CROSS BREEDING OF CATTLE POPULATION IN INDIA

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INTRODUCTION

Dairy farming is an integral occupational support system on which the entire social and economic structure of the village life anchors in India. It provides employment especially self-employment to a substantial number of rural population. Livestock contributes in improving the national nutritional standards by providing valuable balanced animal protein in the form of meat, milk, egg and dairy products and by-products. According to National Commission on Agriculture (1976), 70% of the livestock belong to small, marginal and agricultural workers. So, any improvement of these livestock will definitely help to these categories of people. Among the livestock products, milk is main commodity that has emerged as the second largest agricultural commodity next to rice.

India possesses the largest cattle and buffalo population in the world but average milk production per cow is very low in comparison with advanced countries. Low milk production in India is probably due to low genetic potential for milk production, poor nutrition, management and adverse agro climatic conditions. To cope with the problem, various breeding strategies are in vogue with adoption of exotic germplasm for higher milk production since 1960.

History of crossbreeding

Before a planned development of livestock sector, India possessed a large number of poor producing cattle population along with acute shortage of feed and recurrent animal epidemics. Crossbreeding of indigenous tropical breeds with temperate dairy breeds was undertaken to combine high milk yield and early maturity of European dairy breeds with hardiness, disease resistance and adaptability of local cattle. Crossbreeding experiments clearly demonstrated that crossbreeds were better producers of milk than indigenous breeds and were more adaptable to the tropics than pure-bred exotic breeds.

European missionaries started crossbreeding of cattle in India in 1875 when the 'Taylor Breed' of cattle was developed around Patna, Bihar, by breeding Shorthorn bulls with native cows. European planters started crossbreeding native cows with Ayrshire, Friesian and Jersey in the Nilgiri district of Madras state about one and a quarter century back. The crossbreeding programme started at the Imperial Dairy Research Institute, Bangalore in 1910, involving Ayrshire bulls and Haryana cows. The experiment was expanded to Sahiwal in 1913 and Red Sindhi in 1917. In 1938, crossbreeding of Red Sindhi with Holstein Friesian was started. The Agriculture Institute, Naini, Allahabad started a crossbreeding programme in 1924 with four exotic breeds namely Holstein Friesian, Brown Swiss, Guernsey and Jersey (Dhanda and Pathak, 2011).

Kurup (2002) reviewed crossbreeding of indigenous Indian cattle with exotic breeds to increase milk production. Planned development of the livestock subsector in India began with the launch of the first Five Year Plan in 1951. The First Plan goals in cattle development were primarily to increase milk production; improve milk supply to the large urban demand centers and improve the quality and supply of draught animals for agriculture. The policies laid down for achieving these goals were selective breeding of indigenous cows belonging to the descript dairy breeds, upgrading of nondescript cows with indigenous dairy breeds, and selective breeding of draught breeds. The launch of the Key Village Scheme (KVS) in 1951 was the action programme to increase milk production and, to an extent, to alleviate the shortages in fodder supply. Crossbreeding of Indian cattle with European dairy breeds was introduced as an experiment in the hilly areas during this period. The Livestock Improvement Act enabling compulsory castration of scrub bulls was an attempt to regulate the cattle population growth as well as to enforce a degree of selectivity in breeding. Artificial insemination (AI) was introduced around the same period, as a tool for rapid improvement in the genetic make-up of the stock.

The increase in milk production during the first three plan periods was merely 3 million tonnes. By the end of the third plan the inadequacies of the KVS were apparent, and serious policy reorientation was required to engineer sustained increases in milk production. The interval between the third and fourth plans during 1966–1969 witnessed some of the most momentous policy initiatives by the government in the livestock subsector, particularly for cattle. Development of rural milk sheds and movement of processed milk from the rural areas to urban demand centers became the cornerstone of government policy. This single, epochmaking policy of the government in the late 1960s – to develop dairying in rural milk sheds through milk producers' cooperatives – galvanized the Indian dairy industry to erupt into unprecedented growth.

This policy found institutionalization in the National Dairy Development Board (NDDB), its translation into action in the "Operation Flood Project" and the nationwide cooperative movement launched under the project for marketing the rurally produced milk during the early 1970s. The sluggishness in milk production gave way to rapid growth – from 22 million tonnes in 1970 to nearly 69 million tonnes in 1996. The KVS matured into the Intensive Cattle Development Project, which later became the Government's flagship program for cattle development. Crossbreeding of nondescript cattle became the National Policy for increasing milk production and gained momentum and economic relevance, as the cooperative network under Operation Flood provided the much needed market stimulus and price support for milk.

Several bilateral crossbreeding projects in collaboration with external agencies (UNDP in Haringhatta, West Bengal; Indo-Danish Project in Hasserghatta, Bangalore, Karnataka; and the Indo-Swiss Project in Mattupatty, Kerala) were established during 1962–1964, to study the potential of the policy and to evaluate its impact on milk production and sustainability under Indian conditions. Crossbreeding of nondescript Indian cattle on field scale started only in 1964 with the launch of the Intensive Cattle Development Project (ICDP) by the Government of India. By 1969 it had become the official policy. The pioneering work on large-scale crossbreeding in different parts of India by the Bharathiya Agro-Industries Foundation (BAIF) and the strong recommendations of the National Commission on Agriculture (NCA) in 1974, laid all adverse criticism to rest and legitimised crossbreeding as a powerful tool to rapidly enhance milk production in India.

Genetic basis of crossbreeding

Singh and Joshi (2009) compared the performance of crossbreds with different levels of exotic inheritance and noticed best performance at 50 to 62.5% level. At lower grades productivity fell, while at higher grades, adaptability was poor along with high incidence of diseases. Sahota and Gill (1990) studied relative lifetime performance in different grades of dairy cattle and stated that the length of productive life decreased with the increase in the proportion of Friesian inheritance.

Genetic analysis of production performance of Holstein-Friesian × Sahiwal cows revealed that cows with Holstein inheritance of 5/8 and above had higher yields (total lactation milk yield, 300-days lactation milk yield, peak yield and milk yield per day) than cows of genetic grades 3/8 and 7/16 (Lakshmi *et al.*, 2009). Age at first calving (AFC), lactation milk yield (MY) and calving interval (CI) of crossbred cattle with varying exotic inheritance were reported by Dhanda and Pathak (2011) and results revealed that animals with 50% exotic inheritance exhibits optimum values for all the studied traits.

Saha (2001) reported 26.70 and 17.13 percentage declines in average first lactation milk yield in Karen Swiss and Karen Fries cattle, respectively. Generation-wise evaluation of the performance of various first lactation traits and herd life in Karan Fries cattle by Saha *et al.* (2010) revealed that performance deteriorated after first generation. Effect of paternal generation on first lactation 305 day milk yield (FL305DMY) was non-significant but, it was significant for first lactation total milk yield (FLTMY) and first lactation length (FLL). A decreasing trend was observed over the generation for all first lactation production traits. Maternal generation had significant ($P<0.01$) effect on FL305DMY and FLL. Maximum average FL305DMY (2939.74±127.80 kg) was observed in the first generation, which was significantly different from the average FL305DMY observed in other generations. They also reported maximum average first service period, FSP (161.23±14.56 days), first calving interval, FCI (450.42±16.48 days) and minimum first dry period, FDP (68.83±8.01 days) among the animals belonging to first generation. Due to high milk yield, these animals might be kept in lactation for longer period, resulting in high FCI and low FDP. Sinha (1999) reported highest average 305 days milk yield in the second generation.

Considering all these facts, the technical program for crossbreeding approved by the governments was to breed the present crossbred cattle population using semen from crossbred bulls produced by crossing pure indigenous and exotic animals. This would produce half-breeds with equal inheritance from two widely different parents, one contributing endurance and the other much-needed higher productivity. The exotic donor breeds initially used were Jersey, Brown Swiss, Red Dane, and Holstein-Friesian. The choice of the exotic donor has now narrowed down to Jersey and Holstein. Further, Holstein-Friesian has been found to be the breed of choice for crossbreeding with local cattle in agro-ecological areas where quality feed and fodder resources are adequate to sustain the crossbred cattle and Jersey have been found to be the breed of choice in hilly areas where size of the breed required is small and feed and fodder supply is limited.

Result of crossbreeding

India continues to be the largest producer of milk in world. Several measures have been initiated by the Government to increase the productivity of livestock, which has resulted in increasing the milk production significantly to the level of 102.6 million tonnes at the end of the Tenth Plan (2006-07) as compared to 53.9 million tonnes in 1990-91. The milk production was 121.8 million tonnes in 2010-11 whereas 116.42 million tonnes in 2009-10 indicating growth of 4.66%. India has 199.1 million cattle, as per the 18th Livestock Census, of which there are 72.7 million breedable females (including 16.1 million crossbreds). There are 33.1 million crossbred cattle, of which 16.1 millions are breedable females. About 72.7 million cows produce 44 million tonnes of milk (40 per cent of total 110 million tonnes). Out of 40 per cent of total milk produced by cows, 21 per cent is produced by indigenous cows (56.6 million breedable cows) and 19 per cent by crossbred cows (16.1 million breedable cows). It is obvious that about 22.1 per cent of breedable crossbred cattle are producing nearly 48 per cent of total cow milk (Annual report, Department of Animal Husbandry, Dairying and Fisheries 2011-2012).

Islam *et al.* (2008) compared the milk economic parameters from crossbred cattle owners and indigenous cattle owners and explained that crossbred cows were more economical and gave higher yield than the indigenous cows, inclusion of a few crossbred cows can increase the income of a dairy entrepreneur and provide gainful and round the year employment of its family labour. So, inclusion of crossbred cows should be popularized simultaneously with Artificial Insemination programme to augment milk production of the indigenous and crossbred cows more scientifically and profitably.

As a result of many years of continuous crossbreeding, the cattle population of India now possesses a mosaic germplasm of native cattle and exotic breeds like Holstein-Friesian, Jersey and Brown Swiss. So it is impossible to describe the genetic make up of the crossbred animals in the country.

Performance of crossbred cattle in India

The first lactation yields of animals with different genetic grades in Military dairy farms and National Dairy Research Institute

(NDRI) are reviewed in Table 1 and Table 2, respectively. On analysis of the data, a gradual increase in milk yield is noticed, but the annual phenotypic gain for the period from 1971 to 2010 is only 14.1 Kg in military dairy farms. According to recent reports, Karen Fries animals in NDRI are having a significantly higher performance with respect to milk production traits. The annual phenotypic gain in first lactation yield is 24 Kg in NDRI herds from 1978 to 2010.

Table 1. First lactation yields of cattle maintained in Military dairy farms

Military Dairy Farms			
Genetic Grade	Year	First lactation yield (Kg)	Reference
Half bred Holsteins	1971	2755	Rao and Nagercenkar, 1979
Half bred Holsteins	1980	2787 ± 44	Rao and Taneja, 1980
Holstein X Sahiwal	1982	2785 ± 41	Deshpande and Bonde, 1983
Frieswal	2005	2882.35	Annual report 2005 Frieswal project, ICAR
Frieswal	2010	3309.31	Annual report 2011 Frieswal project ICAR)

Table 2. First lactation yields of cattle maintained in NDRI

National Dairy Research Institute			
Genetic Grade	Year	First lactation yield (Kg)	Reference
Sahiwal	1978	1704	Taneja and Chawla, 1978
Brown Swiss X Sahiwal	1978	3160	
Friesian X Tharparker	1978	3392	
BS F1 half breds	1981	2895	Bhatnagar *et al*., 1981
Karen Fries	2008	3673	NDRI Annual report, 2008
Karen Fries	2010	4160	NDRI Annual report, 2010

Field progeny testing project

Field progeny testing project for improvement in crossbred cattle was undertaken at different centres like Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana in Punjab; BAIF, Uruli-Kanchan, Pune; Kerala Veterinary and Animal Sciences University (KVASU), Mannuthy. The average first lactation yield for progenies of first set of bulls was 2698 Kg in 1977 and it is 2910 Kg in 2010. For improvement of 212.1 Kg of first lactation yield it took 33 years with an average annual increment of 6.4 Kg. In BAIF, the average first lactation yield of daughters of tested bulls was 2976 Kg in 2010 which was 2930 Kg for first set of bulls accounting an average increase of 1.4 Kg. In Kerala, the average first lactation yield increased from 1958 Kg in 1977 to 2402 Kg in 2010. Hence the improvement in first lactation yield of crossbred cattle under the scheme during the period from 1977 to 2010 is 444 Kg which amounts to 13.45 Kg per year (Annual report 2010-11, PDC Meerut).

Indo-Swiss Project- Matttupetty, Kerala

In Kerala the production of local cattle was 723 Kg per lactation and that of Brown Swiss crosses was 2368 Kg in 1974 (Nair, 1974; Chacko, 1983). The average first lactation yield of Sunandini cows for the period from 1973 to 1991 was reported as 1914 ± 27.8 Kg (Chacko, 2005). According to Singh (2005) the average first lactation milk yield of the Sunandhini cows ranged between 1833 and 2502 Kg during 1991-2000 (KLDB Annual Report, 2001-02). The present production of the crossbred cattle of the state is around 2700 Kg. The annual phenotypic gain in milk production in the state from 1974 to 2009 is less than 4 Kg. Anilkumar and Biju (2009) established the progressive reduction in average first lactation yields of Sunandini cows in Kerala.

Indo-Swiss Project, Patiala

According to Menzi *et al*. (1982), the average first lactation yields of Sahiwal, Sahiwal X Brown Swiss and pure Brown Swiss were 1515 Kg, 3190 Kg and 2706 Kg, respectively. Brown Swiss × Sahiwal crosses (F1) produced twice as much milk as purebred Sahiwal, and also more than purebred Brown Swiss. A comparison between imported and locally-born Brown Swiss cows showed that the imported cows were superior in milk yield, while those born in India were younger at first calving and had shorter calving intervals.

All India Coordinated Research Project on Cattle (AICRPC)

The comparison of Brown Swiss, Holstein and Jersey halfbreds showed that Holstein halfbreds were better than the other two groups. In two places Rahori and Jabalpur, where Gir was used as the female, the yield was substantially high.

Table 3. Comparative performance halfbreds (F_1) in 1983

	Holstein	Brown Swiss	Jersey
IVRI Izathnagar	1834 ± 34 Kg	1448 ± 40 Kg	1218 ± 36 Kg
HAU Hisar	2434 ± 39 Kg	2126 ± 59 Kg	1894 ± 30 Kg
CBP Haringata	2063 Kg	1899	1568 Kg
JNKVV Jabalpur	2366 ± 35 Kg	-	1778 ± 44 Kg
MPKVP Rahuri	3240 ± 58 Kg	-	2522 ± 50 Kg
APAU Lam	2193 ± 28 Kg	1853 ± 52 Kg	1546 ± 53 Kg

Source: Indian Council of Agricultural Research, 1983 (Project Coordinator's Report 1982–83).

Government Livestock Farm Hisar

The average first lactation yields of Hariana halfbreds with Holsteins and Jerseys were 2002 ± 52 Kg and 1588 ± 51 Kg respectively (Duc and Taneja, 1984). Holstein-Friesian and Jersey were about 18 months younger than Hariana at first calving, produced two times milk, and had shorter calving intervals. Crossbreds were closer to the exotic breed in age at first calving, but almost midway between the parental breeds in the other traits. The average lactation yields of Holstein crossbreds in 2008-09 and 2009-10 were recorded as 3598 and 3504 Kg, respectively. The improvement is hence more than 60 Kg per year from 1984 to 2009.

Constraints of crossbreeding

***Interse mating*:** Genetic progress in the intermating populations would be maintained and promoted through interse mating (mating of two animals with same genetic makeup). For this, half bred bulls with 50% exotic inheritance are crossed with crossbred animals in the country assuming that 25% exotic inheritance is transmitting to the progenies from both the parents, resulting in 50% exotic inheritance in the progenies which is ideal for maximum performance. In practical situation, exotic inheritance may not be 50% and so the production potential may also decrease.

***Selection of breeding bulls*:** In crossbreeding programmes the exotic inheritance is introduced to the cattle population by artificial insemination using semen from genetically evaluated half bred bulls. The genetic progress achieved by crossbreeding is solely based on the genetic worth of the half bred breeding bulls. The top crossing of the population with 50% crossbred bulls will result in fixing of the exotic inheritance of the cattle population to the most optimum 50% level. *Bos indicus* part of the breeding bull can be of any of Indian dairy breeds like Sahiwal, Gir or Tharparker. For production of such *Bos indicus* breeding bulls breeding farms of indigenous cattle is also needed. Breeding bulls of F1 should be progeny tested to give an idea about the genetic worth of the animals. For reducing the generation interval, techniques like MOET and genomic selection can be employed.

***Culling of unproductive animals*:** In any crossbreeding programme, the segregation of genes can be prevented only by application of high selection pressure by culling low producing animals. Unfortunately in most part of our country it is not possible since cattle slaughter is banned. It aggravates the problem of low productivity.

***Heritability*:** Saha *et al.* (2010) reported low to moderate heritability estimates for first lactation production, reproduction traits and herd life. Low to moderate heritability estimates for total milk yield, 305 day milk yield, lactation length and dry period suggest that these traits can be improved through selective breeding of sires coupled with optimum managemental conditions (Lakshmi *et al*., 2009).

***Correlation of production and reproduction traits*:** Results of Saha *et al.* (2010) indicated that various production traits like FL305DMY, FLTMY and FLL had positive and significant phenotypic correlations with FSP, FDP, FCI, MY/ FLL, MY/FCI and HL, and confirmed that high producing animals were generally poor with respect to reproduction traits but due to their high producing ability, animals were kept in the herd for longer periods. Genetic correlations between various traits revealed that high producing animals generally had high service period, dry period and calving interval. High first service period of high yielders also confirmed the antagonistic relationship between production and reproduction traits. Singh *et al.* (1993) in Jersey × Sahiwal crosses and Bhattacharya (1996) in Karan Fries also found similar results. Critical appraisal of genetic and phenotypic correlations revealed that FLMY and FPY either alone or in combination can be used for evaluation of sires for LTMY. This would help in reducing generation interval and thereby higher annual genetic gain can be achieved in lifetime milk production.

***Management*:** Paul and Chandel (2010) identified that the major factors affecting the milk yield of crossbred animals in the North-East states were the technological and socio-economic constraints, which could be addressed by adopting improved management practices, better feeding practices, controlling of diseases and amelioration of the socio-economic conditions of the farmers through training, education and enhancing access to the funds. Addressal of these constraints will increase actual milk yield by about 66 per cent, sufficient enough to meet the deficit of milk requirement in the region.

According to the annual report of Animal Husbandry Department (2010-11) there is a shortage of dry fodder (40%), greens (36%), and concentrate (57%) in India. Since, milk production is not a highly heritable trait; improvement is possible by manipulation of environmental factors also. It reiterates the importance of feed resources.

Susceptibility to diseases**:** Ingression of many infectious diseases of temperate region, which were not prevalent in tropical countries like infectious bovine rhinotracheitis (IBR) and blue tongue is an important constraint of crossbreeding (Dhanda and Pathak, 2011). They reported that crossbred animals were more susceptible to Foot and Mouth Disease, mastitis and tick borne diseases. Higher incidences of reproductive disorders like anoestrous and repeat breeding in crossbred cattle; and poor sex libido and lower freezability of semen of crossbred bulls leading to very high culling rate were also noticed.

CONCLUSION

Analysis of milk production potential of crossbred cattle in various organized farms in India reveals that the improvement achieved by decades of planned crossbreeding programme is not in consonance with the quantum of money, efforts and other resources employed in reaching the current production level. Of course, it is evident that the total milk production of the country has been increased tremendously in the first few generations of crossbreeding, but the improvement in production performance has been reduced in the subsequent generations. Reduction in milk yield in various studies in crossbreds is mostly attributed to lack of selection of F1 bulls, presence of some heterosis for milk and partial breakdown of epistatic combinations (Singh and Joshi, 2009). Therefore, there is a strong need to review the present status of crossbreeding of Indian cattle breeds with exotic germplasm so as to take suitable measures in realizing the objective of enhancing milk productivity.

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