

CROSS THE ADVANTAGES OF BREEDING IN BEEF CATTLE

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Cross breeding has always been common practice in beef cattle production.

The **term refers to the mating of animals from different breeds.**

Justification for cross breeding lies in the argument that the progeny of such matings have a specific advantage over pure bred progeny. In general, it is assumed that some degree of heterosis (“hybrid vigour”) occurs from specific combinations. Although **there are certainly many advantages in utilising the effects of direct or maternal heterosis, the other very important advantage, namely “complementarity” is often overlooked.**

In order to discuss the advantages of crossing different breeds, some terms need to be defined first.

Heterosis or Hybrid vigour

Heterosis refers to the expected performance of the progeny as a deviation from the average performance of the parent breeds. Put in another way: “How much better (or worse) will the progeny perform compared to the average performance of the parents”.

Consider the following example:

If the expected progeny performance of the Sire breed in a feedlot is a growth rate of 1 600 grams per day and that of the dam breed 1 300 grams per day but the progeny, on average grow at 1 500 grams per day, the heterosis resulted in an extra 50 grams growth rate per day. (50 grams more than the average of sire and dam breeds). That will be positive heterosis. The opposite can also be true, namely negative heterosis, where the progeny, on average, perform less than the average of the parent breeds. In rare cases the average performance of the progeny can outperform the best parent breed (in the case of over dominance or where the one parent breed is ill adapted to the set of environmental circumstances and the other is a poor performer for the specific trait).

This example is considered as direct heterosis.

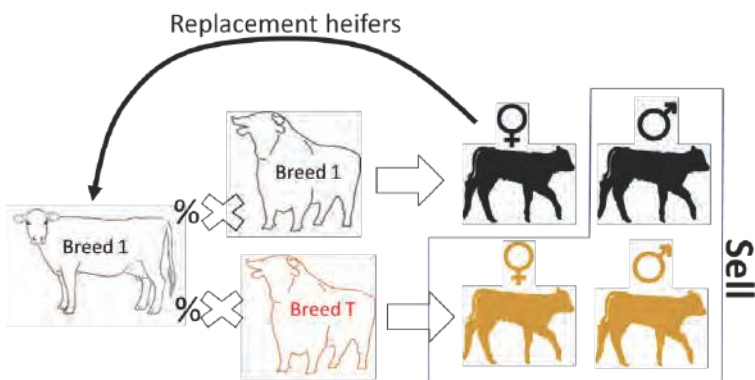
Maternal heterosis refers to the advantage of mating two (or more) breeds to produce female progeny with exceptional maternal abilities, mainly female fertility and good mothering properties. This can be due to hybrid vigour for these traits or a higher level of adaptability to the environment or a production system.

Although hybrid vigour could have obvious advantages, the crossing of different breeds could result in **a very important other advantage, namely “complementarity”.** This is based on **proper knowledge of the strong (and weak) points of each of the contributing breeds. Combining them in a specific predetermined manner will result in establishing progeny that will produce more economically than the parent breeds.** Although not an end objective, this often resulted in the establishment of composite breeds in the past.

The first principle of combining different breeds in mating programs is to **raise the efficiency of production.** If the marketable product is weaners, cow productivity is of the utmost importance. If pure bred cows are well adapted, fertile, of low maintenance

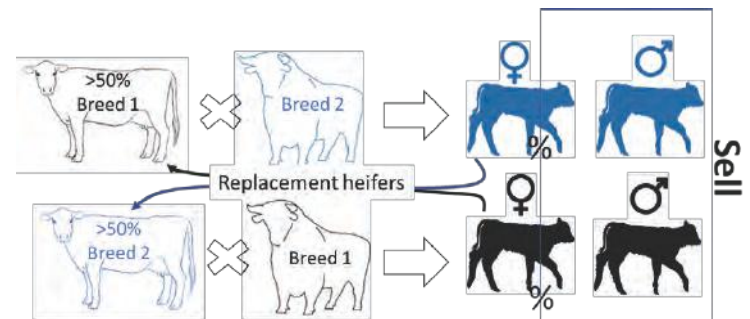
and able to raise calves very well (mothering ability and enough milk), the sire breeds will include bulls from the dam breed, to father replacement heifers and bulls deemed to be “terminal sires” where all the progeny is sold, males and females.

This would be referred to a “Two breed, terminal cross” system where all heifer replacements are selected from within the herd. Practically this means that some of the females will be mated with bulls from the same breed while others will be mated to bulls where all the progeny are sold.



In the example a percentage of the females will be mated to a terminal sire breed (Breed T). The percentage of females mated to such bulls will be determined by the fertility of the females and survival rate of their calves. If the policy is to cull all females that did not rear a calf and the weaning percentage is 80%, it will mean that half the females can be mated to terminal sire breed bulls (80% weaning means 20% females skipped and need to be replaced, if half of the females were mated to Breed 1 females, their heifers will suffice to act as replacement for the culled cows). At 90% weaning, only 20% of the females need to be served by bulls from Breed 1 (At 90% weaning, 10% cows skipped and need to be replaced and half of the calves will be females) resulting in much better utilisation of hybrid vigour or complementarity from the bull breed.

A cross breeding system that is simple and therefore popular, is a “Rotational” system. This can involve only two breeds, but sometimes more than two. Sometimes this is referred to a “Criss-Cross” system of cross breeding. It involves mating cows of one breed (Breed 1) with bulls of a different breed (Breed 2). Due to the mating practice all females will have some percentage of both breeds in time but always at least 50% of the sire breed (as the sire breed will always be pure). This means that some percentage of maternal heterosis will be present in breeding females as well as some direct heterosis in the offspring. To sustain this, cows need to be mated to the bull breed they are less related to. It is also possible to include more than two breeds in, for example a three-breed rotational cross breeding system. Although more will be gained in terms of both maternal and direct heterosis or hybrid vigour, it will complicate management because at least three groups need to be kept during the mating season.

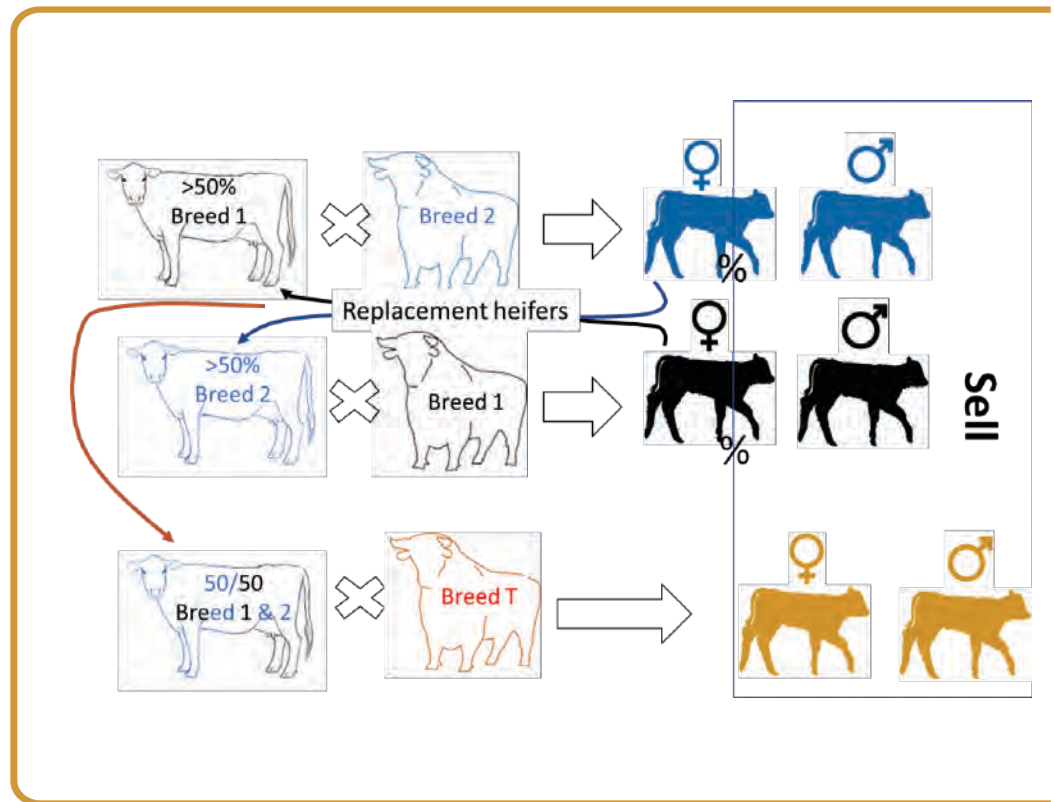


The figure illustrates a two-breed rotational cross breeding system. Sires are pure-breds and must be replaced from outside the system while cows are replaced from selected heifers because of the matings while the rest of the heifers are sold with all the bull calves. Breeding females are mated to bulls from the breed less related to.

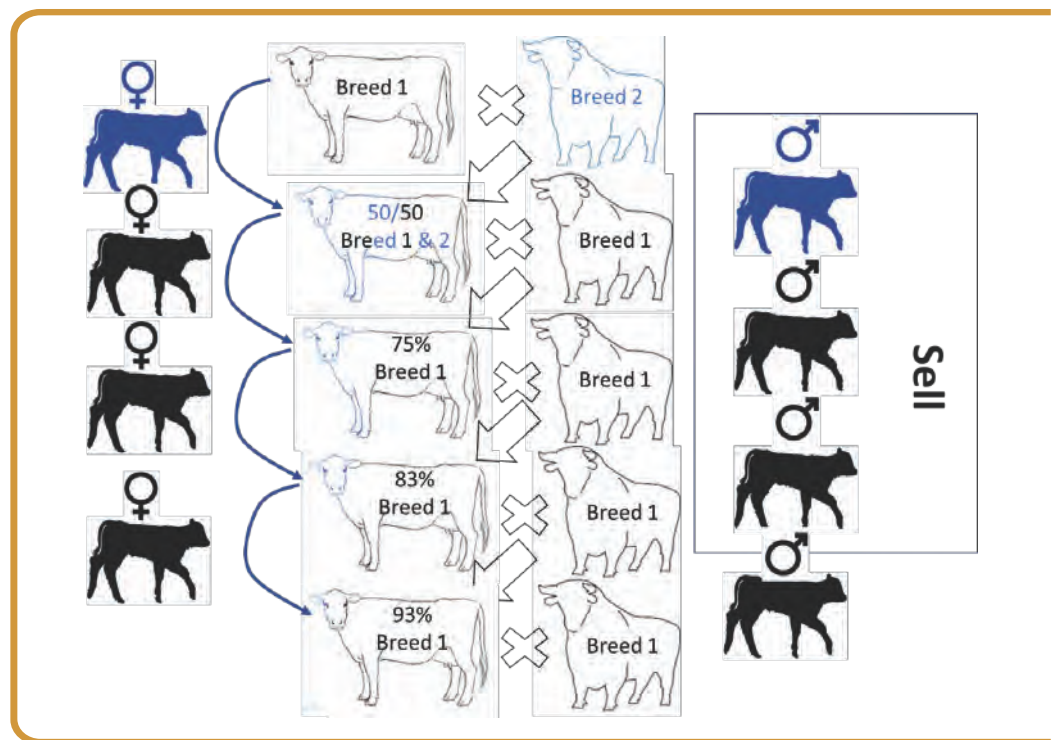
More complex cross breeding systems will be a combination of a rotational cross breeding system with a terminal breed (sometimes called a “Rototerminal” system). This means that some females will be mated to bulls of the terminal breed while others will be mated to the second breed to produce replacement heifers. Typically, younger females (heifers and first calvers) will be mated to the rotational cross while mature cows will be mated to the terminal sire. Such a system will reap the maximum benefit from both direct as well as maternal heterosis. This is, however much more complex to manage.

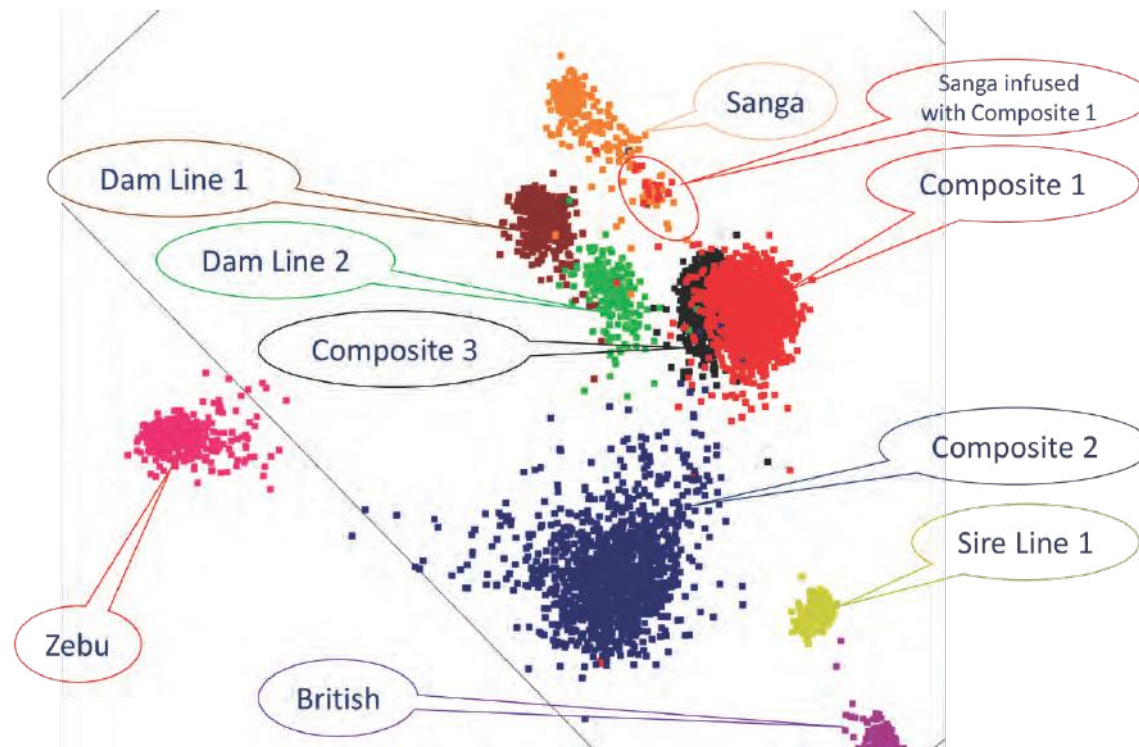
This figure illustrates a two-breed rotational cross combined with a terminal sire. Replacement females are only from the rotational matings and have the advantage of maternal heterosis while the terminal crosses also benefit from direct heterosis. Like, in the example of the Two-breed terminal cross, the reproduction rate and survival of the breeding females and calves will determine the advantage of especially the terminal cross (direct heterosis).

Although not always regarded as cross breeding, top crossing or upgrading and the creation of composite breeds can also be mentioned as cross breeding (until variation is stabilised to a predetermined degree). Top crossing can also be regarded as “infusion” where some wanted properties or characteristics of a breed are introduced in another breed once. All progeny are then back-crossed with the sires from the original breed.



The figure illustrates an instance where some properties from a different breed (Breed 2) are introduced in another (Breed 1) but with the intention to keep on breeding with the original breed. Usually backcrossing will take place on the progeny for a predetermined number of generations to ensure a specific level of breed “purity” before an animal can be regarded as pure. Modern scientific aids can also assist in determining the suitability of specific animals to be classified as parents of stud animals. One such technique is to use the genomic information of individual animals in determining their genetic relationship with the core of the original breed's genetic cluster.





By using the genomic information of several individual animals from a different breed, it is possible to establish the true genetic relationships among those breeds. This, in effect could be expressed as the “genetic distance” among them where closely related breeds can be deemed to have a shorter genetic distance from each other. Although this can be expressed in numerical terms, it can also be illustrated graphically. The next figure illustrates the genetic distances among individual cattle from different breeds. Each dot represents a specific animal and its relative position in a three-dimensional space. The distances between dots represent the genetic closeness or distance among these cattle. Different colours depict different breeds.

Although genetic distances should be considered in more than two dimensions, the figure serves as illustration of such distances.

Considerations for and observations on cross breeding:

- Sire line 1 can be used as terminal cross on both Dam Line 1 and 2 in a two-breed terminal cross. This will result in utilising the maximum hybrid vigour due to the Dam lines being genetically distant (unrelated) to Sire Line 1.
- Similarly, Sire Line 1 can also be used in a two-breed terminal cross breeding system with the Zebu breed, especially as the breeding female of the Zebu breed will be well adapted to sub-tropical (and even tropical) conditions. The genetic distance will also result in good hybrid vigour.
- A combination of the Zebu breed with the British breed, combining maternal and adaptive properties could be used in a two-breed rotational cross. In this case traits of low heritability, such as female fertility and calf survival will benefit due to the hybrid vigour as the breeds are genetically removed. Other good qualities of the British breed, such as meat quality will also add to the benefits.

This maternal heterosis can further be advanced by using a terminal sire from the Sire Line or suitable bulls from one of the Composite breeds, especially when a niche market has specific requirements related to carcass characteristics.

- Adequate variation exists for planned out crossings within the Composite breeds. Out crossing refers to the mating of furthest related (unrelated) lines within the same breed. This will result in a milder form of heterosis (less than cross breeding).
- The figure also illustrates the result on genetic distance where breed infusion took place. The Sanga breed lacked certain qualities and Composite 1 was used to enrich the breed. This was followed up with backcrossing.

Conclusion

Crossbreeding allows for the utilisation of hybrid vigour and complementarity when males and females from different breeds are mated. Not only are gains made for growth and carcass traits, but maternal heterosis will result in more efficient females, if conducted correctly. **Modern technologies can now also assist in optimising cross breeding practices.** Each breed has some unique properties that can contribute to cross breeding. **All cross-breeding systems require careful planning and execution, including good records.**

Successful and sustainable cross breeding depends on the continuation of pure breeding as a reliable source to utilise heterosis and complementarity.

Supplement

Desired properties of breeds used in cross breeding.

Objective of breed in Cross Breeding	Desired properties (one or more)
Dam line in a two (or more) breed terminal cross breeding	· Exceptional Fertility, including early puberty, lack of lactation anoestrus and high reconception rates · No calving problems irrespective of bulls used · Adapted to production system & environment · Lower maintenance requirements
Rotational cross breeding	Depend on role in rotational system, include one or more of: · All or some of the properties of the Dam line · Pre and/or post weaning growth rate · Adaptation to specific environmental conditions · Carcass and/or meat quality · Specific maturity type/carcass weight requirements · Genetic distance from/relatedness with other breed(s) in the rotational system
Terminal bull/line	· Exceptional growth rate pre-wean and/or post-wean · Exceptional feed conversion efficiency · Specific maturity type according to market (including feedlot) requirements · Meat and carcass quality
Breed used for infusion	· Any property or characteristic not present or with low variation in the breed to be enhanced. · Preferably, but not a requirement, closely related to the breed to be enhanced.

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