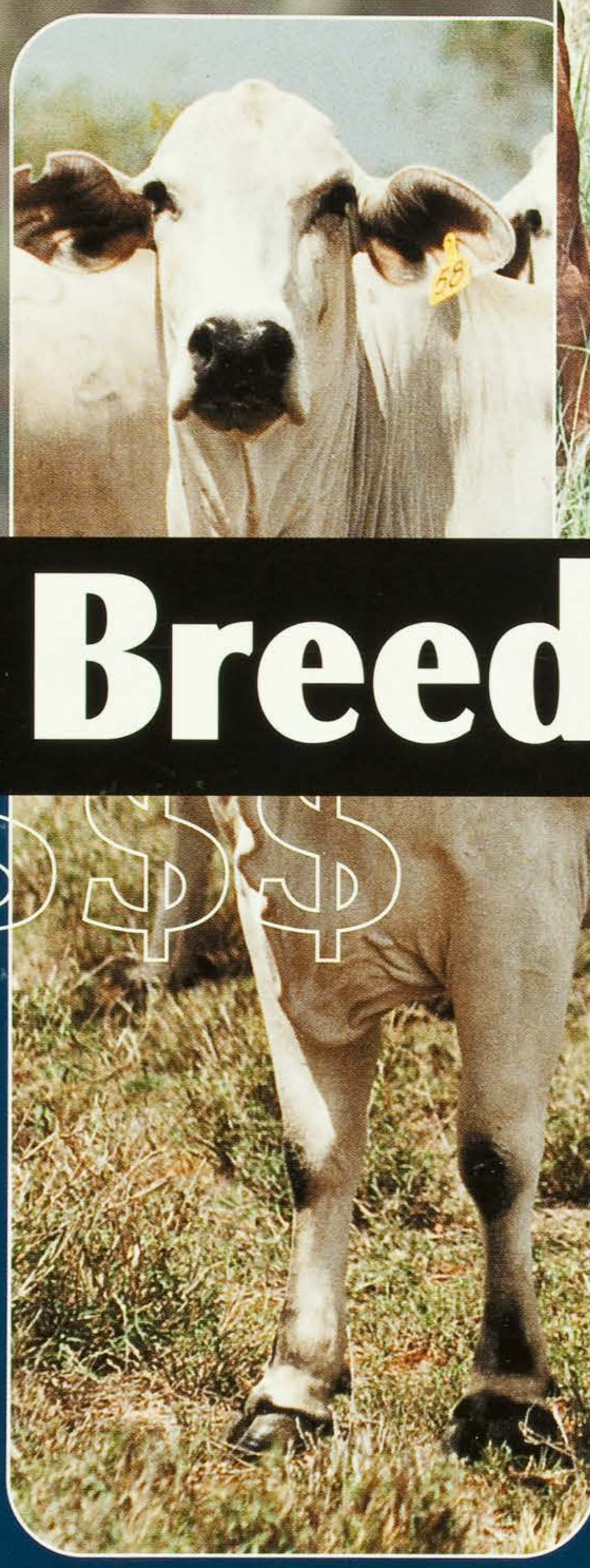


Breeding for Profit

Queensland Government
Department of Primary Industries

Training Series QE 93015

Breeding for Profit

$$$$$

Compiled by John Bertram et al

Department of Primary Industries
Queensland

ISSN 0812-0005
ISBN 0 7242 5400 5
Agdex 420/31

First published in November 1993
Reprinted 2002

Contributors from DPI include

John Bertram, Senior Husbandry Officer
Dr Mick Carrick, Chief Animal Genetics
Dr Dick Holroyd, Principal Husbandry Officer
Morris Lake, District Advisor
Warren Lehman, Inspector
Kay Taylor, Extension Officer
Rod Thompson, Husbandry Officer
Dr Mick Tierney, Senior Husbandry Officer
Russell Tyler, District Advisor
Mick Sullivan, Husbandry Officer
Rick White, Veterinary Officer

Other contributors

Dr Gerry Davis and Heather Burrow,
CSIRO Tropical Beef Centre

Desktop publishing: Heather Lees

General disclaimer

Information contained in this publication is provided as general advice only. For application to specific circumstances, professional advice should be sought.

The Department of Primary Industries, Queensland has taken all reasonable steps to ensure that the information contained in this publication is accurate at the time of production. Readers should ensure that they make appropriate inquiries to determine whether new information is available on the particular subject matter.

Inquiries should be addresses to:
Manager, DPI Publications
Department of Primary Industries
GPO Box 46
Brisbane Qld 4001

Contents

Foreword

Better beef breeding is the goal of all beef producers. The real challenge for producers is to use the best possible breed or mix of breeds and to select the best bulls available within those breeds.

Farm costs, both fixed and variable, are continually increasing. This puts pressure on animal performance requiring more kilograms of beef to be produced per breeder mated and per unit of land area available for production.

Whatever the breeding program used, the important issues include:

- **Using sires that are** reproductively and physically sound and are of superior genetic quality for the fertility, growth and carcass traits appropriate to the herd.
- **Keeping a simple breeding program** that is matched to the production system's capabilities and the environment.
- **Operating** a profitable enterprise within **a sustainable production system**.
- **Turning off animals to match the market specifications** at the earliest possible age for the minimal amount of feed consumed.

In all cases, determine the breeding objectives which will best satisfy your markets for minimal costs.

"STAYING IN FRONT" is the Hallmark of industry leaders.

Breeding for Profit builds on the information in the three companion publications produced by the Department of Primary Industries. These are:

- **Bull Selection;**
- **Female Selection in Beef Cattle;**
- **Beef Cattle Recording and Selection.**

Achievable Gains from a Planned Breeding Program

The previous 3B Program discussed buying better bulls. Those principles continue to be a fundamental requirement when choosing a sire for use in any planned breeding program. Too often, the selection criteria within the breeding herd on commercial properties stop at the colour of the coat and/or the breed. With escalating costs and diminishing rates of return to investment in beef production, there is an ever pressing need to know the market specifications, to be conscious of the available feed reserves and the capital and physical constraints of the property and management and to plan an appropriate breeding program.

What gains are achievable in your herd?

- **What is the typical herd performance?**
- **What is achievable with better breeding under your particular environment?**
- **What increased profit can be achieved in your herd?**

Table 1. An example of achievable gains obtained from central Queensland herds.

Herd description	Typical herd	Achievable herd*	Your herd
No. of cows	100 breeders	100 breeders	
No. of bulls	4%-1 in 25 cows	2%-1 in 50 cows	
Pregnancy rate	80%	90%	
Calving rate	75%	85%	
Weaning rate	70%	80%	
Calf losses	6.0%	3.0%	
Cow death rate	2.5%	1.0%	
Birth weight	35 kg	33 kg	
Weaning weight	185 kg	220 kg	
Yearling weight	240 kg	275 kg	
Turnoff weight (36mths)	465 kg	530 kg	
Breeder liveweight (Lwt)	465 kg	480 kg	
Weaner Lwt per breeder	125 kg	155 kg	
Weaner Lwt/100kg breeder Lwt	27 kg	32 kg	
Lwt calf weaned/cow mated	125 kg/cow mated	180 kg/cow mated (44% increase)	
Returns at $1.30/kg Lwt at weaning	**$162/cow mated**	**$244/cow mated**	

*(Source: Productivity of Hereford, Simmental and Belmont Red Beef Herds in Central Queensland. Burns and others, 1992)

Changing breeds or developing new breeds will be profitable only if whole herd productivity is increased without a disproportionate increase in costs of production or decrease in the value of the carcass produced. The full benefits will only be achieved after careful planning and execution over a number of years. Matching the property's available feed resources throughout the year with whole herd production involves the utilisation of attributes from superior animals and possibly breed specific traits.

Breed characteristics must also be matched to the environment. As for example, the late maturing large European breeds such as Charolais and Simmental, have been shown to produce higher growth rates than the traditional smaller early maturing breeds such as Shorthorn, Angus and Hereford. High growth rate in a temperate environment however is often related to high birth weight in many British and European breed animals which in turn may result in a higher incidence of dystocia and a decrease in reproductive efficiency.

These temperate breeds also have higher growth rates than the tropically adapted breeds under very favourable environments of low parasite levels and abundant good quality feed. This does not necessarily apply under the more harsh conditions in much of Queensland, where there are poorer pastures and higher parasite burdens.

Notes

Market Identification

To target the most suitable market there is a need to understand the genetic variation in any group of animals and then plan to utilise this to have the majority of turnoff animals closely matching the required market. Similarly to target a particular beef market there is a need to know how the herd is currently performing and what changes in management options are available.

There is a need to define market goals within the constraints of environment and management, set the breeding program to achieve those goals and plan to utilise any variation in the herd due to genetics, season or management.

The markets available to commercial producers of beef cattle are:

- **Store market** (feedlot, grass/crop finishers)
- **Domestic market** (light weight)
- **Export market** (heavy weight)

There are very exact specifications available for each market. These are summarised in the graph on the following page and shown in detail in Appendix - Market Specifications.

In order to achieve these markets we must have a suitable environment, a property that has the necessary development such as fences, feed (native, improved pasture, crop or grain) and a herd that can produce to these requirements.

Too often people are keen to take 'on board' a good idea, but lack either the financial or physical resources to carry it through and as a result, they are disappointed with an unsatisfactory result. For example, poor fencing and a high libido bull do not combine to ensure the owner's cows are in calf.

Good yards, handling facilities and good market communication networks enable stock to be 'marketed' and not 'just sold'.

Pasture of a satisfactory standard with a balanced feed year program allow for continuous liveweight gain to reach the market goal. The manager needs to define the current or base level of performance in the herd for productive traits such as pregnancy and weaning rates, calving intervals, etc in order to fully understand and optimise production.

There is a need to know the herd's current level of performance for economically important traits such as fertility, growth and carcass quality before deciding on the future direction of the breeding program. Any changes to the current breeding program, including sire selection, should be aimed specifically at **targeting the appropriate market**.

The value of high fertility, low mortality rates, high growth and carcass attributes that match the market specifications are the object of all successful beef producers.

Summarised market options

The following figures show the markets for grassfed and grainfed beef. The markets are quite specific. Detailed specifications are shown in the Appendix.

Figure 1. Markets for grassfed beef

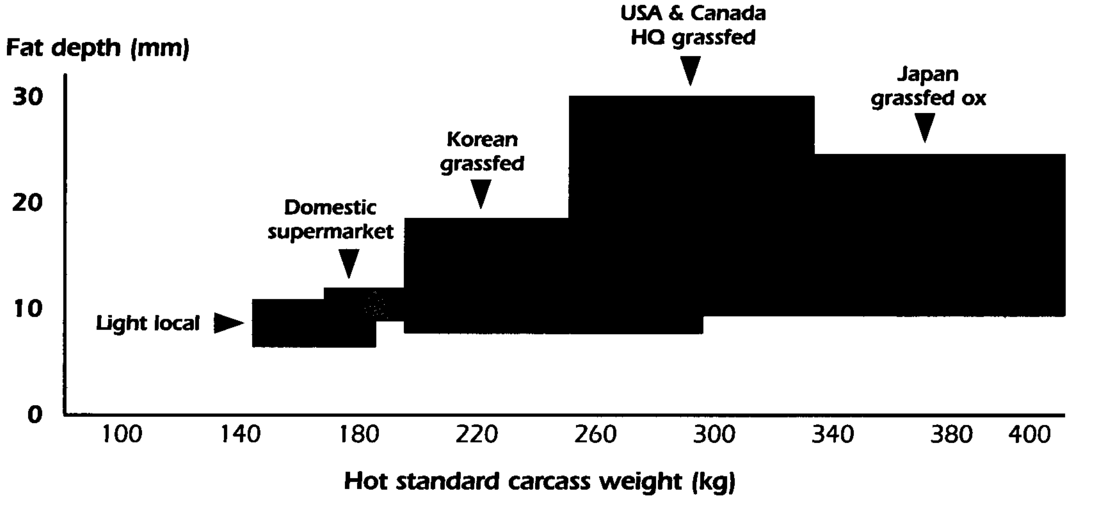
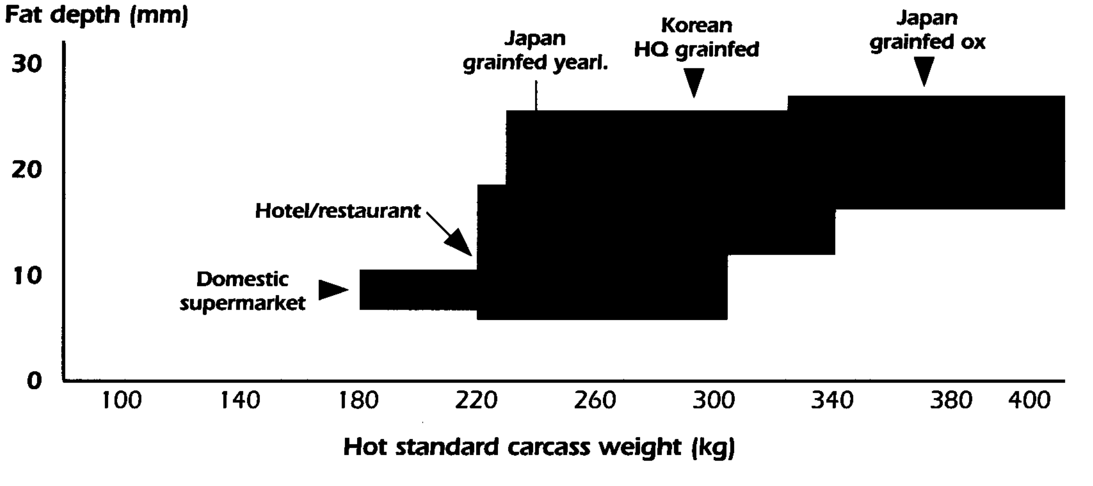


Figure 2. Markets for grainfed beef



Current Herd

There is benefit in being sure of the performance of the current herd in terms of growth rate, conception rate, etc and its potential capacity if extra nutrition is available. A number of producers who have been conscious of maximising performance may well have their breeder herd at optimum size to match the herd's feed requirements to the feed available in most normal seasons. Is it possible to do better?

What are we achieving now?

Ideally, cows in the breeder herd are responsible for conceiving, carrying the foetus, calving and rearing the calf to weaning and repeating this process to have a calf within each 12 month period. This process so often 'falls down' with cows going through the process but taking longer to go about it. Fertility is extremely important in influencing viability.

The younger the age of turnoff, the more important fertility becomes. In some areas of the state, the breeder mortality rate is so high that it dwarfs the benefits of improved fertility. In these instances there is a need to identify where the problem is occurring, determine how big the problem is and then find a solution. The growth rate of the herd may be fair, but can we economically produce those animals at an earlier age for the same weight? This, in fact, may enable targeting another market where age of turnoff will no longer be the limiting factor.

Often the greatest limitation of turnoff cattle in Queensland is that the fat cover is either too little or too great. Overfinished animals can best meet market requirements simply by being turned off earlier. Under-finished animals either require better quantity or quality of feed or need to be redirected to a different market. Carcass attributes of many herds are not necessarily a limitation to many of the current markets. There are, however, examples where some herds require better muscling to take advantage of a different market opportunity. Alternatively, their maintenance requirements may need to be lowered to match the property's ability to produce feed by breeding and/or using smaller framed animals of a lower mature weight.

What are the limitations?

There are often limitations imposed by the owner, manager or family. These limitations can take the form of tradition with a particular breed, a breed with historic relevance to the property or family and more commonly the fear to challenge the store market with crossbred cattle. Change is not a simple process!

How are we progressing?

Apart from the use of management options such as improved pastures, lighter stocking of pastures and forages or supplementing with grain or molasses combinations, many producers have increased animal and herd performance through selection within herd and Buying Better Bulls. Genetic progress within a breed is an ongoing requirement of improved production, but can be further enhanced by crossbreeding.

Breeding Methods

Breeding programs involve systems of management as well as systems of breeding. The basic objective of animal breeding is to enhance the efficiency of production and the quality of the product for the ultimate consumer through planned genetic change.

Straightbreeding

Much of the Queensland beef industry was once based on the British breeds of Shorthorn, Hereford, Poll Hereford and Angus. Southern and western breeders to a large extent have continued to operate within these basic breeds. Northern and coastal beef producers realised the benefits of Bos indicus cattle (most commonly Brahman) and crossed these breeds in an effort to achieve a marketable product with higher growth. These crossbred cattle have either been continually crossed back to Brahman sires to develop a line of high grade Brahman or, in other cases, animals have been selected within the cross and new breeds have been developed eg Santa Gertrudis, Droughtmaster, Braford and Brangus.

As a result of these long term breeding programs, the majority of herds are operating as straightbreds with at best a very minimal boost due to the original crossing of two breeds.

Some advantages of a straightbreeding option are:

- **Management needs few changes.**
- **Genetic evaluation systems eg BREEDPLAN and GROUP BREEDPLAN are easily used.**
- **Breed characteristics in production and adaptation can be utilised.**
- **Breed standards such as colour and markings are retained.**

Straightbreeding enables producers to take advantage of not only good genetic selection practices using Estimated Breeding Values (EBVs) in a cow herd. The breeder management options are simple, not requiring the selection of sires from different breeds to be mated in different paddocks. The sires are often used for a longer period in the herd until being culled for age or unsoundness.

The herd readily functions as a self replacing herd with young breeder replacements produced throughout all age groups of cows. The turnoff animals are relatively similar with often no great variation in market types as can occur in the early stages of crossbreeding. In the market place, conservative store buyers whose criteria for selection are based on looks rather than extra growth rate often pay a premium for even lines of straightbred animals.

Straightbred herds will also continue to be in demand by the commercial beef industry to supply straightbred females for crossbreeding or as in the case with studs, for the production of high performance sires.

In a purebred (or straightbred) situation, studs may focus their breeding programs even further by specifically mating animals that are closely related in particular bloodlines. This process of linebreeding can be used to produce seed stock that can be used with predictable results as parents for outbred or crossbred commercial animals. Linebreeding, or inbreeding, is a system in which the mates are more closely related than average members of the breed or population, while outbreeding or crossbreeding is a system where animals are less related than the average of the population.

Crossbreeding

Some of the breeds currently used in Queensland were formed through the crossing of different breeds eg Brafords were formed initially by the crossing of Brahman and Hereford cattle and then by selection within the crossbred population.

Crossbreeding by commercial cattlemen may be practised for the following reasons:

- **To take advantage of the good qualities of two or more breeds.**
- **To combine these qualities to improve market suitability.**
- **To take advantage of hybrid vigour to give an additional boost to production.**

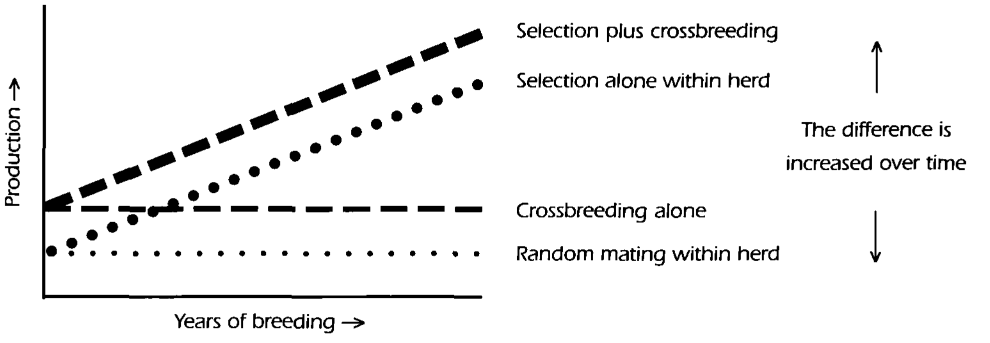
Hybrid vigour or heterosis is the difference between the performance of the progeny and the average performance of the parental breeds. In contrast, the increased levels of performance can result from selection within a breed because selection concentrates a large number of desirable genes, though each of those genes is likely to have only a small individual effect.

To achieve maximum productivity in a commercial herd, producers should aim for **maximum heterosis** through the crossing of unrelated breeds that are adapted to the environment in which the calves will be reared and for the **maximum number of desirable genes** through selection of superior parental animals.

In relatively benign environments, most economically important traits, other than female fertility, are influenced more by selection than crossbreeding. In harsher environments, considerable advantages in both growth and fertility rates can be achieved through a combination of heterosis and selection of superior animals. For greatest benefit in all crossbreeding programs, it is important (or imperative) that the programs be based on straightbred animals of high genetic merit for economically important traits.

Continuing improvement from a crossbreeding program is dependent on improving the average genetic merit of the foundation breeds used in the cross. Figure 3 shows the relationship between selection and cross breeding.

Figure 3. Production response combining selection and crossbreeding

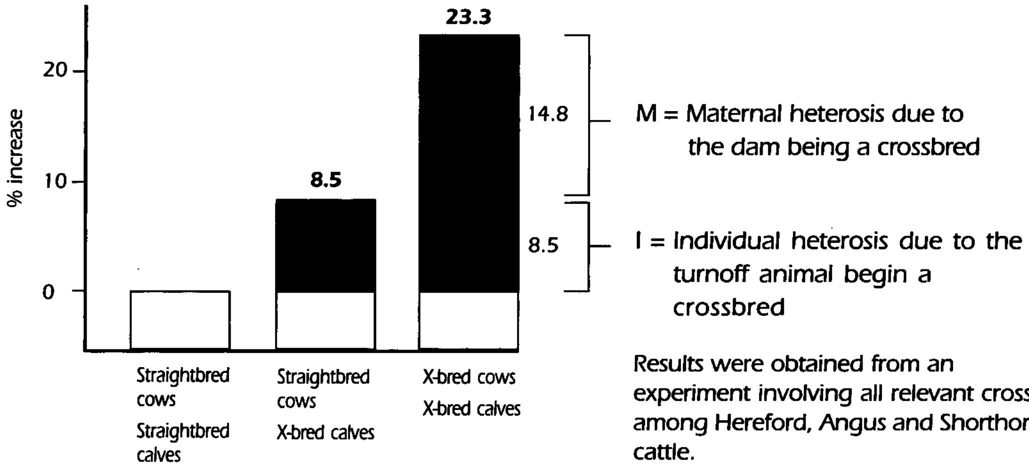


For example, a herd may have an average final weight Estimated Breeding Value of +10 kg. By using a sire of the same breed of +40 kg 600 day weight EBV, then the herd can potentially improve to +25 kg 600 day weight EBV, an increase of 15 kg or about $20/ head. Alternatively, a sire from a different breed could be used to achieve an extra 5 to 10% ($10-20/head) in growth rate resulting from heterosis, in addition to the gain already achieved by selection, giving a total gain of $30-40/head.

In beef cattle, the results of an extensive set of experiments involving Herefords, Angus and Shorthorns were reviewed by American researchers. Many of their results can be summarised in terms of 'weight of calf weaned per cow exposed to breeding', which is a major determinant of profitability. The benefits are achieved through increased fertility of crossbred cows and growth rates of calves.

In Figure 4, it can he seen that if straightbred cows reared crossbreed calves rather than straightbred calves, on average, there would be an extra 8.5 percent increase in weight of calf weaned per cow exposed to breeding. If crossbred dams were then used to rear the crossbred calves, a further 14.8 percent increase could be expected as a result of the better maternal environment provided by the crossbred dams. **Using crossbred dams to rear crossbred calves, the expected extra calf weight weaned/cow would be 23.3% compared to straightbred cows rearing straightbred calves. This results in a potential increased return of $40-45 per cow.**

Figure 4. A comparison of % increase in calf weight weaned/cow exposed to breeding, as a result of mating either straightbred cows to bulls of a different breed (centre), or mating first-cross cows to bulls of a third breed (right)



Results were obtained from an experiment involving all relevant crosses among Hereford, Angus and Shorthorn cattle.

Heterosis or hybrid vigour

Crossbreeding systems accomplish two major objectives. First, they bring together a desired combination of genes from two parents more rapidly than can be achieved with selection. Advantage can be taken of the complementarity among breeds, strains or lines. Secondly the matings may make use of heterosis, In general, the more distantly the parental breeds are related, the greater the amount of heterosis that can be expected. The greatest level of heterosis results from the crossing of the least related purebred Bos indicus and Bos taurus breeds, with far less heterosis expected in crosses between two lines of the same breed. Heterosis is greater for fitness traits which usually have lower heritability. The percent of heterosis in a cross is represented as:

$$\text{Percent heterosis} = \frac{(\text{average of crossbred progeny - average of parents})}{\text{average of parents}} \times 100$$

Notes

Crossbreeding systems

There are many breeds available to use in an almost unlimited number of crossbreeding systems for commercial beef production.

- **Most crossbreeding systems require the continuing input of purebred animals and therefore provide opportunities rather than threats for stud breeders.**

Regular crossing actually provides stud breeders with a substantial incentive to maintain and improve their straightbred populations, particularly in relation to objective performance criteria. Many breeds are very similar in their production characteristics and the selection of individual breeds can have some flexibility depending on animal availability.

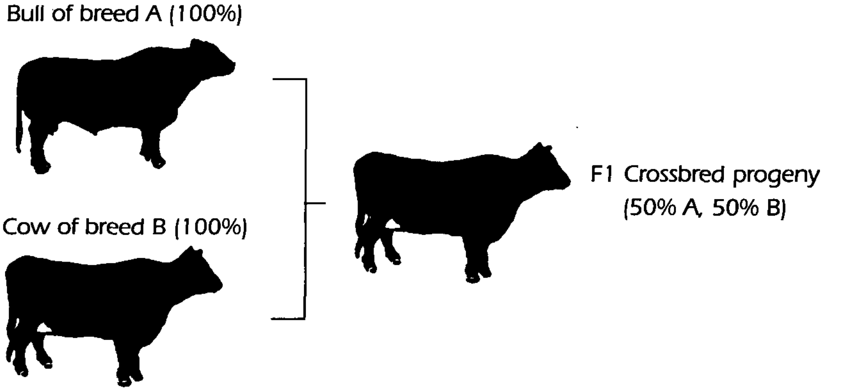
The breed requirements must match the feed resources and it is pointless having a complex breeding program when simple management options such as poor fencing are not being addressed. A practical approach is discussed in the chapter Managing a Crossbred Herd. There are five basic crossbreeding systems available to the commercial beef producer. These include:

Two breed cross

This crossbreeding system produces first cross or F1 offspring, the progeny resulting from the cross of two breeds. The progeny are all sold for slaughter or to another commercial breeder. This system is frequently used in northern New South Wales where there are specific F1 sales.

The system is most useful for situations in which females of a specific breed are well adapted to a given environment. An example is Bos indicus bred females in north, central and coastal Queensland. These adapted females can be mated to a sire of another breed, resulting in heterosis for traits such as growth, improved carcass, feed conversion efficiency and vigour. Figure 5 shows the percentage (%) of each breed type derived from the parent.

Figure 5. Two breed cross occurs where breed A and breed B are two purebreds and the F1 progeny (AB) contains equal parts of the two breeds.

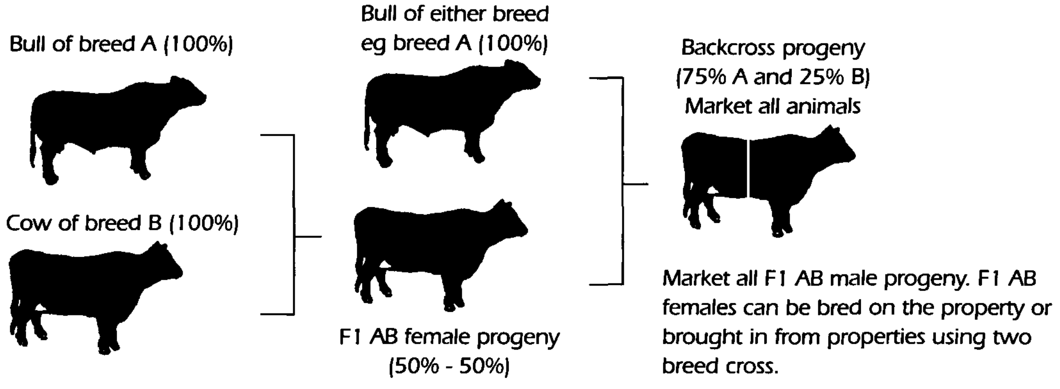


Backcross

In a backcross system the first cross is produced and all male calves are sold for slaughter, whilst the female F1 crossbred progeny are mated to males of one of the parental breeds and all offspring are sold for slaughter. This breeding system takes full advantage of heterosis for fertility and half of the possible heterosis for growth.

This approach is most useful where adaptation to a specific environment is required from a particular maternal breed, with the crossbred F1 female also having satisfactory adaptation, but where characteristics from the other parental breed are desired for carcass or growth traits. This process of backcrossing can be demonstrated with the following example, including the relative percentage input from each parental breed. Continual backcrossing is the system used by producers to 'upgrade' or change from one breed to another without having to buy purebred cows eg development of Brahman herd in Queensland.

Figure 6. The Backcross is obtained where all the females from a two breed cross are mated to a purebred of either of the original breeds. All the backcross progeny are marketed.

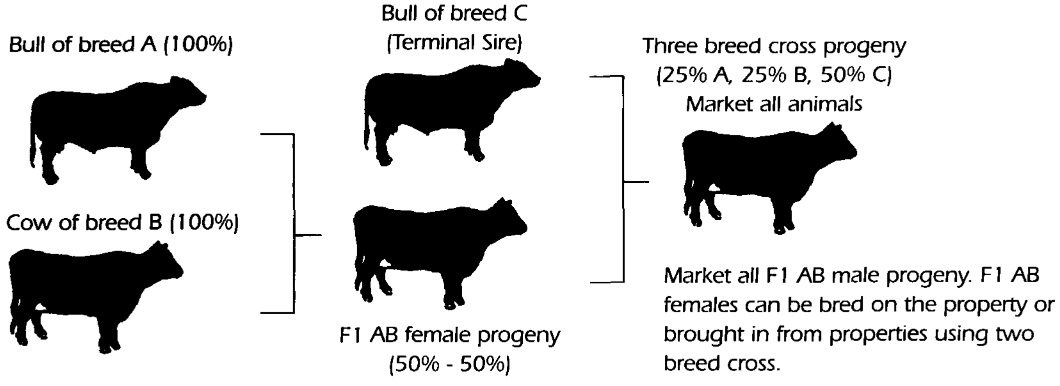


Three breed cross

Three breed cross requires the input of three separate breeds. Along similar principles to the Backcross, all first cross male progeny are sold. In this system though, first cross females are joined to bulls of a third unrelated breed, not to one of the parent breeds as in the backcross. All progeny of F1 dams are sold for slaughter.

This system takes advantage of both maternal and individual heterosis. It has the advantage of using three breeds which all compliment each other. For example, the first two breeds can be chosen to achieve maternal heterosis and adaptation to an environment, whilst the last breed used (terminal sire breed) can produce the most acceptable turnoff animals using selection criteria for desired growth, feed conversion efficiency and carcass traits. This use of the F1 female is generally considered the system which produces the greatest lift in productivity, but it is influenced by the quality of purebreds that are maintained to breed the F1 females. An example of the three breed cross is as follows with the relative influence of each parent.

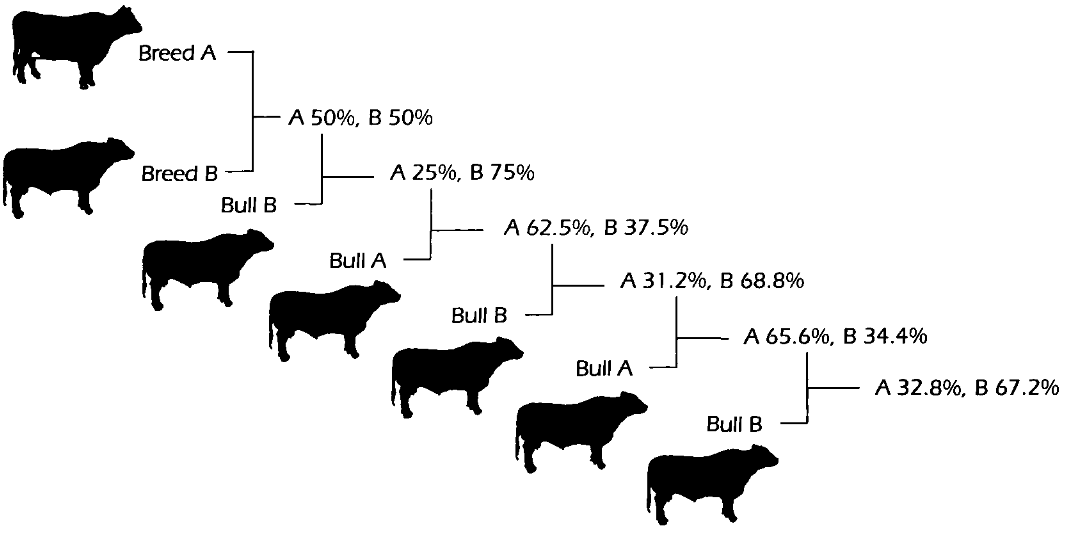
Figure 7. The three breed cross is obtained when all the females from a two breed cross are mated to a bull of a third, unrelated breed. All the three breed cross progeny are marketed.



Rotational cross

Rotational crossbreeding is sometimes referred to as sequence breeding when males of two or more breeds are mated to crossbred females. Each breed contributes its strengths and weaknesses equally to the production system over a number of years. Levels of heterosis achieved depend on the number of breeds involved. Figure 8 demonstrates the percentage of expressed heterosis expected in progeny from alternative crossbreeding systems.

Figure 8. Starting at 50/50%, the rotation stabilises at 65/35% or 35/65%, giving 65% from the last sire line used.



In early years of a rotational crossbreeding program, the variation seen in the progeny may make it more difficult to consistently meet a specific market requirement. This is less likely to be a problem when the breeds used are similar in their performance attributes, although levels of heterosis will also be lower if breeds or breed groupings are relatively closely related. Heterosis expressed in established rotations ie once they have stabilised after many crosses, with a number of breeds (n) contributing equally is $(2^n-2)/(2^n-1)$. From this it can be shown that rotational crosses express more heterosis than composites which use the same number of breeds. This increased heterosis is due to the fact that in rotational systems there is close to maximum heterosis added in each cross with the purebreed.

All animals in the herd benefit from hybrid vigour for both growth and maternal traits. When three or more breeds are used, hybrid vigour levels of 86% or greater compare very favourably with self replacing terminal cross systems, where only about half the progeny show hybrid vigour for growth and only a third of progeny benefit from hybrid vigour in their dam. All females are potentially available for selection as replacements. In self replacing terminal cross systems, about a third of the heifers are not available for selection, thus reducing the possibility for genetic improvement through heifer selection. Nearly all selection pressure must then be through bull selection.

Rotational crossbreeding has specific management requirements where the mating involves several groups of females of different breed combinations mated to bulls of different breeds. Replacement females are generated for the enterprise from the mating program.

Composite breed

An alternative cross breeding scheme is the development of a composite breed or synthetic breed resulting from the crossing of two or more existing breeds. There are many examples of this in Queensland, eg Santa Gertrudis, Droughtmaster, Braford, Charbray, Brangus, Belmont Red and so on. The primary advantage of the formation of composite breeds is that after the formation stage, when the initial crosses are made, management requirements are the same as for straight breeding. Should a market signal indicate a change to the characteristics of the composite, there is tremendous opportunity to change direction by incorporating another new breed or crossbreed, with desirable characteristics and so only change the animal performance as much as necessary.

Obviously, progress requires that the initial choice of breeds is based on those which have very desirable traits for a particular environment. If heterosis can be maintained in a composite population, this system may be competitive with alternative crossbreeding systems.

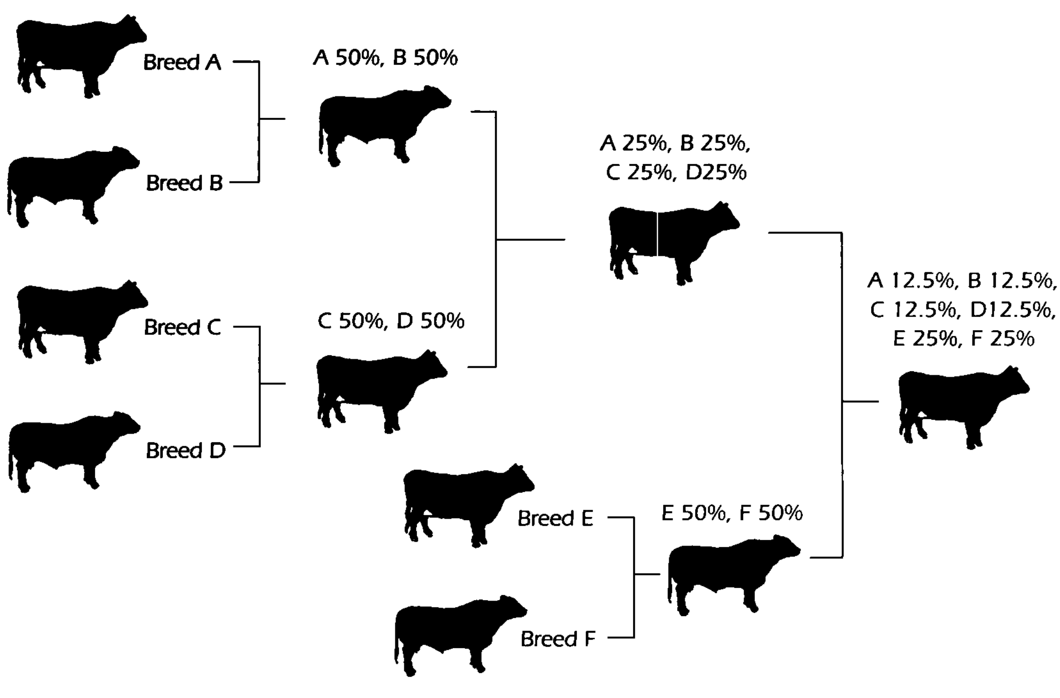
Where two breeds contribute equally and inbreeding is avoided, 50 percent of the initial F1 heterosis may be maintained, particularly in Sanga x Bos taurus breeds (or crosses) and Bos taurus x Bos taurus breed (or crosses). However, this general rule of thumb does not generally hold true for Bos indicus x Bos taurus crosses, where substantial losses of heterosis may occur when F1 crosses are mated to form second or subsequent generations.

The percentage of heterosis increases as more breeds contribute equally in the initial mating program. Even though the heterosis may not be quite as high as that achieved with a three breed rotational cross, the management requirements will be reduced. A general guide to the amount of heterosis retained in a composite breed is given by the formula:

> Heterosis = (number of breeds in the cross - 1) ÷ number of breeds in the cross.
> [eg if there are 3 breeds in a given cross, the amount of heterosis can be expected to be (3-1) ÷ 3 or 2/3 or 67%]

There is greater opportunity to exploit genetic variation in composite populations than in alternative systems. Once the new composite animals are produced, inbreeding is usually not a significant issue when numbers are kept large, eg greater than 200 - 300 breeders. With smaller numbers inbreeding can be a problem. For example in the extreme case where a herd uses only one bull all heterosis is lost after approximately eight generations, ie 40 years.

Figure 9. One simple approach to a composite breed.



The relationship between the various mating systems, percent of maximum heterosis retained and percentage increase in weight of calf weaned per cow exposed is shown in Table 2.

Table 2. Percentage of maximum heterosis expected in progeny.

Mating System	Maximum Heterosis retained		Superiority over parent breeds	
	Individual	Maternal	Increased weight of calf weight weaned/ cow exposed	Increased value of calf weight weaned/ cow exposed at $1.30/ kg liveweight gain
	%	%	%	$
2 breed cross, eg A x B	100	0	8.5	16.50
3 breed cross, eg (A x B) x C	100	100	23.3	45.00
Rotational crosses*				
eg 2 breed	33	67	12.7	25.00
3 breed	86	86	20.0	40.00
4 breed	93	93	21.7	42.00
Composite crossbreed				
eg 2 breed	50	50	11.6	22.50
3 breed	67	67	15.6	30.50
4 breed	75	75	17.5	34.00
5 breed	80	80	18.6	36.00
6 breed	83	83	19.3	37.50

* After this breeding system has been used for about seven (7) different matings and also refers to Bos taurus to Bos taurus or Sanga x Bos taurus crosses.

Notes

Breed Selection

To some people breed selection is offensive, to some it is a challenge and to others who have no hard facts, an endless debate. Producers who are particularly conscious of the beef production in their operation are ultimately concerned about the weight and quality of beef sold per cow mated or per unit area of grazing land.

Issues influencing production include:

- **Fertility and sound structure**
- **Survivability - survival/mortality**
- **Maternal ability**
- **Growth rate**
- **Environmental adaptation**
- **Carcass characteristics/maturity rate.**

Currently, in excess of 40 breeds of cattle are available for use in Australia. No one breed is the best for all environments and all markets. Some breeds are better for certain characteristics in particular environments than others. The continental breeds are generally larger with leaner carcasses than British breeds. However there are variations about accepted 'norms' eg not all late maturing breeds are large or marble poorly. Not all early maturing breeds are small or have sufficient fat cover.

Differences claimed by many breed groups relative to other breeds are not always quantified with objective data. In addition we should be aware that for many traits, there is often as much variation genetically within a breed as there is between breeds. Variation within a breed is usually an advantage but is not a prerequisite to successful crossbreeding eg with Brahmans there is not much variation in tick resistance but this is a benefit in crosses.

Breeds can be loosely ranked according to the broad trends exhibited by large numbers of animals and several large scale trials. Breed rankings in a temperate climate have been shown in Table 3, for birth weight and likely calving difficulty, dam calving difficulty, milk production, growth rate, carcass fat, lean/bone ration and early age of puberty.

The choice of breeds used in a crossbreeding program should take into consideration the complementarity of different breeds, ie the opportunity to match the good points of two or more breeds. We need to match the genetic resources with feed resources.

Complementarity is exploited in specialised crossbreeding systems when crossbred cows of small to medium size and optimum milk production (maternal breed) are mated to sires of a different breed noted for good growth rate and high quality carcasses (terminal sire breeds). Fluctuation in breed composition between generations in rotational crossbreeding systems can result in considerable variation among cows and calves in level of performance for major economic traits unless breeds used in the rotation are similar in performance characteristics.

Table 3. Breed rankings in a temperate climate (unless otherwise indicated)

Birthweight and likely calving difficulty (A)	Dam calving difficulty	Milk production (B)	Growth rate (A) Tropical (▪)	Growth rate (A) Temperate
Maine Anjou Chianina Charolais Brahman(*)	Simmental Charolais Blond D'Aquitaine South Devon Limousin Red Poll Hereford	Friesian Jersey	Brahman Sahiwal Africander Droughtmaster Santa Gerturdis Belmont Red	Maine Anjou Blond D'Aquitaine Charolais Gelbvieh Simmental Chianina
Gelbvieh Brown Swiss Blonde D'Aquitaine Simmental South Devon	Maine Anjou Gelbvieh Devon Brown Swiss Friesian Murray Grey Beef Shorthorn Galloway Angus Chianina Jersey	Brown Swiss Simmental Sahiwal Gelbvieh Red Poll	Angus Beef Shorthorn Galloway Jersey South Devon Brown Swiss Friesian American Angus Limousin Hereford Murray Grey Red Poll Devon Gelbvieh Maine Angou Charolais Blond D'Aquitaine Simmental Chianina	South Devon Brown Swiss Friesian
Friesan Limousin Sahiwal(*)	Belmont Red Santa Gertrudis Droughtmaster Brahman Africander Sahiwal	Brahman Santa Gertrudis Droughtmaster South Devon Maine Anjou Blond D'Aquitaine Charolais Chianina Angus Beef Shorthorn Murray Grey Limousin Galloway Devon		American Angus Limousin Hereford Belmont Red Santa Gertrudis Droughtmaster Murray Grey Red Poll Brahman Africander Sahiwal Devon
Red Poll Hereford Devon Santa Gertrudis (*) Droughtmaster(*) Africander (*)		Belmont Red Africander Hereford		Angus Beef Shorthorn Galloway Jersey
Murray Grey Beef Shorthorn Angus Galloway Belmont Red Africander (#) Brahman(#) Sahiwal(#)				

Carcass Fat (C)	Lean/Bone Ratio (D)	Earliness of puberty
Beef Shorthorn Jersey	Blond D'Aquitaine Limousin Charolais Chianina	Jersey
Angus Galloway Red Poll Hereford Devon Brahman Sahiwal Murray Grey	Maine Anjou Gelbvieh Simmental South Devon Murray Grey Angus Galloway Brown Swiss	Friesian Angus Galloway Murray Grey Beef Shorthorn Red Poll Brown Swiss Gelbvieh South Devon Simmental Maine Anjou Belmont Red
Belmont Red Santa Gertrudis Africander Droughtmaster Friesian South Devon Brown Swiss Gelbvieh	Red Poll Hereford Devon Sahiwal Belmont Red Santa Gertrudis Africander Droughtmaster Brahman Beef Shorthorn	Hereford Devon Santa Gertrudis Droughtmaster Sahiwal Blond D'Aquitaine Charolais Limousin Chianina
Limousin Maine Anjou Simmental	Friesian Jersey	Brahman
Charolais Blond D'Aquitaine Chianina		

ABBREVIATIONS

- A Sire Breed Effect
- B Dam Breed Effect
- C When slaughtered at the same weight
- D The higher the lean/bone ratio, the more valuable the carcass
- * Sires mated to Bos taurus (non-zebu cows)
- # Sires and Dams mated to the same breed
- ▪ Extremely stressful environments eg far north Australia

The rankings on this page are based on United States Department of Agriculture research results with some modifications on the basis on New Zealand and Australia experiments (which were reported in the Victorian Department of Agriculture's Hamilton Pastoral Research Institute Research Review for 1987-88). The highest value is at the top of the columns. Breeds within sections are relatively similar and within breed variation would be as important as variation between breeds. Bos indicus and Bos indicus crosses estimates are from QDPI and CSIRO research.

In association with these trends, American data in Tables 4 and 5 show a range of breed groups and various carcass traits, eg liveweight and factors influencing meat quality.

Table 4. Breed group means for carcass traits adjusted to 19% fat trim

Breed Group[a]	Shrunk liveweight (kg)	Carcass weight (kg)	Fat thickness (mm)	Marbling score[b]	Retail product %	Bone %
Jersey - X	400	244	9.3	11.8	68.0	13.0
Hereford-Angus-X	425	266	13.3	10.2	68.4	12.6
Red Poll-X	422	264	10.8	10.4	68.2	12.8
South Devon-X	459	291	11.5	10.9	68.5	12.5
Tarentaise-X	462	293	11.0	11.2	68.6	12.4
Pinzgauer-X	467	291	11.5	11.2	68.0	13.0
Sahiwal-X	432	276	13.0	9.7	68.5	12.5
Brahman-X	469	302	13.8	9.5	68.4	12.6
Brown Swiss-X	520	329	11.5	11.2	68.1	12.9
Gelbvieh-X	531	337	11.3	10.6	68.7	12.3
Simmental-X	569	360	13.8	11.9	68.6	12.4
Maine-Anjou-X	556	358	12.0	11.5	68.4	12.6
Limousin-X	552	358	15.0	11.0	69.7	11.3
Charolais-X	587	376	13.8	12.6	69.1	11.9
Chianina-X	632	414	14.3	11.7	68.8	12.2
Hereford dams[c]	492	311	12.5	10.6	68.4	12.6
Angus Dams[c]	461	293	12.5	10.9	68.6	12.4

Table 5. Breed group means for factors identified with meat quality at 458 days of age

Breed crosses[a]	Marbling[b] score	Percent choice	Tenderness test (kg)[d]	Taste panel scores[e]		
				Flavour	Juiciness	Tenderness
Chianina - X	8.3	24	3.6	7.3	7.2	6.9
Limousin-X	9.0	37	3.5	7.4	7.3	6.9
Brahman-X	9.3	40	3.8	7.2	6.9	6.5
Gelbvieh-X	9.6	43	3.5	7.4	7.2	6.9
Sahiwal-X	9.7	44	4.1	7.1	7.0	5.8
Simmental-X	9.9	60	3.5	7.3	7.3	6.8
Maine-Anjou-X	10.1	54	3.4	7.3	7.2	7.1
Tarentaise-X	10.2	60	3.7	7.3	7.0	6.7
Charolais-X	10.3	63	3.3	7.4	7.3	7.3
Brown Swiss-X	10.4	61	3.5	7.4	7.2	7.2
Pinzgauer-X	10.8	60	3.4	7.4	7.2	7.1
South Devon-X	11.3	76	3.1	7.3	7.4	7.4
Hereford-Angus-X	11.3	76	3.3	7.3	7.3	7.3
Red Poll-X	11.5	68	3.5	7.4	7.1	7.3
Jersey-X	13.2	85	3.1	7.5	7.5	7.4

[a] X represents sires of stated breed mated by AI to Hereford and Angus cows with assessment on F1 progress.
[b] Marbling: Scored 1 (negligable) -17 (moderate), with higher score indicating more marbling.
[c] Includes straighbred progeny but does not include Hereford-Angus cross progeny.
[d] Warner-Bratzler shear test: The lower the score, the more tender the meat.
[e] Taste panel scores: 2=undesirable, 5=acceptable, 7=moderately desirable, 9=extremely desirable.

Distribution of traits

There are genetic differences within breeds as well as differences between breeds in their ability to express characteristics. These differences are shown in the Figures 10, 11 and 12.

Figure 10. Genetic variation for retail product weight at 485 days of age, as indicated by growth rates for the various breeds and also showing the variation within the breed.

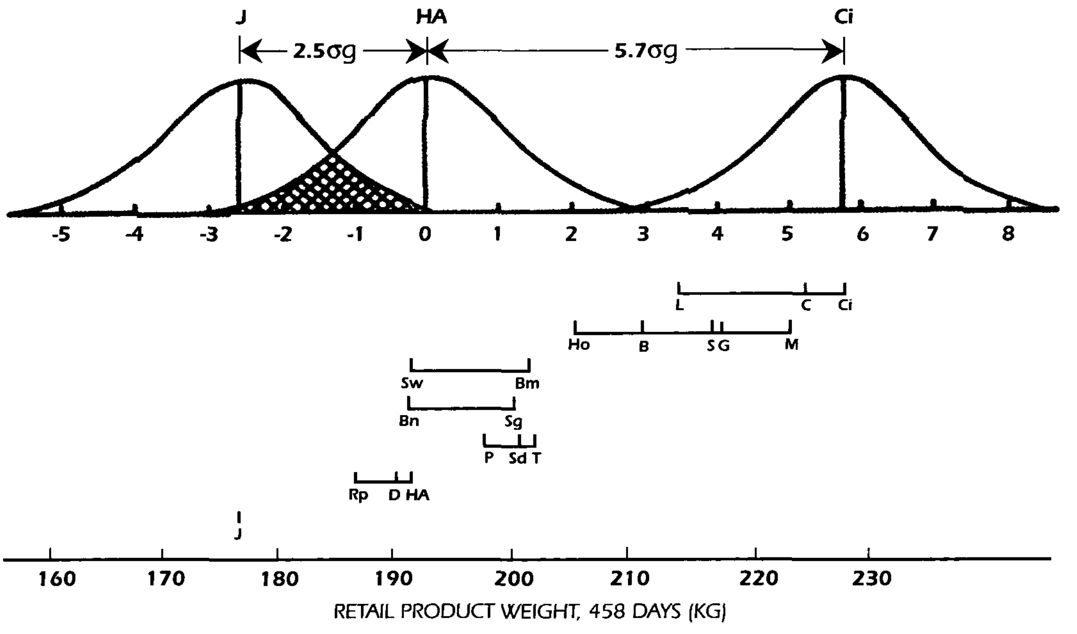
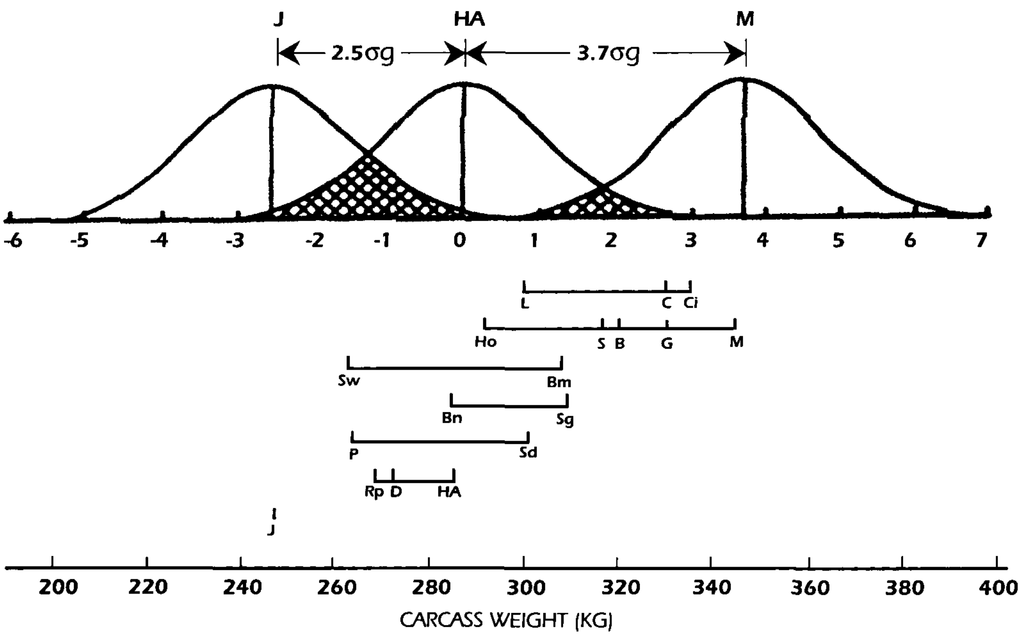
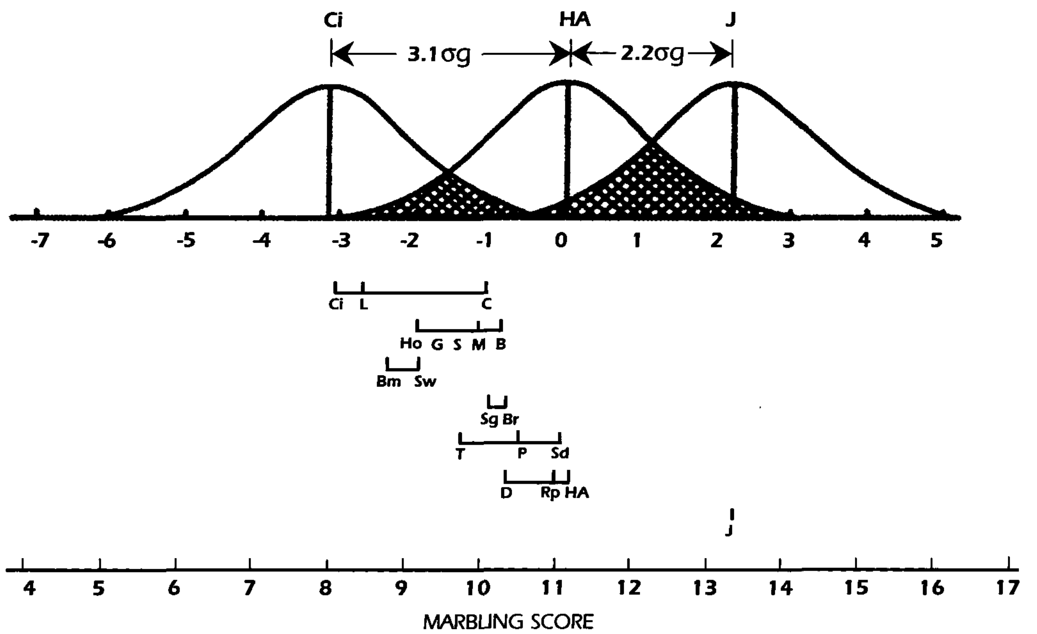


Figure 11. Genetic variation for carcass weight at 485 days of age for the various breeds and also showing the variation within the breed.



NOTE: The key for breed type identifiction is on the following page.

Figure 11. Genetic variation for carcass weight at 485 days of age for the various breeds and also showing the variation within the breed.



Key for breed types

J	Jersey	P	Pinzigauer	G	Gelbvieh
HA	Hereford-Angus	Bn	Brangus	Ho	Holstein
R	Red Poll	Sr	Santa Gertrudis	S	Simmental
D	Devon	Sw	Sahiwal	M	Maine Anjou
Sd	South Devon	Bm	Brahman	L	Limousin
T	Terentaise	B	Brown Swiss	C	Charolais
				Ci	Chianina

Notes

Superior Sire Selection

No matter what breeding program is being used, the choice of the sire has a profound effect on the long term performance of the herd. Many of the features we look for in a sire were discussed at the Department's Buying Better Bulls field days. Producers benefit from selecting for traits that have the largest amounts of genetic variation and/or the highest heritabilities because those are the traits that will respond best to selection. Some traits are more readily transmitted from sire to progeny and some traits can be identified in the sire and produce a desirable response in the female progeny.

A long term selection study at the US Meat Animal Research Centre, Nebraska, has clearly documented the power of bull selection versus selection applied to females.

Table 6. The responses in terms of genetic improvement in yearling weight over 20 years for three selection methods

Selection method	Improvement (kg)
heifer selection alone	5.5
bull selection alone	50.0
bull plus heifer selection	51.0

On a percentage basis, bull selection alone accounted for almost 90 percent of the total genetic improvement in yearling weight. This fact should not be taken as a criticism of the potential genetic contribution of cows, since good bulls will have good mothers. However, the genetic merit of cows will depend largely on bulls used previously in the herd. Moreover, the average cow will produce six to eight progeny in a lifetime in the commercial herd whilst the bull influences 120 to 159 progeny in four to five years of working life.

By using Artificial Insemination (AI) a bull's effect on the future genetics of the herd becomes even more important with the potential for many thousands of calves to be sired by one bull. The dairy industry is a good example of the use of AI to achieve rapid genetic progress in the herd through good selection practices with sires.

In many herds, a large proportion of the females produced are kept as replacements so that little selection is possible. On the other hand only a small proportion of males need to be retained as bulls, allowing considerable opportunity to select the best.

The traits discussed during the bull selection days focused on four broad issues as identified by producers at virtually all of the days. These can be summarised as:

- **Fertility**
- **Growth**
- **Carcass characteristics**
- **Temperament**

In all these selection characteristics, it is important that the traits under selection are of economic importance to the producer, are able to be measured and are at least moderately heritable or under genetic control.

Fertility

Fertility, as a current herd benefit, can be evaluated using testicular tone or 'sponginess' as an indicator of semen quality. Fertility also has an important effect on the future productivity of the herd with scrotal circumference affecting not only semen production of male calves, but also having a positive relationship with age at puberty, time of conception and conception rate of female progeny. Producers rightfully identified 'libido' as an independently important attribute which can be objectively assessed and selectively used to achieve desirable conception rates. In addition, the bull must be structurally sound in legs, feet, penis and prepuce. These can be identified during libido testing.

Bulls must have a sound delivery system, free of premature spiral deviation and/or a 'broken penis', a physical injury causing the penis to deviate. Other sheath and penile abnormalities may also be identified during an effective serving capacity test. Fertility testing should be carried out prior to purchase and at the commencement of each mating season.

Growth

Growth characteristics are best assessed by the liveweight of the animal. In recent years, the use of 'BREEDPLAN' information which identifies the genetic potential of the animal for a range of criteria including birth weight, milk production, weaning, yearling and final weight, provides an opportunity for significant progress. This information is supplied by BREEDPLAN in the form of Estimated Breeding Values for these traits.

Selection based on Estimated Breeding Values rather than a combination of genetic and environmental factors (eg previous feeding or husbandry activities) will provide opportunity for long term progress within the herd. The more heritable the trait, the greater the opportunity to make progress within a breeding program. A range of heritibilities is shown in Table 7.

Carcass characteristics

Carcass attributes often selected by producers are a composite of muscling and fat. Muscling can be assessed by using Estimated Breeding Values for eye muscle area as some indicator of overall muscling or by effective muscle scoring. There is a slight relationship between the curvature of the 'hindquarter' muscles on each side of the animal when fat has been taken into consideration and the size of the eye muscle along either side of the backbone. Carcass weight and fat thickness may explain 60% of variation in carcass muscle. Even though we have excellent technology in Australia for measuring Eye Muscle Area (EMA), the addition of EMA to carcass weight and fat thickness may only account for a further 9% of the variation. Fat, and particularly subcutaneous fat (fat just under the skin), can often deceive many a bull buyer into thinking a bull is well muscled when he is actually poorly muscled but well fed. As the animal deposits greater amounts of fat under the skin, there is a trend for increased marbling, or fat distributed within the muscle. There are however, exceptional animals that will marble well with only minimal subcutaneous fat.

Rather than concerning ourselves with Eye Muscle Areas, Muscles Scores or fat thickness, the ultimate goal of producers must be to improve the Retail Beef Yield (RBY) %, involving a combination of carcass weight, fat thickness and possible EMA in heavier carcasses.

Temperament

Temperament is often mentioned as a trait frequently considered by producers. An effective measurement, flight speed, has been developed particularly for Bos indicus bulls. Producers should be aware that sales are often not a good time to make relative decisions regarding temperament. Animals can express abnormal behaviour due to the immediate pre-sale handling that has occurred. Such behaviour can be abnormally unfavourable or, alternatively, animals may have been sedated to make them tractable. Selection in the paddock is therefore a more desirable option for this trait.

Table 7. Heritablility estimates for some characters in beef cattle

Character	Heritability Range	Heritability (%) Temperate	Heritability (%) Tropical
Reproduction			
Conception	low	0 - 5	5 - 20
Calving interval	low	0 - 10	na
Calving ease (heifers)	medium - high	15 - 50	na
Semen quality	medium	25 - 40	6 - 44
Scrotal circumference (18mth)	medium - high	20 - 50	28 - 36
Serving capacity (18 mth)	low - high	15 - 60	na
Maternal ability	medium	20 - 40	na
Gestation length	medium	15 - 25	na
Conformation and Growth			
Weaning score	medium	25 - 35	na
Body length	medium	25 - 45	na
Chest girth	medium - high	25 - 55	na
Wither height	medium - high	30 - 50	na
Birth Weight	medium	35 - 45	35 - 45
Milk yield	medium	20 - 25	na
Weaning weight	medium	20 - 30	3 - 50
Gain - birth to weaning	medium	25 - 30	30 - 40
Yearling gain (pasture)	medium	30 - 45	20
18 month weight (pasture)	medium - high	40 - 50	30
Mature cow weight	high	50 - 70	25 - 40
Dry season gain	medium	na	30
Wet season gain	low	na	18
Carcass (US)			
Dressing percent	medium - high	30 - 50	na
Carcass weight/day of age	medium	25 - 45	na
Tenderness	high	50 - 70	na
Rump fat P8 site	medium - high	30 - 40	na
Eye muscle area	medium	20 - 25	na
Other traits			
Cancer eye susceptibilty	medium	20 - 40	na
Eyelid pigmentation	high	45 - 60	na
Temperament	medium - high	25 - 50	na
Tick resistance	medium	na	20 - 35
Worm resistance	medium	na	25 - 30
Buffalo fly resistance	medium	na	20 - 30

na: not available

(Sources: 'Selecting Beef Cattle for Maximum Production in the 80's 1981. AGBU, UNE, Ed Hammond, K. et al; Davis, G.P. 1993 'Genetic Parameters for Tropical Beef Cattle for Northern Australia. Aust. J Agric. Res.,44,179-198.)

Managing a Crossbred Herd

Crossbreeding can lead to improved performance and production provided management can handle the different systems. With experience and over time, management will improve as very few people can do everything right the first time.

There are a number of crossbreeding systems which will be dealt with in this section. The choice will depend on the environment, the property facilities, the management capabilities, time available and the production and marketing systems on offer.

General considerations

If you wish to develop crossbreeding systems for your own herd, you should consider the following questions which are similar to those asked in a computer model developed by New South Wales Department of Agriculture called 'F1-Breed', which is used for deciding first-cross cow breed types.

Ask yourself the following questions related to your property:

- Property location, eg tropical or subtropical, ticks or tick free environment.
- Pasture quality, eg poor, medium or lush.
- Available breeds on property or that can be purchased, eg Bos indicus, large dairy, British.
- Unavailable/unacceptable breeds, eg Small dairy and large European breeds.
- Yard facilities. Suitability of yards to handle Bos indicus breeds and for additional drafting options during handling of stock.
- Producer attitude to handling Bos indicus cattle.
- Preferred crossbreeding system, eg buy-in F1 females or breed own.
- Selection criteria applied to progeny, eg weaning weights, hardiness to environment.
- Acceptable level of calving difficulty/level of eye cancer tolerated in the herd.
- Market specifications of the turnoff animal the producers are aiming to breed.
- Age at which stock are sold, eg weaning.
- Degree of finish (overfinished/satisfactory/underfinished) to meet market requirements.

Whichever system is chosen, the breeder gains most benefit by knowing what to expect from it, how to manage it and what peculiarities are associated with that system.

There are a number of practical considerations that will have to be looked at:

- How many different breeding herds will be required?
- How many paddocks will be necessary? With the introduction of a new bull breed this may need extra breeding paddocks to accommodate the various mating arrangements.
- Artificial breeding, using semen from suitable bulls of particular breeds will reduce the need for extra animal groups and could be considered as an option.
- The option of buying replacement females or bulls, especially in smaller herds where extra overheads can quickly defeat any benefit, should be considered.
- Where crossbred females are retained for breeding (as in three breed terminal and rotational crosses) there is a need to identify the genotype or breed composition of individual animals in order to mate them to best advantage. This does not necessarily require individual numbering but could be based on a coloured tag or a firebrand number for each genotype.

To be successful you need to be committed to the breeding program. There will be temptations to keep crossbred females for breeders because they often are bigger and look sleeker, However, unless they can fit into a system that optimises results and are correctly identified, this will lead to animals later in the breeding program which are of indeterminate, jumbled genotype and which are of little or no extra benefit. This will lead to great variation in slaughter stock, resulting in difficulties meeting specific market requirements. You have to stick to the plan.

Some specific breeding systems designed to suit your own production and marketing system are outlined below. If you require more information please contact your local Beef Genetic Improvement Project Officer.

Terminal cross

The terminal crossbreeding systems employ two, three, four or more breeds in an organised sequential system of crossing with all of the final cross going to slaughter. The sire used to produce the marketed progeny must provide the genes for high growth rate and good carcass attributes to suit the particular market goals of the producer. This system is relatively quick and easy to start and operate but presents more difficulties as the number of breeds increase. It is relatively quick to terminate and return a fully stocked pure breeding herd.

Two breed cross

The two breed crosses require a cow herd of a particular pure breed. Part of the cow herd is used to breed replacement purebred females and the balance to breed crossbred progeny. The crossbred progeny are either all sold for slaughter or the females go to another crossbreeder who is using F1 cows. The exact numbers retained to breed replacement females and those available for crossbreeding need to be determined to ensure that sufficient replacement females are available. This will depend on culling policy and weaning death rate.

An alternative to breeding replacements would be to buy in all replacements. This removes the need for separate breeder paddocks and the need for bulls of two different breeds. It also means that all calves are crossbred compared with only a percentage being crossbred in a self replacing herd (a herd which breeds replacement females). Purchasing replacement females is particularly suitable for the smaller herd where a self replacing system necessitates having more bulls than necessary for the number of cows or where there are insufficient paddocks for different breeding programs. For this to be successful there must be a ready supply of good quality purebred females available for purchase.

The main caution would be to avoid mating cows which are potential dystocia cases and heifers with large European bulls. This may necessitate some objective measures of pelvic areas. Selection of bulls for lower birthweight (low birthweight EBVs are the most accurate predictor of low birthweight) will also go a long way to avoiding dystocia. Replacements for the herd breeding crossbreed calves should be adults from the replacement breeding herd and not heifers - all heifers go into the replacement breeding herd. An example is shown on page 31.

Backcross

The backcross involves mating one of the two parent breeds back to the F1. This removes the need for separate mating paddocks for F1 cows, but means that identification is even more necessary as some backcross calves can look very similar to purebreds, especially with Herefords. Property facilities will need to accommodate at least two breeds of bulls when replacements are bred on property. This system does however, lend itself to producing a consistent product as has been desired by several breed societies and/or markets.

Three breed cross

A three breed terminal cross self replacing system requires a minimum of three mating paddocks to accommodate the different mating arrangements. One purebred herd is needed to breed purebred replacements, one purebred herd to breed F1 cows, and the F1 herd to breed the terminal slaughter animals. One purebred herd produces turnoff animals with no hybrid vigour and the other produces turnoff animals with hybrid vigour for growth.

The terminal cross animal benefit both from hybrid vigour for growth and hybrid vigour for maternal traits in its dam. In a fully self-replacing herd only about one third of the herd can benefit from maternal hybrid vigour as the majority of cows are the purebreds needed to keep the herd going with replacement females. The relative proportions of female lines can be worked out using pregnancy rates, age of culling, death rates and other cull losses. These can be started as for a two breed terminal cross, but as F1 heifers become available at mating age, they are retained and mated to the terminal sire, and a corresponding decrease of numbers is made in the purebred herd. The potential for dystocia when using European terminal sires could be a problem for F1 British x British heifers but would be minimal for Bos indicus x British F1 heifers. In smaller herds, this terminal sire will be under-utilised for the first year or so. In larger herds where more than one terminal sire is to be eventually used, purchase of terminal sires is done as female numbers justify.

It is important to note that in the first 10-12 years, no F1 cull for age occurs and so replacements are only needed for deaths and other culls. During this period the breeder has several options:

- Settle down to the stable herd structure determined initially to be ideal for the herd and simply sell F1 heifers to slaughter or other breeders, or practice very heavy performance culling in the F1.
- Increase the proportion of F1s in the herd, therefore increasing the number of terminal cross calves sold in this period. (A terminal sire x F1 cow system is generally more productive than a Breed A x Breed B F1 producing system)

The few replacements needed to replace F1 culls and deaths could be bred by AI each year or by leasing a bull every few years to breed replacements for losses over the previous few years (the pure bred herd is adjusted yearly to account for fluctuation in the F1 herd and so keep the property fully stocked). For larger herds, one, rather than multiple sires can be run to breed the F1 replacements.

Two years before the first cull for age F1 cows are sold (three years when practising 2 year old mating) it is necessary to mate sufficient of the pure bred cows to breed sufficient F1 replacements for the first loss due to cull for age two (or three) years later. At the same time the herd structure should be adjusted to approximately the numbers in each breeding herd originally determined appropriate for a stable three breed terminal cross on that property.

An alternative to the gradual increase of F1 females, would be to use AI or lease bulls in the first year and mate all or a large proportion of the herd to produce the full complement of F1s in one go. Then the herd reverts to either of the structures described above. This method would mean most of the existing bulls would have a year off, yet there would be the added expense of AI or leasing of bulls. This could be an unacceptable cost to many, but the herd would be turning out more terminal cross stock a few years earlier than the gradual start up. An example of a three breed self-replacing terminal cross system after it has stabilised is given on page 32.

To increase the proportion of the herd actually breeding terminal cross sale cattle, buying in purebred replacements could change the herd structure in the example to 50 purebred females and 100 F1 females giving 14 extra F1 calves and 57 extra terminal cross calves though at this proportion, little selection of F1 heifers is possible. Another alternative, assuming a good available supply of F1 females, is to buy in these animals. This means the whole herd can produce terminal animals and the management is much simpler, though costs of purchase may reduce benefits to some degree.

Rotational cross

Rotational crossbreeding systems involve using purebred bulls of two or more breeds in a sequential rotation over crossbred females bred from previous generations of purebred bulls and crossbred cows as shown in the two breed rotational cross on page 33.

The system is very organised so that hybrid vigour and the complimentary characteristics of each breed can be best used and optimised.

'Herd 1' is always mated to breed A bulls. Heifers from this herd always move to 'Herd 2'. 'Herd 2' is always mated to breed B bulls. This continues until the heifers from the 'last' herd move back to Herd 1' and are mated to breed A bulls.

A good but simple identification system is important so heifers can be drafted to the right mating paddocks after growing out and so strays can be returned to the correct paddocks.

Proportions in each herd should be roughly the same. If proportions are too different, it may not be possible for the smaller herd to produce sufficient replacement females for the next herd, or there will be little opportunity to select females for the more desirable production traits. Also there will be a wastage of good heifers from the larger herd as fewer numbers will be required as replacements in the smaller herds.

Composite breed

The possibilities for starting are as numerous as the possible composites. However they generally follow the pattern:

- A first generation, where purebred bulls of a range of breeds are mated to purebred females of one or more breeds.
- A second generation of mating of the crossbred female progeny from generation 1 with either purebred bulls of one or more breeds or with crossbred bulls from generation 1.
- Subsequent generations of mating the crossbred females of the preceding generation with pure or crossbred bulls, until a single predetermined mix of breeds is reached. These are then intermated as a purebred would be.

Once established these are managed the same as for any pure breeding system.

Glossary of Terms

Additive gene action. The effect where the expression of a trait is controlled by one or more pairs of genes, each of which act in an additive manner.

Additive effects. See Additive gene action.

Backcrossing. A mating system where the crossbred female progeny are mated to a male of either parental breed.

Bos indicus. The breeds of cattle referred to as tropical or humped breeds, eg Zebu breeds including Brahman and Sahiwal.

Bos taurus. The temperate, British and European breeds of cattle, eg Hereford, Angus, Murray Grey and Charolais.

BREEDPLAN. A performance recording system, operated by the National Beef Recording Scheme, which uses an animal's own performance plus the performance of all known relatives in the herd and all genetically correlated (or related) traits to estimate breeding values.

Complementarity. The use of two or more breeds in roles that are consistent with the strengths and weaknesses of the breeds, eg cows of moderate size and optimum milk mated to sires noted for high growth rate.

Composite. A breed resulting from the mating of two or more existing breeds and animals are selected from within the progeny to continue the breed eg Belmont Red, Droughtmaster.

Crossbreeding. Mating system in which two or more straight breeds are combined.

Desirable genes. Genes which, when present, improve the animal performance.

Estimated Breeding Value (EBV). An estimate of an animal's value as a parent for a particular production trait, eg growth rate and is calculated from the measured performance of the animal and its close relatives for that trait (see BREEDPLAN).

F1. The first generation of progeny from the crossing of two breeds.

Fitness traits. Traits related to reproduction, survival/mortality of cattle.

Genes. The basic unit of heredity. Each gene has two or more forms which can be the same or different.

Hereditary. A condition controlled or influenced to some degree by gene action. This is in contrast to characters which are entirely controlled by environmental variables.

Heritability. That fraction of the total variation for any trait in a population which is due to additive genetic effects. The efficiency of transmission of a trait from parent to offspring.

Heterosis. Differences in performance or vigour of crossbred progeny from the average of the parental breeds.

Hybrid vigour. See Heterosis.

Inbreeding. A system of mating in which mates are more closely related than average individuals of the population to which they belong.

Individual heterosis. The positive difference in performance of the individual compared to the average of its parents often in respect to the turnoff animals. Usually referred to as 'nicking' by stud breeders.

Line breeding. A form of inbreeding in which an effort is made to maintain high relationship in subsequent generations with a favoured ancestor.

Maternal heterosis. Positive differences in the performance of the crossbred female which are used to give further performance benefits in an additive way to the progeny.

Outbreeding. A system of mating in which mates are less related than average individuals of the population being intermated.

Outcrossing. Mating unrelated animals within the same pure breed. Often 'unrelated' is interpreted to mean no common ancestors in the first four to six generations of their pedigrees.

Percent choice. The percentage of animals grading choice in the American carcass grading system (a fat grade).

Rotational. A crossbreeding system which systematically used three or more breeds crossbreeding in rotation.

Sanga. The Sanga breeds appear to have developed thousands of years ago from a mixture of Bos indicus and Bos taurus breeds.

Sequence breeding. Breeding systems in which males of two or more breeds are used in sequence on crossbred female population.

Straightbred. Animals of a particular breed as opposed to crossbred animals.

Synthetic breed. A new breed established from the mating of the progeny of two or more existing breeds (see Composite).

Terminal cross. The progeny of a particular crossbred mating that are sold for slaughter and bred for market and growth attributes.

Vigour. Increased productivity of an animal as part of healthy growth.

Warner-Bratzler shear. The force required to sever the muscle fibres of a piece of meat and used as an indication of tenderness.

Appendix

Market specifications

Japanese market sample specifications

PASTURE FED	APGF50	AP1	AP2	APY	Japanese Feeder Steer
	Pasture fed grain finished for 50 days	Pasture fed 1st quality	Pasture fed 2nd quality	Pasture fed Yearling	(Shipping to Japan for feedlotting)
Carcass Weight	300-360kg	300-360kg	300-380kg	200-240kg	Liveweight: 275-300kg
P8 Fat	12-22 mm	12-22mm	8-16mm	6-12mm	Age of maturity : Mid to late
Age	Max 4 teeth	4 teeth	Max 7 teeth	0 teeth	AUSMEAT fat score : 1-2
Sex	Castrate male	Castrate male	Castrate male	Cast males/heifer	AUSMEAT muscle shape : B or C
Meat Colour	1-5	1-6	1-7	1-3	Age: 9-12 months
Fat Colour	4-6	4-6	6-9	4-6	Breed: Angus or M/Grey
Marbling	2	2			

GRAINFED	APGF90	AGF300	AGF200	AGF150	AGY
Carcass specification after grain feeding	Pasture fed grain finished for 90 days	Grainfed 240 days of feed	Grainfed 180-200 days on feed	Grainfed 150 days on feed	Grainfed yearling 90-120 days on feed
Carcass Weight	300-360kg	360-420kg	360-420kg	320-400kg	200-260kg
P8 Fat	12-22mm	22-32mm	22-32mm	16-27mm	6-12mm
Age	Max 4 teeth	4 teeth	4 teeth	4 teeth	0 teeth
Sex	Castrate male	Steers	Steers	Steers	Steers/heifers
Meat Colour	1-5	2-4	1-4	1-5	1-3
Fat Colour	2-4	1-3	1-4	1-5	2-3
Marbling	2 and 3	5+	3-4	2	2
Liveweight specification at feedlot entry					
Liveweight	440-500kg	280-320 kg	360-440kg	440-500kg	260-300kg
P8 Fat	6-10mm	4-8mm	4-10mm	6-10mm	4-8mm
Age	18-22 months	9-12 months	16-20 months	18-22 months	9-12 months
Sex	Steers	Weaned steers	Steers	Steers	Steers/heifers

Korean market sample specifications

PASTURE FED	APY	Korean Grassfed Type 1B	Korean Grassfed
	Pasture fed yearling	High quality pasture fed	AUSMEAT P1
Carcass Weight	200-240kg	225-340kg	180-280kg
P8 Fat	6-12mm	8-12mm	5-12mm
Age	0 teeth, <18 months	6 teeth max, <3 years	6 teeth max, <30 months
Sex	Steers/heifers	Steers, bulls and heifers	Steers, heifers and young cows
Meat Colour	1-3	2-4	Dark meat excluded
Fat Colour	4-6	<7, fair distribution	Yellow fat excluded
Eye Muscle Area		Min 58 sq.cm at 12th rib	
Muscling		C or better	

GRAINFED	Boneless Type 1A	Frozen bone-in	AGY
Carcass specification after grain feeding	High quality grainfed, 150 days on feed (suggest European crosses)	AUSMEAT K1 100 days on feed	Grainfed yearling 90 days on feed
Carcass weight	225-340kg 280-340 preferred	225-340kg 240-280kg preferred	200-260kg
P8 Fat	10-22mm	4-12mm	6-12mm
Age	24 months, (2 teeth)	6 teeth	0 teeth, <18 months
Sex	Steers/heifers	Steers/heifers	Steers/heifers
Meat Colour	<3	1-5	1-3
Fat Colour	1-3	4-6	0-2
Marbling	3	1 and 2	2
Muscling	C or better	C or better	C+
Liveweight specification at feedlot entry			
Liveweight	320-360kg	320-360kg	260-300kg
P8 Fat	2-6mm	2-6mm	4-8mm
Age	15-16 months	15-16 months	9-12 months
Sex	Steers/heifers	Steers/heifers	Steers/heifers

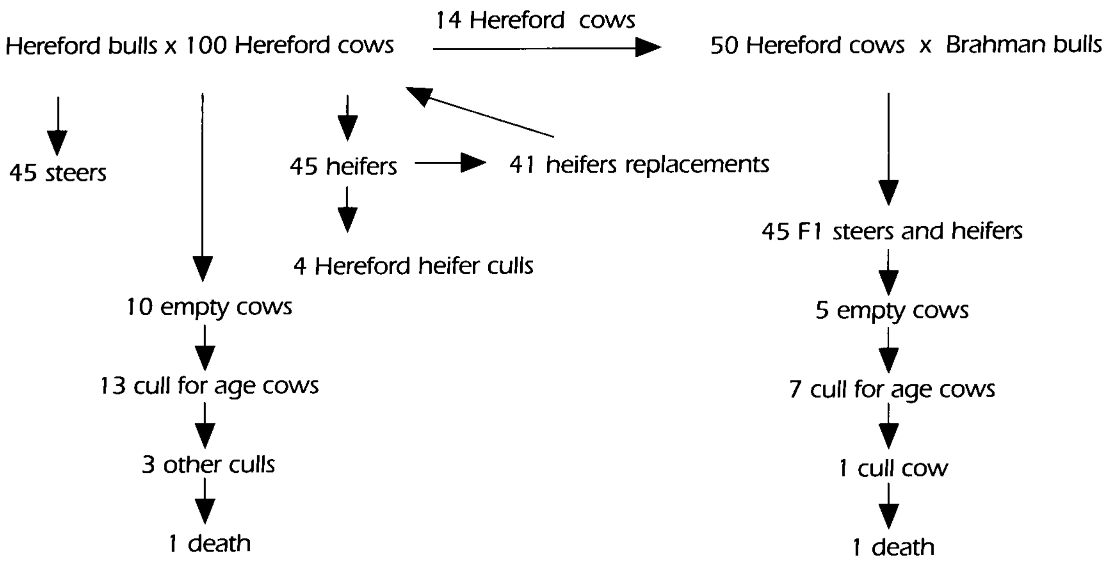
Market	Store Specification	Live Specification	Carcase Specification
Butcher Shops			
Demand from stores is subdued with noticeable movements of stock from Victoria to the central west of NSW	Liveweight (kg): Sex: Muscling: No special requirements	Liveweight (kg): 300-400 Fat score: 2+/3- Sex: Steers/heifers Age: <16 months Muscle score: A,B,C	HSCW (kg): 160-220 Fat depth (mm): 6-9 Dentition: 0 Butt shape: A,B,C Fat colour: Creamy white (0-3) Meat colour: No dark meat 1-6 Eye muscle area: >60 sq cm Marbling score: nil requirement
Hotels, Restaurants and Institutions			
Demand from stores is subdued with noticeable movements of stock from Victoria to the central west of NSW	Liveweight (kg): 300-400 Age: to 15 months Sex: Steers/heifers Muscling: A,B,C	Liveweight (kg): 410-570 Fat score: 2+/4+ Sex: Steers/heifers Age: <16 months Muscle score: A,B,C	HSCW (kg): 220-300 Fat depth (mm): 6-22 Dentition: 0 Butt shape: A,B,C Fat colour: White (0-2) Meat colour: 1-4 Eye muscle area: nil requirement Marbling score: nil requirement
Supermarkets			
Mild conditions have favoured the turnoff of feedlot cattle reducing feed times from 100 to nearer 70 days. This has ensured steady supplies	Liveweight (kg): 230-260 Sex: Steers Muscling: A,B,C Genetics:	Liveweight (kg): 340-400 Fat score: 2+/3- Sex: Steers/heifers Age: <16 months Muscle score: A,B,C	HSCW (kg): 180-220 Fat depth (mm): 6-9 Dentition: 0 Butt shape: A,B,C Fat colour: White (0-1) Meat colour: 1-4 Eye muscle area: >60 sq cm Marbling score: nil requirement
EEC HGP - Free Beef			
Grass fed and grain fed and certified free of Hormonal Growth Promotants (HGPs)	Liveweight (kg): Sex: Muscling: Genetics: No special requirements	Liveweight (kg): <620 Fat score: 2+/4- Sex: Steers/heifers Age: <30 months Muscle score: A,B,C	HSCW (kg): <327 Fat depth (mm): 4-17 Dentition: 0-4 Butt shape: A,B,C Fat colour:Creamy white - white (0-3) Meat colour: 1-3 Eye muscle area: nil requirement Marbling score: nil requirement
Manufacturing			
Exported to many markets around the world and used domestically	Liveweight (kg): Sex: Muscling: Genetics: No special requirements	Liveweight (kg): <420 Fat score: Sex: Bulls/steers/heifers Age: Muscle score: A,E	HSCW (kg): >220 Fat depth (mm): Dentition: 0-8 Butt shape: A,B,C,D,E Fat colour: nil requirement Meat colour: nil requirement Eye muscle area: nil requirement

Specifications current at February 1993

Examples of Crossbreeding Options

The following is an example of a crossbreeding system using two breeds

150 cow herd in a two breed self replacing terminal cross



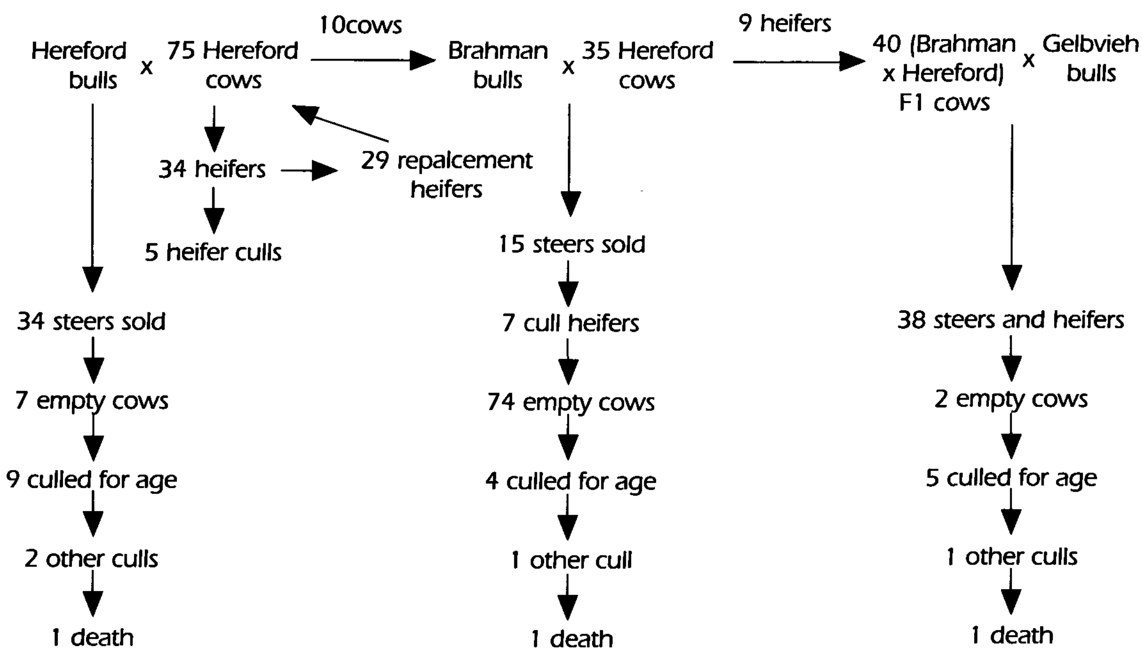
Considerations:

- Little selection of heifers
- Low other culling percentage
- 90% calving rate for Herefords
- Cull for age at 9 years old
- Cull 2-3%, death rate 1%
- Under a system of lower calving rates there may not be sufficient heifers

(You can substitute the breed most suitable to your environment and management system)

The following is an example of a crossbreeding system using three breeds

150 cow herd in a three breed self replacing terminal cross



Considerations:

- Only Hereford cows, 2nd calf or later, to be put in as replacement with Brahman bull
- May need to occasionally buy in replacement Hereford cows or modify the cull for age policy to maintain numbers
- 90% calving rate in Herefords
- Cull for age at 9 years old
- Cull 2-3%, death rate 1%
- Under a system of lower calving rates there may not be sufficient heifers

(You can substitute the breed most suitable to your environment and management system)

The following is an example of a crossbreeding system a rotational cross

150 cow herd in a two breed rotational cross

Brahman bulls x 75 cows (2/3 Hereford 1/3 Brahman) → 35 steers

Brahman bulls → 4 empty cows → 9 cull for age → 6 other culls → 1 death

20 heifers →

← 20 heifers

75 cows (2/3 Brahman 1/3 Hereford) x Hereford bulls

75 cows (2/3 Brahman 1/3 Hereford) → 35 steers

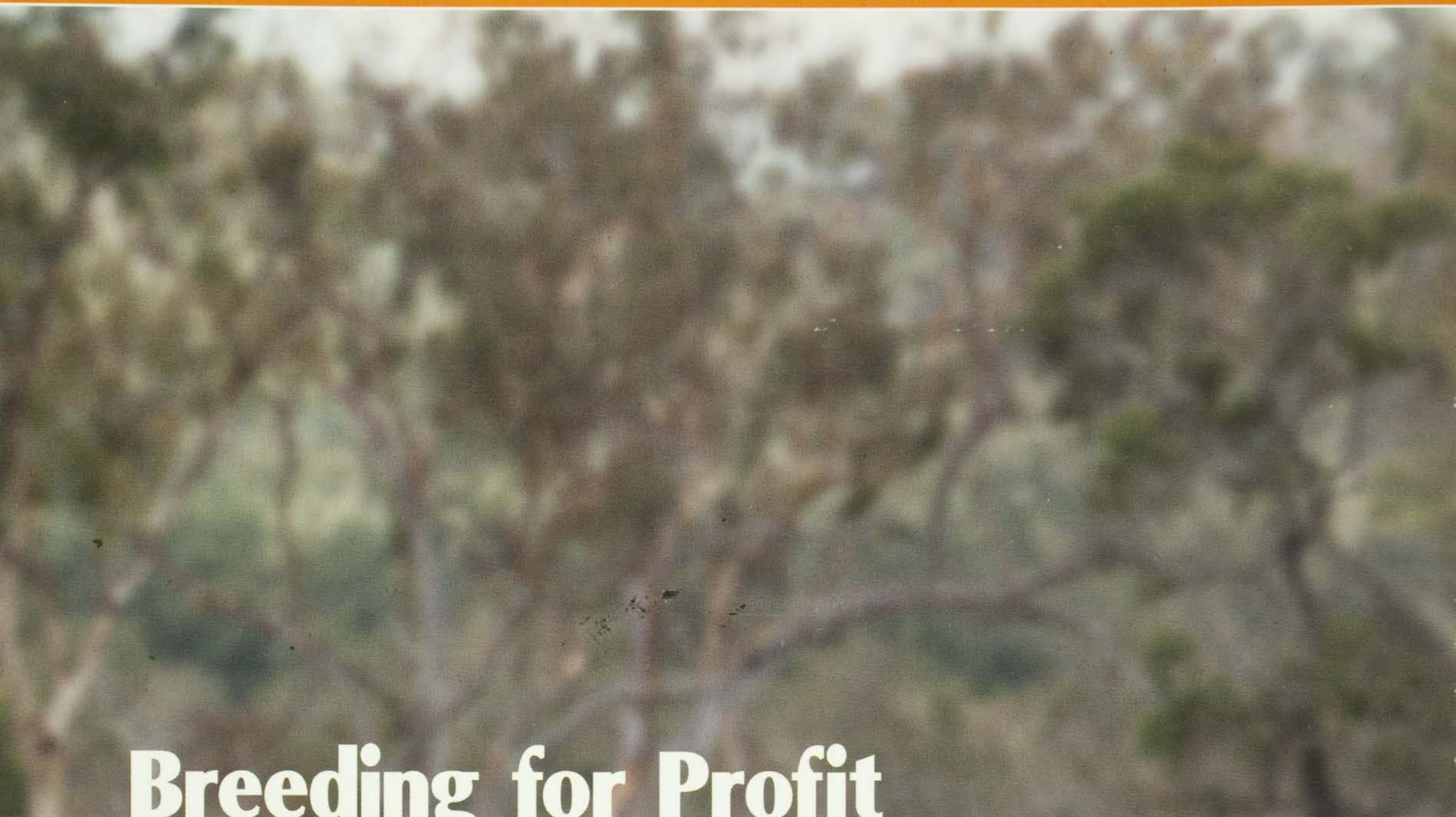
Hereford bulls → 4 empty cows → 9 cull for age → 6 other culls → 1 death

Considerations:

- 95% calving rate
- Higher selection of heifers possible
- Higher culling of older cows possible
- Cull for age at 10 years

(You can substitute the breeds most suitable to your environment and management system)

Notes



Breeding for Profit

will assist you to:

- define the markets you are aiming for
- determine breeding goals to serve these markets
- plan breeding programs to meet those goals.

Achievable Gains from a Planned Breeding Program

In a previous publication we discussed Buying Better Bulls. Those principles continue to be a fundamental requirement when choosing a sire for use in any planned breeding program.

Too often, the selection criteria within the breeding herd on commercial properties stops at the colour of the coat and/or the breed. With escalating costs and diminishing rates of return to investment in beef production, there is an ever pressing need to know the market specifications, to be conscious of the available feed reserves and the capital and physical constraints of the property and management and to plan an appropriate breeding program.

Many producers would suggest that there is room for improvement in their herds.

- What gains are achievable in your herd?
- What increased profit can be achieved in your herd?

Gains need not only be achieved in terms of reproduction, growth rate and survival, but should be in terms of quality and weight of carcase produced in as short a time as possible.

If you can increase weaning weight by 10 to 15%, decrease death rates in both calves and cows to 2 to 3% and increase turnoff weight by 50 to 60 kg you may be able to increase your profitability by 40% compared with your current herd. If the carcases produced achieve maximum returns, the increase in profitability can be even greater.

Breeding for Profit builds on the information in the three companion publications produced by the Department of Primary Industries. These are:

- **Bull Selection;**
- **Female Selection in Beef Cattle;**
- **Beef Cattle Recording and Selection.**

PLANNED BREEDING ENABLES YOU TO KNOW WHERE YOU WANT TO GO WITH YOUR HERD AND HOW TO GET THERE.