred than the indigenous breeds involved in the crosses.

4.3.3. Consequent to the improvement of health and management standards, farmers are more inclined and find it more profitable to have higher exotic inheritance crossbreds and a considerable population of farm community prefer to rare even crosses with high percentage of exotic inheritance or even pure bred exotic animals. The economic advantage they claim in terms of total fluid milk, total fat and protein, life time productivity, revenue from female followers, however, needs to be scientifically examined and genetically validated.

4.3.4. The Punjab Dairy Farmers' Association (PDFA) has organized a large program for cattle improvement for milk through HF. Majority of animals have high HF inheritance and female crossbreds are further crossed to pure HF (bred with pure local or imported HF semen). There are similar populations of high exotic inheritance crossbreds, primarily of Jersey and HF in other parts of the country, which have been subjected to selection for improvement of milk production with high exotic inheritance.

4.4. National Project for Cattle and Buffalo Breeding

Appreciating that bringing about genetic improvement is a long term activity; the Government of India initiated "National Project for Cattle and Buffalo Breeding" in October 2000 for a period of ten years. The Project envisaged genetic up gradation and conservation of important indigenous breeds. The results from some states were encouraging but did not reach the expectations for want of total commitment, services and goods support on behalf of the state animal husbandry institutions. This program has now been merged with the National Dairy Plan.

4.5. **National Dairy Plan Phase-I** is a central sector scheme for a period of 2011-12 to 2016-17 with total investment of Rs. 2242 crore. It is a scientifically planned multi-state initiative with project development objectives of increasing productivity of milch animals and help milk processors to have access to organized milk processing sectors. It envisages a provision of technical inputs supported by appropriate policy and regulatory measures to meet the 100 % bull replacement needs of 'A' and 'B' graded semen stations by the end of NDP I and thereafter largely through producing high genetic merit bulls by pedigree selection and progeny testing programmes.

The programme provided that to breed about 35 % of breedable animals required by the end of NDP I, the country would need to produce some 100 million high quality disease free semen doses and make available about 900 high genetic merit bulls for replacement of bulls maintained at all 'A' and 'B' graded semen stations. The breeds identified for establishing progeny testing programme include: Holstein Friesian, HF crossbred, Jersey CB, Sunandini cattle and Murrah and Mehsana buffalo and the breeds identified for pedigree selection programmes to begin with include: Rathi, Kankrej, Tharparkar, Gir, Sahiwal and Hariana cattle and Nili-Ravi, Jaffarabadi, Banni and Pandharpuri buffalo.

4.6. **Rashtriya Gokul Mission** is a new programme launched recently by GoI with the objective to converse and develop indigenous breeds in a focussed and scientific manner. Realising the importance of the indigenous breeds and the need to protect and conserve them, the major objectives of the scheme includes breed improvement programme, enhanced milk production and productivity, upgrade nondescript breeds and distribute disease free high genetic merit bulls of indigenous breeds. The mission is to be implemented through the state implementing agency (State Livestock Boards) and State Gauseva Ayogs. The scheme is proposed to be funded on 100% grant-in-aid basis during the remaining part of 12th Plan by the Central Government.

Establishment of village level integrated indigenous cattle centres 'Gokul Gram', strengthening of Bull mother farms, establishment of Field Performance Testing (FPR) and setting up of Breeder Societies and 'Gopalan Sangh' are among others, the main components of the Mission. Though all these areas have been part of different programs of the government in previous policy announcements, it is for the first time that a focused approach has been taken by the Government.

The "Gokul Gram" will be set up by and function under the auspices of State Implementing Agency or in Public Private Partnership mode. The Gokul Gram will maintain milch and unproductive animals in the ratio of 60:40 and will have capacity to maintain about 1000 animals with in house fodder production. The national experience with running of improvement programs under government control as mentioned at 4.1 has not yielded expected results in the past, however with financial support, commitment of implementing agency and strong monitoring this program should be a new path setter for indigenous animals' improvement.

5. BREEDING POLICY AND PROGRAMS

5.1. Breeding Policy - A Critique

5.1.1. The main objective of this Breeding policy document is to address the importance of rich biodiversity of cattle and buffaloes in India which are endowed with genetic variation in production types, adapted to tropical environments, feed resources and comparative disease resistance, and to propose a policy frame work for improvement and conservations of these animals.

5.1.2. Having been subsidiary to Agriculture, Livestock Sector (LS) has not received its due as far as Policy support and Institution building are concerned. Whilst the Crop Agriculture has played crucial role in shaping the performance and development of land based agriculture sector, animal based landless and marginal agriculture has eluded the support it deserved. Even when the annual growth of crop agriculture was negative, animal agriculture recorded a growth consistently of around 4.0 % annual.

5.1.3. Growth in the livestock sector has in fact been anchoring the agriculture growth which has been inconsistent and contributions of LS to agricultural GDP growth has consistently grown over the years reaching as high as 36 %. The LS has provided sustainability in agriculture, ensuring nutritional security (particularly animal protein so essential for children and nursing mothers), poverty alleviation and women empowerment.

5.1.4. Some of the important changes witnessed by India's LS sector in the recent years include,

(i) Increase in production and productivity of milk mostly confined to cross bred females and marginal increase from indigenous descript and nondescript cows.

(ii) A limited increase in commercialization of produce and its marketing.

(iii) Fragmentation of land holding of livestock owners / farmers and non-availability of grazing area for animals belonging to marginal or land less animal owners.

(iv) A large number of male calves getting wasted post birth due to their limited use.

(v) Intense use of tractors and reduced use of animal power in agricultural operations.

(vi) Rise in total cost of production and squeeze in farm profit.

(vii) Mostly un-organized milk and meat processing sector.

(viii) Liberalization of external trade and other sectors.

(ix) Decline in resource base of feed and fodder.

(x) Heavy pressure for diversion of agricultural land to non agriculture uses.

(xi) Non availability of credit for animal activity or financial support for animal owners for calamities, diseases or accidental loss of animals.

(xii) Inadequate incentives or subsidies for planned animal breeding.

5.1.5. As discussed in Section 4, the history, programmes of animal breeding and the results obtained there from have been analyzed.

5.1.6. The problem of Breeding Policy of Livestock and strategy remained the same over years but from the implementation platform, the gains both genetic and economic could not be obtained broadly due to the failure to identify the stake holder and the problem of financial requirements needed for the deliverables. In the absence of these basic requirements no breeding policy could be implemented.

5.1.7. For effective breeding policy / strategy the two basic issues will have to be sorted out. Firstly, what to do with the surplus cattle and buffalo in numbers; and secondly, what to do with feed and fodder non-availability on short and long run basis.

5.1.8. Two specific lines of approach, a short-term and a long-term, need to be considered. The first and foremost is to separate breeding of cattle and buffalo. There is no problem in solving the existence of surplus buffalo as a plan for the same is given in an earlier chapter. With regard to cattle, if an effective selection is to be done, the plan has to be to reduce the number of unproductive cattle and eliminate the males through technical and technological inputs. Baring well-developed native breeds, a strategy for grading up of rest of the breeds needs to be implemented as detailed in this Section.

5.2. Breeding Policy vis-à-vis Milk Demand

5.2.1. Demand scenario for milk and milk products requirement for 2030 clearly suggests that the annual increase in production should be more than 4 %. In fact the purchasing power, nutritional demands of the nursing mothers and infants, change in food preferences and above all the essential protein requirement of large vegetarian population of the country, propels the demand to a growth of 6-8% annual.

5.2.2. Compared to the actual production of 132.43 MT of milk in 2013, and a demand growth of 6.0 %, the requirement will be 203.85 MT in 2020 and 365.07 MT by

2030. In case of a demand growth of 8 %, this requirement will grow to 236.73 MT and 511.29 MT in the years 2020 and 2030, respectively. This is the greatest challenge in terms of the genetic capacity and capability to increase it, feed and fodder availability, the carrying capacity of the land and total environmental considerations.

5.2.3. Given the present state of animal husbandry and milk productivity, even considering a modest demand increase of 6 %, a pragmatic approach has to be adopted which will result in almost doubling of average productivity from the descript and nondescript population of cattle and buffalo. Most intensive selection process, even if practiced rigorously and successfully on our recognized milk producing breeds, shall very limitedly help in bridging the demand gap. In fact, the best of these animals (total descript population of about 11.8 million breedable females) have milk yield ranging from 1050 to 3200 liters per lactation (average 1500 liters) and vigorous selection and grading up process over the next decade or so can take us to a lactation yield of only 2000 - 3800 litres. What should be aimed at is to simultaneously address rest of 46.0 million non-descript breedable female animals to potentiate them to an average production of 1500 to 3000 liters of milk per lactation within one or two generations. Such results can best be achieved only if high genetic merit indigenous / crossbred / exotic germplasm is used on these nondescript low yielding animals, wherever feasible.

5.2.4. To strategize production of milk from the existing bovine population, therefore, a pragmatic and revolutionary and not evolutionary approach is needed. This should include, reducing the number of unproductive animals through reproductive health control, regulating male births through sexing technology (both from descript breeds and nondescript animals), fast up scaling of productivity, ensuring grading up and conservation of our national wealth of descript breeds and fast replacing the nondescript population through grading up or crossbreeding depending upon the eco-regional, agro-climatic and socio-economic condition of the animal keeper.

5.3. Breeding Policy vis-à-vis Centre-State Relations

5.3.1. Under the Constitution of India, Animal Husbandry is a State subject. Since animal improvement programs are proposed on national perspective, there is need to minimize conflicts in plan implementation. It is important that national policy provides for national implementation with modifications as may be necessary considering the local ecological imperatives. For example, as breeds of animals prevail across states, presence of the same breed in more than one state need not vitiate the national expectations of a breeding program. While the states need to avoid unnecessary duplication, they need to undertake responsibilities through proactive collaboration across states. The state which has the largest number of animals of a given breed could be the leader of a breeding programme and the other minor state (s) could take programme implementation guidelines as well as report for monitoring to the leader state. There needs to be a central authority (**National Animal Breeding Board**) to coordinate, implement and monitor the central program.

5.4. Breeding Policy - Program Approach

5.4.1. Analysis of previous breeding policy programs bring forth some important issues that often have been neglected with glaring consequence of even well meaning programs not been able to produce the desired results. The envisaged National Animal Breeding Board / Authority should address the following issues:

(i) Registration of animals and their identification.

(ii) Facilitating the states in the formation of breed societies and breed groups from among the animal keepers.

(iii) Linkage of AI with the state breeding policies, services and other public sector support.

(iv) Providing for a national blue print for infrastructure, manpower, training, quality control, biosafety, monitoring, technical and financial support for implementation of the policy.

5.5. Breeding Policy - *General Guidelines for States and Central programmes*

5.5.1. The general guidelines will consist of the following:

(i) Control of stray male and female animals through legislative framework.

(ii) Identification of animals in their breed tracts, registrations of these animals, formation of breed societies or groups as the most critical prerequisite for a breeding policy.

(iii) States with more than one indigenous breed should have specific species wise and breed wise improvement policy addressing animals across the state boundaries.

(iv) Selective breeding of defined indigenous breeds of high milk yield or excellent draft abilities be intensified to improve their production and reproduction potential among both the groups.

(v) Adding more milk should be the new priority among the draft breeds as well. This strategy is meant to add more economic returns from draught animals and greater acceptance of these animals by animal keepers as these animals are losing their bearing and usefulness in the changed agriculture.

(vi) The best ways of checking the number reduction among descript cattle breeds and to ensure their conservation and proliferation, is to give an economic advantage to the farmers / animal keepers through a incentive policy for fast genetic up-gradation of these animals. This implies production and use of semen of the highest genetic merit only.

(vii) Farmers having cross bred animals of different exotic inheritance and having means to sustain high exotic inheritance to breed their animals with pure exotic semen, locally produced or imported.

(viii) The semen, embryos, animals, etc, imported into the country should adhere to the requirements of the minimum production and health standards and such standards should be laid down by the Central Authority regulating the imports and also registering its use.

(ix) Pure bred exotic animals be bred to respective breeds. The policy advocates use of semen of higher merit animals for breeding these animals to keep the tempo of genetic improvement and generational production increase.

(x) In view of the raging A1 /A2 milk controversies, and the fact that there is no scientifically validated study to prove the human health implications, the fact remains that zebu cattle produce A2 milk and several exotic (*Taurus*) breeds of animals have different levels of A1 gene; the breeding policy may, as far as possible, prefer future import of pure exotic semen from animals with A2 A2 inheritance.

5.6. Breeding Policy for Non-descript Cattle

(i) Non-descript, graded and low producing cattle that habitat in the geographic entity of the recognized breeds (the breeding tracts of defined indigenous breeds) should be graded up with the semen of defined indigenous regional breeds only.

(ii) All non-descript indigenous population which does not fall within the breeding tract of the defined breeds should be bred in one of the two following ways depending upon the animal type, the region, the resource ability of the animal owners, adequate facility for feed and fodder, marketing facilities, agro-climatic conditions and the preference of the farmers in a monitored programme.

(a) Inseminated with semen from the best indigenous dairy breeds of the country, OR

(b) Crossbred with semen of either Jersey × Zebu or Holstein Friesian × Zebu crossbreds of highest genetic merit, OR

(c) In the absence of high potential semen of indigenous dairy breeds, the next preference should be to potentiate these low grade non-descript animals through crossbreeding to produce a F_1 first generation heterosis effect and a perceptible increase of milk.

(iii) All crossbreds animals of different exotic inheritance should receive crossbred semen of only the same parental breed of high genetic merit, progeny tested or having one of the parents with a milk production record of over 5000 liters/ lactation yield. Cross bred bulls of different inheritance levels from half-bred to any higher exotic inheritance be ranked as a single genetic group for crossbreeding purposes.

(iv) The breeding policy should direct towards exploitation of the potential of vast nondescript population to higher production within a single generation time span (F-1) using:

(a) High potential recognized indigenous breeds suited for the region, or

(b) High potential exotic pure bred breeds suited for the region, or

(c) High potential cross bred semen (Friesian × Sahiwal or available alternate crossbred semen) having high milk yield and known ability to produce superior female progeny.

(v) High genetic merit crossbred (Frieswal and other crosses) semen can be used, with fast and notable returns in milk production, on very low producing nondescript animals.

(vi) The current status of improved health management and disease control in the country ensures the survivability and lowered morbidity of exotic pure bred and crossbred animals of higher exotic blood / genetic merit.

(vii) The state agencies should raise high pedigreed bulls from elite females for free distribution among animal owners in villages that are remote, have no infrastructure for AI and are beyond easy approach for improved animal husbandry practices.

5.7. Breeding policy for Recognized Cattle Breeds

(i) Breeding policy should mandate coverage of all breedable females by making available semen from bulls of the same breed with superior milk potential. Only males of high genetic merit be used as the gain is dependent upon efficiency of selecting the superior males.

(ii) Producing males from elite females among each recognized breed, having high genetic potential.

5.8. Breeding Policy for Buffaloes

(i) The greatest challenge is to increase the pace of production improvement in shorter span and the policy frame work is to address not only the genetic issues of milk productivity but also growth, body weight, male calf weight gain, milk composition and processing of milk as buffalo milk for product formation.

(ii) Buffalo selection should, hence forth, have the added criteria of selection for body weight, weight of the calf and growth of the calf (0-6 month's body weight gain).

(iii) The buffalo breeding protocols with focus on the above issues will mostly be in conformity with those of indigenous cattle.

(iv) Selective breeding to grade up the productivity among established descript native breeds.

(v) Grading up of low producers in and around the regions associated with the descript breeds with high merit semen of the same breed.

(vi) Nondescript low producing buffaloes to be crossed/upgraded with the semen of the best descript/defined breed in terms of the trait of interest, Murrah for milk and Jaffarabadi for fat and body weight.

5.9. Semen Production and Distribution

5.9.1. For efficient bull / semen production program, the pre requisite of any improvement strategy, should be taken up for each of the recognized breeds prioritized by each state or central organizations. This will involve:

(i) Identification, selection and registration of elite females (bull mothers) representing the top 10 % of the breed in its eco-region.

(ii) The farmer / animal owner given identity card / certification of the animal enrolment in the bull production program.

(iii) The farmer is provided the incentives commensurate with the milk producing capacity of the bull mother linked to his being partner to bull production. While he will keep the female calf born, the male calf will be handed over to the state department in a pre-determined arrangement at a pre-determined price.

(iv) The farmer has to ensure the calf will have a weight gain determined for each breed for the 6 months he will rear the calf. The farmer / animal owner will receive a maintenance incentive during the months he/she maintains the calf and a full price at the end of this period.

(v) The semen for insemination, to be used on the prospective bull mother selected on the basis of best recorded performance, will be determined in partnership with the state AHD, who will also ensure AI and the pregnancy of the female in a time span provided.

(vi) During the initial phase, the semen used will be either from the bulls already with the state governments or from selected males whose mother's production is (known) a minimum of twice the standard deviation more than the average of the contemporary females. Subsequently, semen from only selected male progeny born from elite mothers will be used. In the third phase only progeny tested semen will be used which has a proven superiority of production and reproduction.

(vii) Every State with descript breeds must have a bull / semen production program clearly defined and targeted in a time bound fashion with demarcated responsibility.

6. POLICY STRUCTURE AND POLICY IMPLEMENTATION FOR SUSTAINABLE USE AND CONSERVATION

6.1. General Policy structure and implementation

6.1.1. Cattle and buffalo breeds have ecological distribution that does not follow the geo-specific boundaries of the states. Identification of animals in their breed tracts, registrations of these animals, formation of breed societies or groups is the most critical prerequisite for a breeding policy.

6.1.2. Several states have more than one indigenous breed; therefore, specific species wise and breed wise improvement policy should address animals across the state boundaries.

6.1.3. Adding more milk should be the new priority among the draft breeds as well. This strategy is meant to add more economic returns from draught animal and greater acceptance of these animals by animal keepers as these animals are losing their bearing and usefulness in the changed agriculture scenario.

6.1.4. The best way of checking the number reduction among descript cattle breeds and ensure their conservation and proliferation, is to give an economic advantage to the farmers / animal keepers through a policy for fast genetic up-gradation of these animals. This implies production and use of semen of the highest genetic merit only.

6.1.5. Through planned breeding, superior genes for production, attempted to be introduced into the breeding program can deliver the envisaged results only if simultaneously each of the following input is also provided with and need also to be part of Policy document.

(i) Adequate feed and fodder.

(ii) Nutrient, mineral supplementation.

(iii) Optimum shelter and management support system for the animals.

(iv) Animal registration with timely vaccination and health care.

(v) Storage, transport and marketing of the produce.

(vi) Insurance and risk coverage of the valuable animals.

(vii) Breeding program strategy implementation to address each of these issues as part of the policy structure.

6.2. Financial support, and Investment in Technology

6.2.1. The livestock sector should get at least 20.0 % of the total agriculture allocation (presently around 6.0 %), especially when livestock sector, contributing 26.5 % to Agriculture GDP, is poised for a high demand driven growth and the sector has capacity and technology to deliver an annual growth of over 5 to 6 %.

6.2.2. Application of breeding program, principles, procedures, and techniques is a long term investment in livestock sector, the results of which don't fructify within a quarter or a season but over generation (3-5 years). The major underlying fact behind the limited success of each policy enunciation has been a gross disconnect between the funds required and the financial support provided. Short time compromises in financial allocation in violation of appropriate needs, lead to long time failures.

6.2.3. Over the years, there hardly has been any commitment or sizable investment in field for application of modern biotechnology, which have found routine application in breeding and breed / animal improvement world over and has also been scientifically tested and proved within the country. The procedures and techniques for fast multiplication of elite animal like ETT, ONBS, IVF, synchronization etc. Madan *et al.* (1996), Madan and Prakash (2007) have no alternatives if fast breed improvement is to be ensured.

6.2.4. Use of sexed semen technologies to stop the wastage of males and augmentation of female population will add very significantly to farmer revenues both among cattle and buffalo and a colossal national saving of animal wastage amounting to over Rs 10,000 crores annually.

6.3. Policy Implementation, Review and Monitoring

6.3.1. Though most state governments have formulated a general conceptual breeding agenda, there is urgent need for having a specific **policy implementation document** in tune with national perspective and demand scenario, local agro-ecology and socio-economics of stake holders.

6.3.2. Breeding policy for indigenous purebreds, graded, non-descript, exotic and crossbreds should be separately formulated (Nationally and in each State) to be implemented in an identified time frame with defined breeding goals under different production systems and demand of the state.

6.3.3. For breed improvement program, state-wise or area / zone (within state)-wise, bull and semen requirement among the major genetic groups / breeds be worked out and the availability, storage, distribution, utilizations and quality control of semen doses ensured.

6.3.4. There is a need for ccontinuous review and monitoring of the national breeding schemes as well as the State breeding policy implementation for specific breeds so as to oversee genetic programme of entire cattle and buffalo population of India. There should thus be a Central designated Authority **"National Livestock Germplasm Authority of India"** setup under Central Government with jurisdiction across all states to monitor, evaluate, regulate breeding of males and semen production, and ensure its quality control and distribution in the country.

6.3.5. The strategy document for implementation should be a part of the policy frame work and should have identified components, goals, targets and deliverables. The breeding policy implementation document should include the following elements:

(i) Choice of species / breed / animal.

(ii) Choice of selection criteria.

(iii) Design of the breeding scheme – selection criteria and breeding protocols.

(iv) Financial implications including special services, insurance, micro financing and incentives.

(v) Quality evaluation of the bulls / semen.

(vi) Identification, selection and recording of animals.

(vii) Genetic evaluation and monitoring of genetic improvement.

(viii) Nutritional, health care and other infrastructure input requirement including storage and marketing of the produce.

(ix) Qualitative and quantitative identification of economic benefits.

(x) Documentation, data recording and information retrieval system.

(xi) An annual breeding strategy review should be in place with each policy document.

6.4. Research support

6.4.1. A strong research component should be an essential feature of livestock policy structure with adequate finances, manpower and infrastructure to support investigations and intervention encompassing evaluation of genetic improvement and selection technique including use of genomic tools / chips, fertility evaluation and management, intensive bovine production and management systems, regenerative reproductive technologies, sexing procedures and production of sexed semen, climate / environmental change effects on livestock and their amelioration, product processing and development technology innovations on livestock, livestock products, and buffalo milk as an Indian Brand.

As planning, implementation and evaluation forms a continuous process, the identified research elements should be approached interactively rather than step-by-step.

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