

## Crossbreeding in Cattle: A Review

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### ABSTRACT

*The importance of crossbreeding in livestock species has been known for a long time; it has been used heavily in cattle to improve productivity for several decades. Crossbreeding allow to combine favorable characteristics from the breeds involved and to exploit heterosis. Crossbreeding system is of two types viz. terminal and continuous depending on retention of crossbred female in the herd or not. In cattle crossbreeding is mainly used to improve milk production in India while in tropics crossbreeding with zebu cattle is done to improve adaptability and disease resistant ability. The ideal exotic inheritance to be maintained in the indigenous cattle is 50% where there is scarcity of green fodder and 62.5% is suggested where there is adequate feed and fodder along with good marketing facilities. Though crossbreeding with exotic germplasm resulted in improves production and reproduction potential but it also resulted in dilution of indigenous livestock. Exotic breeds are more susceptible to tropical diseases, harsh climate and poor quality feed and fodder and as the crossbreds which required constant input of good managemental conditions in comparison to the native cattle. Therefore, it is advisable to use crossbreeding with caution based on tested bulls or semen, quality fodder and suitable breeds for particular region in India.*

**Keywords:** Crossbreeding, Synthetic breeds, Inheritance.

### INTRODUCTION

The milk production in the country was 17.0 million tonnes during 1950-51 and has increased to 165.4 million tonnes in 2016-17. Also, the per capita availability of milk in 1950-51 was 130 gm/day and has increased to 355 gm/day in 2016-17. The indigenous and non-descript cattle contribute 11.3% and 9.5% respectively while exotic/crossbred contribute

25.4% to the total milk production in the country (BAHFS, DAHD & F, AHS series-18). Among numbers of initiative under-taken by the government for improving the productivity of milk over the period; crossbreeding was the major step. Crossbreeding is systematic mating system of two or more well defined breeds within the same species.

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The history of crossbreeding in India dates as far back as 1875 when William Taylor, the Commissioner of Patna Division started an industrial institution by raising public fund. Taylor breed was developed by crossing Shorthorn cattle with local cow (Sinha, 1951). Later in 1934, a new breed called –“Jersindh” was developed by crossing Jersey and Red Sindhi at Military Dairy farm, Allahabad and at Bangalore by crossing Jersey and Tharparkar a new breed “Jerthar” was developed (Wakchaure et al., 2015). In 1963, at Kerala using Brown Swiss and Jersey (5/8) on local Non- descript cows and a new breed of cattle “Sunandini” was developed (Chacko, 1994). Since then, many breeds of cattle were developed and some are well known for their milk production.

Crossbreeding is the most effective and rapid approach for genetically improving the non-descript zebu cattle population by crossing with exotic dairy cattle breeds particularly in milk shed areas around peri-urban and industrial towns. In these areas there are good marketing facilities for milk and milk products and also green fodder and quality feed are present around the year. Crossbreeding experiences with exotic dairy cattle breeds like Holstein Friesian, Brown Swiss and Jersey has proved that there is rapid genetic improvement in the non-descript cattle and marked improvement in productivity. Holstein Friesian cattle have been recommended as the breed of choice in the irrigated plains and Jersey cattle as breed of choice in hilly terrain and coastal areas for crossbreeding. Exotic inheritance in crossbred cattle should be maintained in between 50 and 62.5%. Beyond this exotic inheritance the crossbred acquires the problem of adaptability and other diseases like mastitis, milk fever, FMD etc.

#### **Reasons of crossbreeding-**

The reason for crossbreeding is to increase the overall efficiency of a production system through crossing breeds which have their genetic merits in different traits and to produce individual dairy cattle with intermediate performance between that of two more

extreme parent breeds (Simm, 2000). One of the most important reasons of crossbreeding is to obtain benefits of heterosis. Heterosis is highest in first generation and then reduced to half in the second generation, so it is advisable that the F1 crossbred females should be bred with genetically superior progeny-tested crossbred males having exotic inheritance between 50 and 75% (Sreenivas, 2013). Crossbreeding mostly done in animals due to-

1. To take advantage of complementation- Crossbreeding allows combining of the traits from both the breeds which are better in one another or from sire and dam breed. This increases the efficiency of the whole production system. For example: Reduce age at first calving, high milk production from sire breed and good adaptability, disease resistant ability from dam breed.
2. Averaging breed effect- Crossbred animals are having traits which are the result of crossing of two distinct breeds and they are intermediate for each trait which might be more profitable overall. So, crossbreeding increases the efficiency of each animal in the production system.
3. Crossbreeding is done to grade up the non-descript breeds and thus improving their performance.
4. Crossbreeding is a step forward to create a new synthetic breed or composite breed.
5. Crossbreeding is done sometime to introduce a specific gene. For example: Brahma breed is used in crossbreeding to introduce tick resistance in European breed.
6. Finally, the most important reason for crossbreeding is to exploit heterosis. Heterosis is usually more for traits which are low heritable i.e. fitness, reproductive and production traits.

#### **System of crossbreeding**

A planned crossbreeding definitely increases the production. There are many crossbreeding system which can be used for genetic improvement in animals depending on types of heterosis required (direct or maternal) number of breeds to be used in crossbreeding and whether or not replacement females are

produced or purchased. On the basis of whether or not replacement females are produced or purchased crossbreeding is of mainly two types- (A) Terminal and (B) Rotational crossbreeding system.

(A) Terminal crossbreeding system: In this system of crossbreeding females are not retained in the herd, they are purchased from outside herds. Terminal crossbreeding system uses direct or individual heterosis. Terminal crossing is used to combine the strengths of two or more breeds, this is what is known as “Breed Complementarity”; this is mainly done to achieve a higher frequency of desirable traits among crossbreds than that found in a single breed. Breed complementarity means potency of one breed complement the weakness of another breed. For example; Native breeds are having good adaptability and disease resistance but poor in milk production while the exotic breeds are poor in adaptability and are susceptible to tropical diseases but good in milk production. In breed complementation sires and dams which are being used must be different and must possess complementary traits. Some of the terminal crossbreeding systems are-

1. Two pure breed cross: This is the simplest crossbreeding system. In this two different breeds are crossed to produce F<sub>1</sub> offspring which are used for production purpose and not for breeding. This system maintains full extent of heterozygosity and so as the heterosis. The biggest disadvantage in the system is that large populations of pure breeds are to be maintained to have continuous production of crossbred.
2. *Inter se* mating: In this system F<sub>1</sub> offspring produced by crossing of two pure breeds are mated among themselves. The system gives 100% in F<sub>1</sub> which declines to 50% in F<sub>2</sub>.
3. Three breed cross: This system gives a maximum amount of heterosis as it take advantages of both individual as well as maternal heterosis and can also be used to complement each other. In this system two

breeds are first crossed and the resulting female crossbred is then crossed with third breed also called as terminal sire to produce offspring which are used for production.

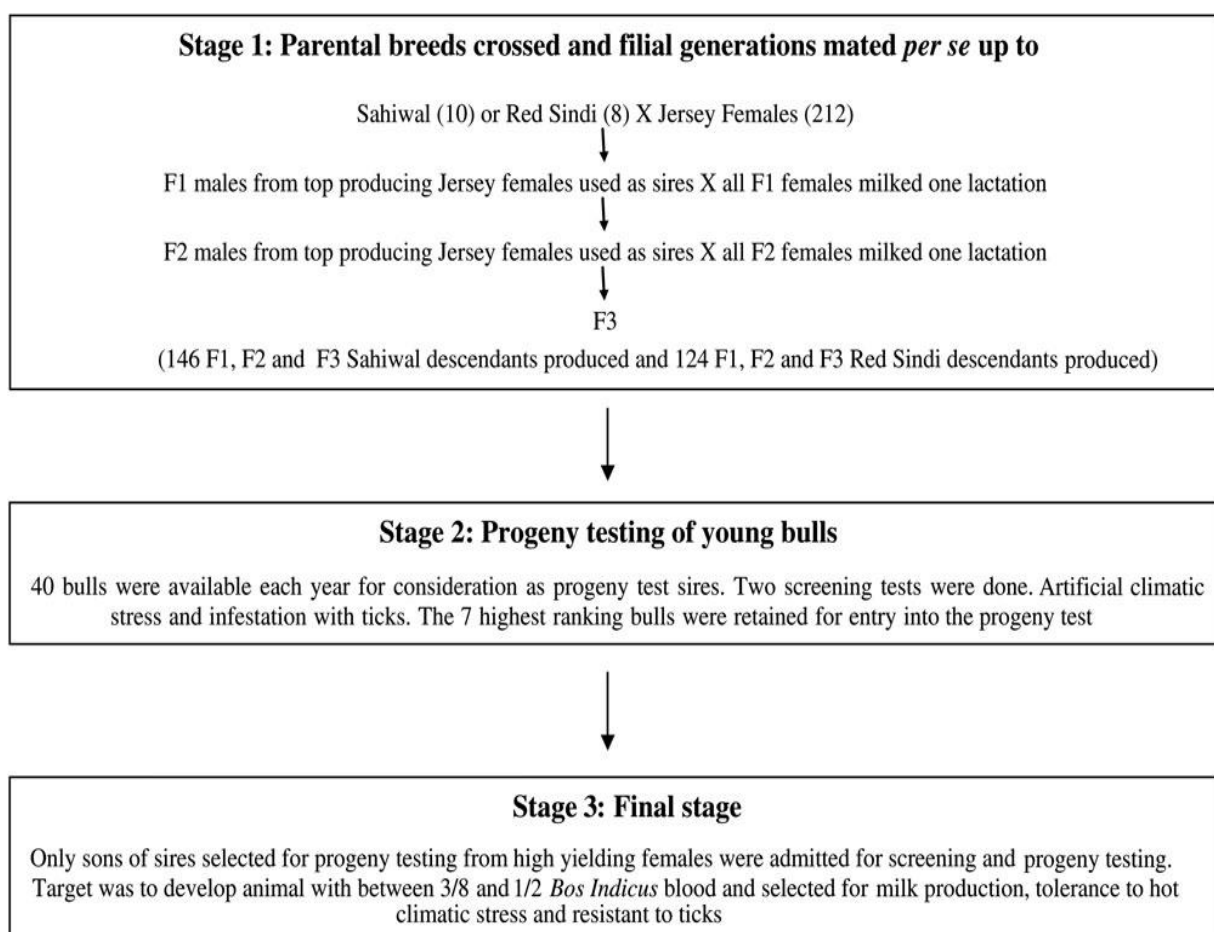
4. Four breed cross or Double cross: Four breeds are used in this system. Two breeds say A and B are crossed and on other side breed C and D are crossed, the crossbred produced from both these crosses are then crossed with each other (AxB crossed to CxD).
  5. Back cross: Two breeds are crossed (AxB) the male calves are sold while the female calves are back crossed to unrelated males of one of the parental breeds. It take advantage of both maternal as well as individual heterosis.
- (B) Rotational or continuous crossing: It differ from terminal cross in that it produces its replacement females for further crossing and sire are purchased from outside to avoid inbreeding. Thus, crossbred offspring have two functions: heifers are saved for replacement while other offspring are either sold out or reared for commercial purpose. Methods of rotational crossing are-
1. Two-breed rotational crossing or criss-crossing: It is a crossbreeding system in which two breeds are used in sequence so it is also called as criss-crossing. First males of breed A is crossed with female of breed B then females (AxB) from this cross is allow to cross with males of breed B. The resulting crossbred ((AxB)xB) is then crossed with males of breed A and so on. The system gives 100% heterosis in first generation, 50% in the second, 75% in the third gradually settles down to 67% in succeeding generations. The crossbred acquire 2/3 of their inheritance from the breed of their immediate sire and 1/3 from other sire.
  2. Three-breed rotational crossing: Here males of breed A is crossed with breed B, the resulting female crossbred is mated with males of breed C; the females from this cross is then mated with males of

breed A. The female progeny from this cross is mated to males of breed B and so on. In this type of crossing offspring have 4/7 of their inheritance from the immediate sire, 2/7 from the breed of their second sire and 1/7 from the third sire. This system attains 85.7% heterosis upto 7<sup>th</sup> generation.

#### Synthetic *Bos taurus* x *Bos indicus* breeds

Synthetic breeds are made up of two or more component breeds, and are designed to benefit from hybrid vigour without crossing with other breeds (Bourdon, 2000). Many attempts have been made to develop new synthetic breeds by

crossing *Bos taurus* and *Bos indicus* in India and as well as in abroad. Cunningham and Syrstad (1987) describe two methods: the first method involves two parental breeds which are mated to produce the F1 generation. The F1 individuals are selected to undergo inter se mating to produce the F2 generation. The same process is repeated in subsequent generations (Figure 1). In second method three breeds could produce a synthetic with 25 percent local genes (*B. indicus*), 25 percent from one of the *B. taurus* breeds and 50 percent *B. taurus* genes from a second exotic animal.



**Figure1. Summary of the breeding programme used to develop the Australian Milking Zebu. Source: Developed from Hayman (1974).**

The most important that should be remembered for successful development of synthetic breed is genetic soundness. Genetic soundness involves the appropriate choice of breeds and breeds composition; requires large population to avoid inbreeding and adequate breeding programme based on progeny testing.

#### Australian Milking Zebu

Australian Milking Zebu (AMZ) was developed by CSIRO in Badgery's Creek, northern New South Wales. It was developed by crossing Sahiwal/ Red Sindhi and Jersey. This breed was evolved for combining high milk production ability and heat tolerance

ability. AMZ cows have Age at first calving 30 months, 1987 kg milk yield in 244 lactation length (McDowell, 1985).

#### Australian Friesian Sahiwal

The government of Queensland, Australia develops one of the successful synthetic breeds: the 50:50 Sahiwal:Friesian - Australian Friesian Sahiwal (AFS) (Galukande et al., 2013). Emphasis was on milk yield and tick resistance. The programme was initiated in 1961 by crossing Sahiwal with *Bos taurus* dairy breeds, but only the Friesian crosses were retained. Same breeding programme was used as in AMZ. The AFS was bred for milk letdown, tick resistance and milk yield. Under extensive grazing on tropical pastures, the AFS averaged 2556 litres of milk and 105 kg of fat, which compares favourably with the HF performance of 2291 litres of milk and 82 kg of fat (Alexander, 1986).

#### Brazilian Milking Hybrid

The Brazilian Milking Hybrid was the result of a research and development programme conducted by the National Dairy Cattle Centre of the Federal Research Organization of Brazil with the assistance of Food and Agriculture Organization's United Nations Development Programme (FAO/UNDP). Its main objective

was to obtain estimates of heritabilities and genetic correlations on the dairy, reproduction, growth and adaptation traits needed to design breeding programmes for synthetic dairy cattle breeds suitable for the dairy production system of Brazilian tropics (Madalena, 2002).

#### Girlando

Another synthetic breed is the Girolando, composed of 62.5% HF and 37.5% Gir developed in Brazil. The Girolando produces 80 percent of the milk in Brazil and is characterized by an average of 3600 kg of milk with 4 percent fat content, and has a CI of 410 days (Girolando Associacao Brasileira Dos Criadores de Girolando, 2005).

#### Jamaica Hope

This is the earliest synthetic breed developed for dairy purpose in Jamaica in Hope farm. It is composed of 80% Jersey inheritance, 15% Sahiwal and 5% Holiestien –Friesian inheritance. It is characterized by 34.5 months age at first calving is with 2930kg milk yield and calving interval 439 days (Galukande et al., 2013).

Some of the synthetic breeds that are developed in India by crossing *Bos indicus* and *Bos taurus* breeds.

Crossbred	Place where developed	Utility	Exotic breed	Indigenous breed	Exotic inheritance
Taylor	Patna	Dairy	Shorthorn	Non-descript	
Jarsindh	Allahabad	Dairy	Jersey	Red Sindhi	62.5%,
Jerthar	Bangalore	Dairy	Jersey	Tharparkar	50%,
Sunandini	Kerela	Dairy	Brown Swiss	Non-descript	62.5%,
Frieswal	Merut	Dairy	Holstein Friesian	Sahiwal	50%,
Karan Fries	Karnal	Dairy	Holstein Friesian	Tharparkar	50%,
Karan Swiss	Karnal	Dairy	Brown Swiss	Sahiwal and Red Sindhi	50%,

#### Advantages of crossbreeding

The crossbreeding mating system is used as a tool to improve productivity through heterosis and breed complementarity to match genetic resources with feed resources, climate, management levels and markets. In crossbreeding through favorable heterosis in many traits of economic importance has benefited the breeders, besides these other

advantages of crossbreeding are (Gosey, 1991)–

1. **Individual heterosis-** Heterosis (hybrid vigor) is the degree to which crossbred calves deviate from the average of calves of the parental breeds. Crossbred cattle have milk production, lactation length, growth rate decrease in age at puberty,

first calving and calving interval, better reproductive efficiency.

2. **Maternal heterosis-** Crossbreeding takes advantages of maternal heterosis by using crossbred cows. Maternal heterosis is usually greater than individual heterosis for maternally influenced traits and, as a result, crossbreeding programs should include use of a crossbred cow.
3. **Effects of crossbreeding accumulate-** Crossbreeding may result in relatively small levels of heterosis (4 percent) for each trait, but these heterosis effects accumulate so that there can be large increases (25 percent) in overall productivity.
4. **Rapid adaptation to changing market or resources.-** Terminal sire systems give the breeder an opportunity to change sires rapidly so that calves can be changed according to market demands or resources.
5. Crossbred animals are docile, can be easily handled and more suited for machine milking.
6. Heat detection and artificial insemination is easier in cows.
7. Price of crossbred cow milk is less in comparison to native breed.

#### **Disadvantages or limitation of crossbreeding**

Though crossbreeding has given very impressive results it is seen that crossbred cannot perform well at the field level. Some the disadvantages are listed below-

1. Primary investment and maintenance expenditure is high in crossbreeding.
2. For less availability of good quality of feed and fodder the crossbred animals are susceptible to contagious diseases like FMD, babesiosis, theileriosis, mastitis, milk fever, ketosis, etc, v
3. Very high culling rate persist in crossbreed's male about 40-70% due to poor libido, semen quality and freezability.
4. Crossbred male value is trivial.
5. The most important disadvantage is crossbreeding is diluting the native genetic resources.

#### **Future Prospects of Crossbreeding**

New technology and system in past decades has given a good outcome in the improvement of dairy cattle. Systematic breeding strategies should be followed consistently for profitable crossbreeding. Artificial insemination is the most conventional method through which crossbreeding can be fasten. This requires the selection of bulls i.e. progeny tested bulls to have faster genetic improvement. Females should also be selected for adoptive traits and fitness traits. Selection of both male and female will lead to faster improvement, but the descript breeds should not used in crossbreeding. The use of sexed semen can also quicken the improvement through crossbreeding.

#### **CONCLUSION**

Crossbreeding is an effective tool for improving production and productivity of zebu cattle. Depending on the objective of crossbreeding, system of crossbreeding should be used in order to have good outcome. The  $F_1$  progeny shows high degree of heterosis which then start to deteriorate in the coming progeny generations. However this problem can be overcome by developing synthetic breed and continuous production of  $F_1$ , which requires large population of the pure breed to avoid inbreeding. Maintenance of synthetic breed requires proper recording and use of progeny tested bulls. For sustainable production there should be planned breeding policy along with availability of progeny tested bulls.

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