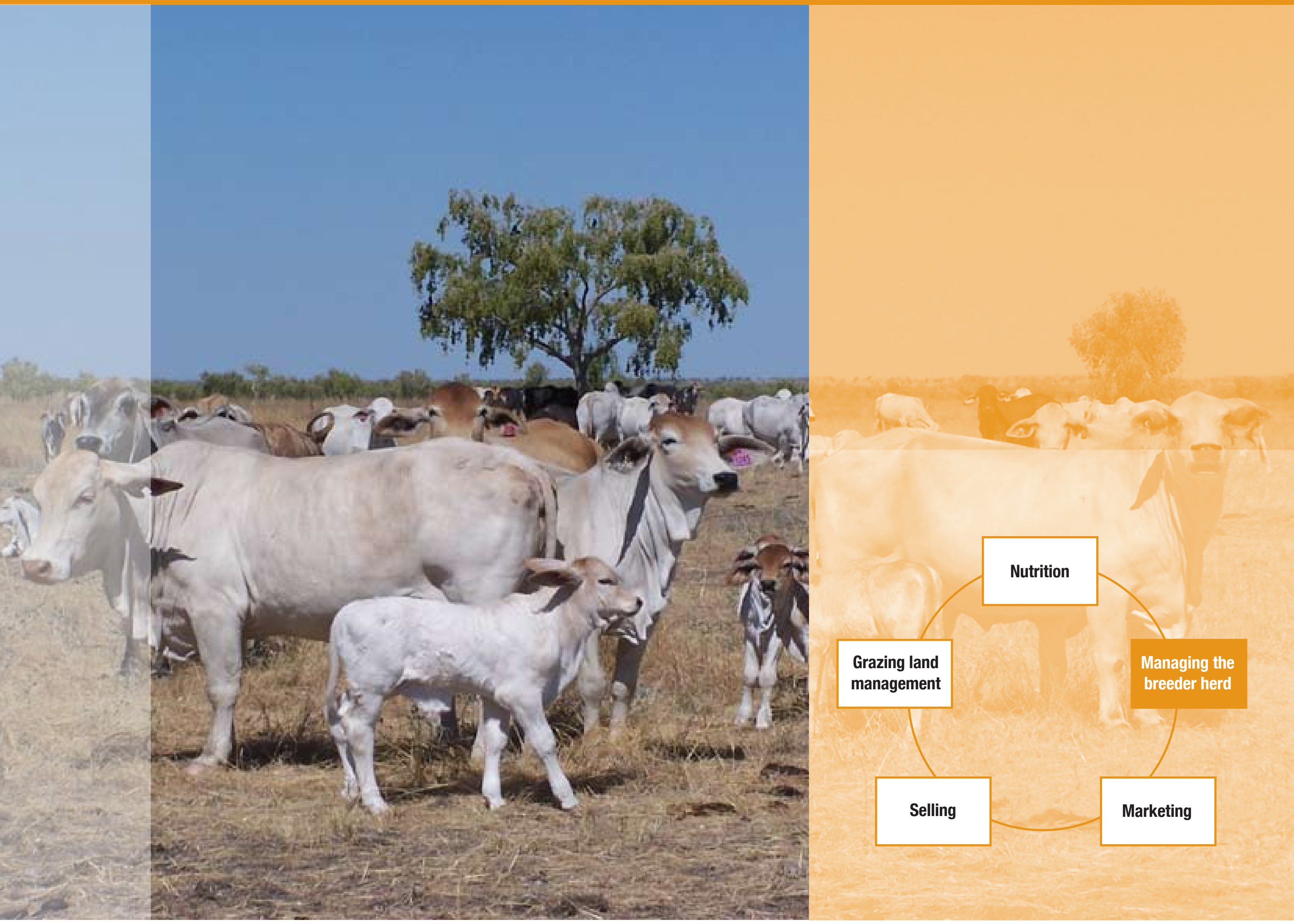


Managing the breeder herd

Practical steps to breeding livestock in northern Australia

Published by Meat & Livestock Australia Limited
May 2006

ABN 39 081 678 364
ISBN 1 74036 9297

Managing the breeder herd

Contents

A Quick Quiz to start you thinking

Do I understand the basic principles of my breeding program or are there things I could be doing better? Here is a quick self-assessment guide. Answers are on the last page.

1. The EDGE network is:

a) A group of retired St George Rugby League players who meet twice a year.
b) A manual on keeping garden beds tidy.
c) An acronym for a gardening group in central Queensland—Everyone Does Gardening Everyday.
d) A set of highly developed educational packages produced by MLA to help beef producers manage their business operation.

2. Is the *bull cost per calf* derived by a formula that includes:

a) The price paid for the bull divided by the number of cows he gets in calf each year.
b) The purchase price of the bull less the salvage price when he is culled divided by the number of cows he serves in his lifetime.
c) The purchase price of the bull less the salvage price when he is culled divided by the number of weaners he actually produces during his time in the herd.
d) The average price paid for the bull less the average sale price of the bull divided by the number of years it is kept in the herd and multiplied by the bull percentage used.

3. The minimum scrotal circumference for a 2-year-old bull of any breed in a sale catalogue should be:

a) 28 cm.
b) 34 cm.
c) 40 cm.
d) 46 cm.

4. The single most important factor that determines how long it takes for a breeder cow to get back in calf is:

a) The condition of the cow at calving.
b) The age of the previous calf at weaning.
c) The time of year when she calves.
d) The weight of the cow at weaning.
e) All of the above.

5. Ovulation in the cow occurs:

a) Just before she comes on heat.
b) While she is on heat and allowing the bulls to serve her.
c) 10–15 hours after she goes off heat.
d) None of the above.

6. The gestation period (time from conception to calving) of a cow is approximately:

a) 260 days.
b) 280 days.
c) 300 days.
d) 320 days.

Do I need to read this book?

One of the key activities of Meat and Livestock Australia (MLA) is to ensure that beef producers are able to access and implement the latest research results and management recommendations for their enterprise. A basic understanding of 'why' and 'how' things happen is fundamental to adoption of any new technology.

Leading researchers and extension officers in the various fields have developed a series of educational workshops and comprehensive training manuals, combined into a package called the EDGE*network*. Much of the information contained in this booklet is extracted from *The Breeding EDGE* workshop manual. It was specifically designed to assist producers to develop a breeding program. It utilises basic genetic and reproductive principles and explains modern technologies to achieve desired production targets.

It is the hope of MLA that producers who read this booklet will be better informed on how to manage their breeding herd. Furthermore, it is envisaged that it may encourage enthusiastic operators who are keen to understand their business, to participate in a 3-day *Breeding EDGE* workshop. In a workshop environment, they will explore and develop in greater depth, the basic principles introduced in this booklet—the ultimate aim being to breed more and better livestock.

Introduction

Achieving desired production targets relies on development of a breeding program that utilises genetic and reproductive knowledge and technologies. This booklet introduces primary producers to the concepts of evaluating their personal breeding programs and considering opportunities for improvement.

It commences with a study of male reproduction. This includes the factors that can influence the bull cost per calf, fertility issues of bulls and male structural soundness. Next it examines the female reproductive structure and reproductive cycle, and the annual reproduction calendar.

The section that follows considers reproductive rates, then outlines how to select physically and reproductively sound bulls and how to correctly identify the heifers and cows that producers should retain for breeding and those that should be marketed. There is a brief introduction to the diseases that affect reproduction and how to control them.

The main thrust is managing the herd to capture benefits. The aim of a commercial breeder is to produce one calf per cow each year (i.e. 365-day interval—gestation of 280 days, followed by 85 days to get the cow back in calf). What tools are needed to achieve this goal? There are guidelines on how to identify and recognise existing resources. Producers are introduced to the pasture curve for summer rainfall areas, the nutritional requirements of the breeder cow and the assessment of body condition scoring. The advantages and disadvantages of seasonal and controlled mating and breeder herd segregation strategies are also covered, along with issues such as pregnancy testing, weaning, herd health, fertility problems and animal temperament.

The producer is then introduced to the science behind genetic improvement in the beef industry. Topics include the value of genetics, basic genetic principles, methods and tools for genetic improvement, breeding systems and selecting suitable breeds.

Producers will gain an understanding of how basic genetic principles assist in business, what are the advantages and disadvantages of the methods and tools available for genetic improvement, and how they impinge on various breeding systems. They will learn the fundamentals of developing a breeding objective and identifying the factors that influence traits in meeting breeding objectives, as well identifying animals suitable for attaining those breeding objectives.

Reproduction

Reproduction is probably the single most important factor affecting the economics and profitability of beef cattle breeding operations in northern Australia. For bulls, reproduction is all about the capacity and ability to sire a large number of viable offspring in each mating year. For cows, reproduction is all about the capacity to conceive and rear a calf to weaning each year following puberty. The cow that produces a live normal calf within 365-day calving intervals and rears that calf to weaning is superior to the cow that has longer inter-calving intervals or fails to wean the calf.

Reproduction forms the basis of livestock improvement as it allows the transfer of genetic material from one generation to the next and can greatly influence genetic gain. Independent of growth potential, reproductive function influences the age of the calf and thereby the total amount (kg) of beef turned off at any point in time.

Many factors influence and can impact on reproductive performance. Improved management of reproduction can increase economic returns to cattle producers. In severe environments where nutrition is a major stress factor, improvements of 5–10% in weaning rates are possible through improving nutrition and management. This then provides additional opportunities for implementation of genetic selection strategies in breeding programs to improve profitability. Furthermore, reproductive function can be improved by focusing selection on the economically important criteria and traits related to fertility.

Measuring reproductive performance

Reproductive performance is influenced by a number of independent traits. Measures for the bulls include:

- physical and structural soundness
- scrotal size and sperm production capacity
- semen quality, including morphology
- serving ability/serving capacity.

Measures for the cow include:

- weight and age at first oestrous cycle
- the intercalving interval
- lactation status at subsequent pregnancy diagnosis.

Measures for the breeder herd include:

- conception rates determined by pregnancy diagnosis (PD)
- branding and/or weaning rates
- kilograms of calf weaned per 100 kg of cow mated.

The reproductive performance measures set out in Table 1 can be calculated using the formulae provided.

Table 1. Calculations for reproductive measures

Performance measure	Calculation
Pregnancy percentage	= $\frac{\text{Pregnant females}}{\text{Females joined}}$ x 100
Calving percentage	= $\frac{\text{Calves born within a 12 month period}}{\text{Females joined in previous 12 month period}}$ x 100
Weaning percentage	= $\frac{\text{Calves weaned}}{\text{Females joined in previous 12 month period}}$ x 100
Branding percentage	= $\frac{\text{Calves branded}}{\text{Females joined in previous 12 month period}}$ x 100
Weight of calves weaned per cows joined	= $\frac{\text{Total weight of all calves at weaning}}{\text{Number of females joined in previous twelve months}}$
Kilograms of calves per 100 kg of cows joined	= $\frac{\text{Kilograms of calves weaned}}{\text{100 kg of females joined in previous 12 month period}}$

Limitations to the above measures include:

- fertility cannot be assessed directly for bulls
- pregnancy status for cows requires skills in pregnancy diagnosis, which should be coupled with an assessment of lactation status
- branding and weaning rates (in isolation) do not provide indications of when or where reproductive losses may be occurring
- unless birth dates are known and a restricted joining period used, a slight ‘creep’ in inter-calving interval can often be overlooked
- it is important to consider that these rates must be calculated for a standard or specific period of time (e.g. 12 months) to allow accurate analysis and comparison. This is difficult in a herd where controlled mating is not carried out, as distinctions between calving periods become blurred.

Benefits of calculating reproductive rates

Calculating a number of reproductive rates can help to identify areas of loss. A combination of pregnancy diagnosis, lactation status, branding rates and weaning rates will help to determine stages and possible causes of low herd fertility and assist in the following:

- identifying the importance of age, weight, body condition and lactation status impacts on herd fertility
- identifying how management, nutrition and breeding practices can be modified to optimise fertility
- making an assessment of whether disease status of both cows and bulls may be interfering with herd fertility.

Bull costs per calf weaned will depend on: 1) purchase price (or production cost of home-grown bulls); 2) bull salvage value at ultimate sale; 3) number of breeding seasons that involve the bull; 4) bull mortality rates; 5) number of cows per bull; 6) weaning percentage achieved; 7) whether bulls are checked annually for soundness and fertility.

Table 2 provides three scenarios of bull cost per calf calculations: Scenario 1 is a ‘typical’ herd bull cost and lifetime calf output. Scenario 2 uses the same bull costs with improved calf output, while Scenario 3 uses the same cost/calf as Scenario 1 but employs the better management decisions associated with Scenario 2. This inturn allows a producer to spend more on genetically superior animals.

Table 2. Bull cost per calf calculations

	Scenario 1	Scenario 2	Scenario 3
Bull purchased cost ($)	2,500.00	2,500.00	3,880.58
Transport ($)	100.00	100.00	100.00
Landed cost ($)	2,600.00	2,600.00	3980.58
Bull mortality rate %	3	3	3
Effective bull cost	**$2,675.00**	**$2,675.00**	**$4,100.00**
No. mating seasons used	4	5	5
Bull % used	4	3	3
No. cows mated per bull/year	25	33	33
Weaning rate (%)	75	80	80
Calves per breeding lifetime	75	132	132
Salvage value of bull ($)	800.00	800.00	800.00
Net bull cost	1,875.00	1,875.00	3,300.00
Bull cost per calf	**$25.00**	**$14.20**	**$25.00**

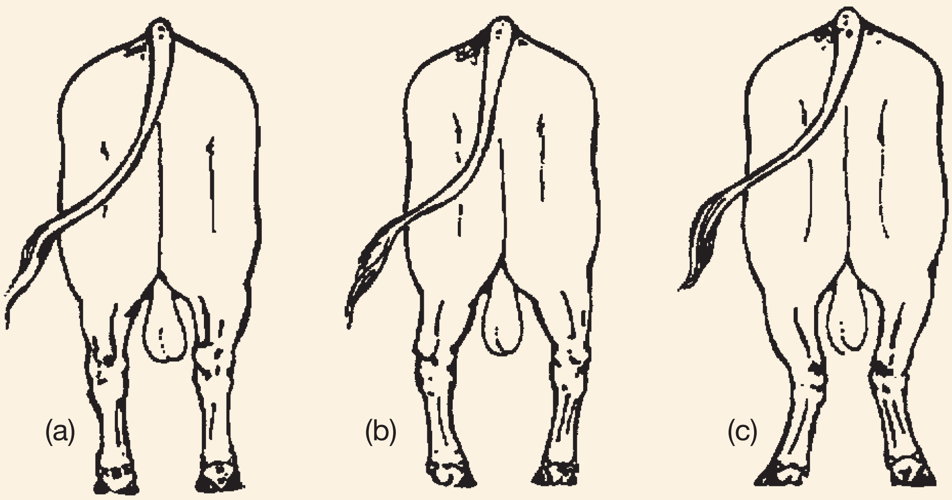
Key components of bull fertility

While there is no single criterion or test for a reliable and consistent measure of the fertility of a bull, a bull breeding soundness evaluation (BBSE) can be used to distinguish infertile or sub-fertile bulls from those that meet satisfactory fertility standards. The BBSE involves assessing four key components—physical (structural) soundness, scrotal size (functional testicles), semen assessment (including morphology where appropriate) and serving ability—to provide an indication of likely fertility.

Physical (structural) soundness Assessing a bull's structural soundness should include a systematic examination of eyes and surrounding areas, jaws, mouth and teeth, limb structure, joints, stance, gait (at trot), hoof and claw structure.

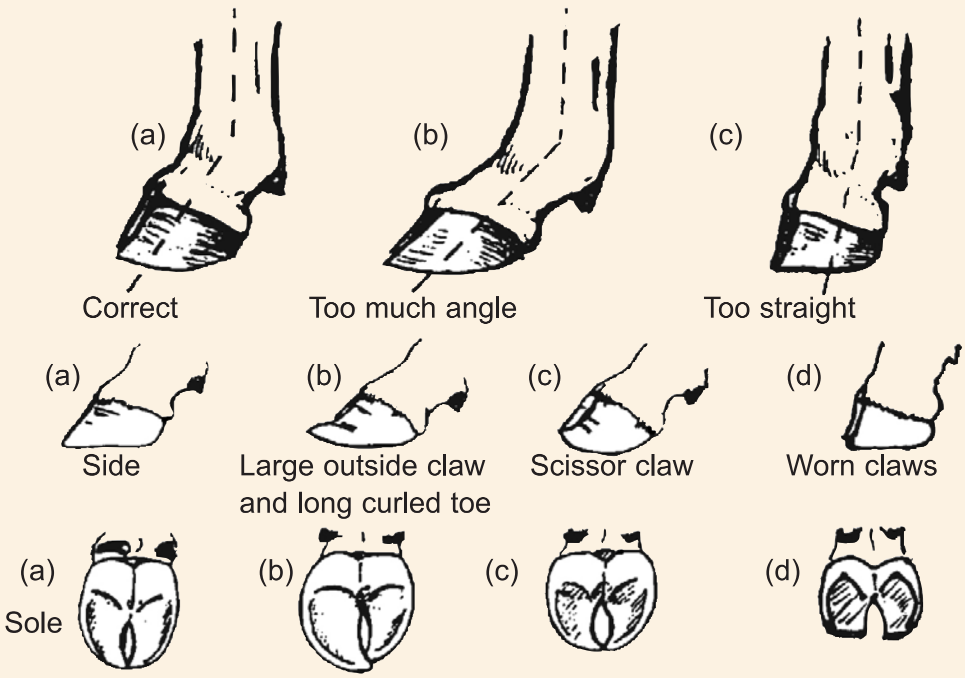
Common problems (Figure 1) include post legs (excessively straight), sickle hocks (standing under), swollen and puffy hocks, bow legs and cow hocks. Leg and foot structures are moderately heritable. Likewise any structural defects are passed on to offspring.

Figure 1. Common leg and feet problems



Hind limb conformation
(a) normal (b) bow legged (c) cow hocked.

Figure 1. cont.

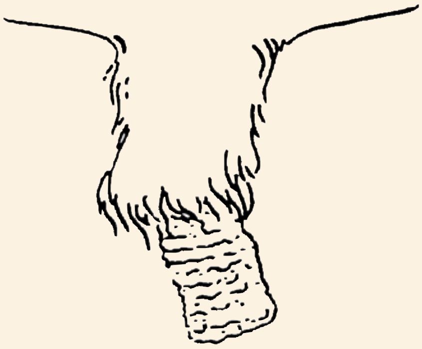


Source: Bertram (ed.), 2003, *Bull Selection: An aid for beef producers for Buying Better Bulls*, Queensland Department of Primary Industries (QDPI).

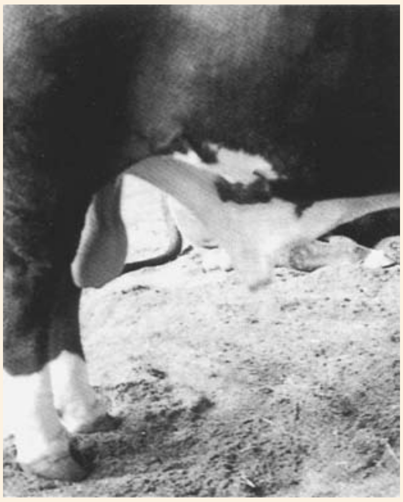
A broad understanding of male reproductive anatomy and physiology is needed to implement sound bull management programs that enable genetic progress. Close inspection of bulls prior to purchase will eliminate the more obvious structural and reproductive defects, and where possible bulls should be purchased subject to a BBSE.

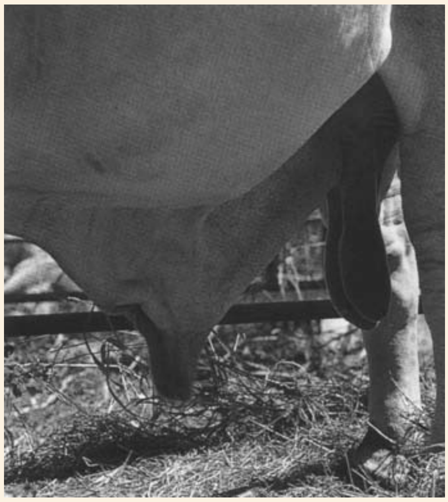
Sheath, prepuce and penis The penis is housed within the prepuce and sheath. The prepuce is the inner lining of the sheath and is the pink mucosa, seen at the end of the sheath (a protective structure of skin covering the prepuce, which extends internally from the opening point or hairline and attaches to the shaft of the penis). Figure 2 shows some structural problems that can occur.

Figure 2. Sheath and penis structural problems



Above: Everted preputial mucosa





Left: desirable Right: undesirable

Source: Bertram (ed.) 2003, *Bull Selection: An aid for beef producers for Buying Better Bulls*, Queensland Department of Primary Industries (QDPI).

Measuring scrotal circumference Scrotal size (Table 3) is a useful criterion for assessing bull fertility for the following reasons: it is easily measured and is repeatable, and can take place at a younger age than most other male traits; it is related to a bull's own fertility, and is a highly heritable trait that influences the scrotal size of male offspring. Finally, it is genetically correlated—scrotal size in a sire is positively related to scrotal size of his male progeny, and also earlier puberty and enhanced fertility of his female progeny.

A north Queensland study using Droughtmaster cattle found that bulls with larger scrotal size per kilogram liveweight (an extra 1.6 cm at 12 months of age) were from a line of cows that had a 9% higher pregnancy rate and an 18% improvement in fertility in the lactating cows. In addition, progeny from higher fertility cows were born 16 days earlier than the low fertility line.

Acceptable standards for scrotal size for different breeds are now established. Good information is available for *Bos taurus* bulls, but not yet readily available for *Bos indicus* bulls. The major factors influencing scrotal size include: genotype, age, liveweight, nutrition, and timing of nutritional stress.

Table 3. Scrotal circumference threshold levels

Scenario	Age months	Scrotal size (SS) threshold (cm)
Bos taurus and *Bos indicus* derived bulls on moderate to good nutrition	12–15	30
	18	32
	24+	34+
Bos taurus and *Bos indicus* derived bulls on a poor to marginal plane of nutrition	24+ (weight range 300–350 kg)	28

Common conditions that interfere with fertility and can be diagnosed by palpation of testicles include:

- unequal size of testicles
- softness and flabbiness of testicles and tail of epididymis
- hardness of one or both testicles
- thickened scrotal skin.

Semen and spermatozoa

A semen sample is often collected as part of a routine BBSE conducted by a veterinarian and examined crush-side under a microscope to assess factors such as volume, colour, density and motility. Often a sample is taken for later laboratory examination to determine the percentage of normal spermatozoa and, in the case of semen for artificial breeding, for the percentage of live normal spermatozoa (this helps to determine the number of cells available for dilution to be placed into straws).

Trials in north Queensland have concluded that the percentage of normal sperm is the most important semen characteristic of a bull going into natural mating, and is an accurate forecast of his paddock fertility.

Libido and serving ability

Bulls vary widely in their capacity to sire offspring. Libido is the sexual desire of a male to serve a receptive female, and in trials conducted as part of the *Bull Power* project in north Queensland, numbers of mounts, mounts plus serves and libido score of bulls that had passed a reproductive examination (palpation, semen examination and considered structurally sound) were found to be positively related to calf output in multiple sire matings.

The incorporation of serving-capacity testing as part of the breeding soundness examination enables the producer to first identify bulls that are able to serve (free of penile and structural abnormalities) while reducing the risk of bull failure in single sire matings. The aim of conducting a consistent, standard serving capacity test is to make comparisons between bulls, across locations and between years.

The serving-capacity test provides an indication of the bull's ability to serve. This includes an assessment of structural soundness (legs, feet, sheath, penis and anatomy). The serving capacity test is a measure of the sex drive (libido), or eagerness of the male to seek out a female on heat, and provides information about one of the many traits that influence calf output. The test is based on the number of times a bull will mount and successfully serve a restrained female (over a 20-minute period for *Bos indicus* bulls and a 10-minute period in *Bos taurus* bulls). Bulls are stimulated by allowing access to stationary standing females (as displayed by females in oestrus). In addition to the visual cues, the presence of pheromones in the females or oestrus leads to the flehman response (flaring of nostrils while sniffing the air) in the bull and arousal of its interest in the female.

Other factors affecting bull fertility

Sexual maturity Puberty is defined as the time when a bull is capable of producing 50 million live sperm per millilitre. In contrast, sexual maturity is the combined effects of both semen production (50 x 10^6 and 70% normal spermatozoa) and the ability to achieve one serve, which is necessary in the herd mating situation.

The testicles usually grow steadily between about 7–10 months of age (a little later in Bos indicus bulls), though other male structures such as the penis and prepuce grow at different rates. The testicles grow more rapidly after 7–10 months of age until 18–24 months of age, during which puberty occurs.

Puberty in bulls is usually reached by between 14–18 months, but it can be reached at a younger age in more fertile animals. Factors influencing when bulls reach puberty include:

- genetic effects (later in *Bos indicus*)
- nutritional influences (poor nutrition delays the onset of puberty, conversely over-fatness may also influence pubertal development).

Diseases In bulls, diseases may be transmitted venereally (through sexual intercourse) to females, affecting female fertility, or may indirectly affect male fertility. Diseases carried by bulls, and which affect herd fertility, include vibriosis (campylobacteriosis), trichomoniasis and infectious bovine rhinotracheitis (IBR). Vibriosis and trichomoniasis are the two most common diseases affecting herd fertility.

Nutrition The nutrition regime that bulls are subject to throughout their life affects their fertility, and also their ability and desire to serve females. Bulls fed on grain diets or those having surplus protein and energy often have fat deposits in the neck of the scrotum. This can limit the normal testicular function of thermoregulation and result in poorer quality semen. In addition, grain diets can produce swelling in the joint capsule of the hocks in some bulls. Grainfed bulls frequently become lethargic during mating activities.

Bulls raised on diets low in digestibility, protein and/or energy frequently have a smaller scrotal size at a given age, with a corresponding effect on sperm production and quality.

Bull wastage Bull wastage (or premature breakdown) can increase bull cost per calf, as it decreases the number of calves produced over the lifetime of the bull. Such wastage can be due to a large number of factors, including:

- structural defects resulting in lameness and sometimes inability to serve
- degenerative conditions (such as arthritis) limiting serving ability
- age structure in the bull team, with increased proportion of physically unsound older bulls
- reproductive abnormalities, particularly in the testes, penis and prepuce
- infertility due to testicular degeneration, the incidence of which increases with age
- infertility due to disease effects
- traumatic injuries due to fighting.

It is therefore important to keep the age of the bull team as young as possible, not only to gain benefits from genetically superior sires, but also to ensure the highest level of fertility in the team by eliminating older and unsound bulls. Older bulls tend to be heavier and more dominant, and if they are less fertile this has an adverse effect on herd reproductive rate.

Production losses due to the failure of a bull to reproduce can make this an expensive situation. The most frequent problem is sub-fertility (58% of bulls in the Bull Power project sired less than 10% of calves). This means the majority of bulls may not contribute significantly to the herd reproductive rate, and thus do not pass on their desirable growth or carcase traits.

A veterinarian should carry out a BBSE to examine bulls for soundness—prior to sale or purchase, and annually for existing bulls. Such an examination involves:

- checking that the bull's overall structure including legs, feet and external reproductive organs are free from defects
- assessing the sheath, scrotum and testicles
- measuring and recording scrotal circumference to ensure it is within the acceptable limits
- palpating of the testicles to check for normal tone, size and function
- collecting a semen sample and a microscopic examination and assessing the quality and percentage of normal sperm,

Bull buyers should seek the Australian Association of Cattle Veterinarians (AACV) Breeding Soundness Examination Certificate of Approval, designated by the AACV symbol in association with the following categories: 1) scrotal size; 2) physical; 3) semen; 4) morphology; and 5) serving.

Bull buyers should be aware that the sale and relocation process may temporarily impair fertility. This may be due to the bull's exposure to diseases not previously experienced, poor nutrition or stress. For this reason, bulls should be purchased at least two months before mating, to allow them time to acclimatise (let down) in the new environment before mating commences.

Female reproduction

Reproduction in the female is hormonally driven and influenced by genetics, nutrition and management factors. Unlike the bull, the female is born with her lifetime quota of 'ova', which she sheds during oestrus cycles throughout her reproductive life. The female has limited opportunities to pass on her genetics to the progeny, with a maximum of 8–12 calves per breeder.

Reproductive events in the female are marked by:

- expression of oestrus (heat) in the presence of a fertile male
- ovulation and fertilisation of the ovum (egg)
- implantation, growth and survival of the embryo and foetus
- maintenance of pregnancy
- birth and survival of a viable calf
- adequate lactation for calf survival and good calf growth through to weaning
- early return to reproductive activity after calving to achieve the next pregnancy.

The effects of nutrition overlay the basic genetic differences for reproduction between breeders. In northern Australia, under-nutrition is most frequently the limiting factor. This means that timing of mating and of calving should be closely related to seasonal conditions.

Key components of female fertility

Structural soundness In the breeder herd structural soundness is associated with increased longevity, decreased breakdown, and the production of turnoff cattle and replacements that are less likely to break down.

Assessment prior to mating should focus on obvious structural faults that will impede the animal and its progeny from functioning normally and effectively. Selection for female structural soundness should focus on the following areas: eyes, mouth, hind limbs, feet and claws, gait, joints, udder and teats, and pelvic structure (width, height and pelvic area).

The female reproductive cycle

Successful reproduction involves cycling (regular heat periods), mating, conception (fertilisation of the ovum), gestation (pregnancy), parturition (birth) and lactation (suckling the calf).

Sexual maturity Puberty in the female is defined as the age (or weight) at first oestrus when ovulation also occurs. This is the age/weight when reproduction can occur—in other words, the onset of sexual maturity.

Recently researchers have scanned ovaries for follicular development, revealing that many crossbred heifers are first ovulating at a younger age than pure *Bos indicus* heifers.

In tropical beef cattle, nutrition is the major factor influencing puberty. As indicated earlier, wide variations in nutrition, particularly in the immediate post-weaning period (first dry season), influence the rate of sexual development and hence age and weight at which puberty occurs—as a general rule the harsher the conditions and the poorer the nutrition, the longer before the onset of puberty. To achieve desired weights of 280–300 kg at the time of first mating, ensure that heifers have reasonable weight gains post-weaning.

Female progeny from sires with larger scrotal size tend to reach puberty at a younger age and have higher pregnancy rates. (This concept is covered in the section on male reproduction.) Selection for scrotal size (moderately heritable) will have a long-term indirect effect on age of puberty and fertility in heifer offspring.

Females reaching puberty at an earlier age have the potential to produce an extra calf over their reproductive life. However, this benefit does carry some potential risks. Conception at a younger age means smaller pelvic opening and increased risk of calving difficulty.

A number of physical changes in the reproductive tract occur at different stages in the cycle. There are also behavioural changes during the oestrus cycle, which are useful diagnostic aids. Signs of oestrus include:

- behavioural changes (i.e. chin resting, mounting and being mounted by other animals, congregation into groups of oestrus cows, restlessness and bawling)
- swelling and reddening of the vulva
- vaginal mucus discharge adhering to tail and legs
- abrasion of skin and rub-marks on tail heads and pin bones
- ruffling of tail hair
- increased tone in the uterus and cervix on palpation.

More care in oestrus detection is needed for cattle of *Bos indicus* origin or content, because in these breeds duration of oestrus is usually shorter and more variable, and intensity of oestrus displayed is often lower. Signs of oestrus, particularly behavioural signs, are not as well displayed as in other breeds/strains.

The average duration of oestrus is 6–18 hours; being slightly shorter for heifers. The length of oestrus is affected by:

- breed (shorter in *Bos indicus*)
- nutrition (higher incidence of short cycles in poorly fed cows which eventually become anoestrus (sexually inactive)
- temperature stress
- age (shorter and less variable in heifers)
- transport stress (increase in number of short cycles)
- ovarian abnormalities (either increased or decreased cycle length)
- uterine infections (increased cycle length).

In cattle, ovulation occurs 10–15 hours after the end of oestrus, with heifers tending to ovulate a little earlier than cows. Behavioural oestrus (heat) may recommence from 35–45 days after calving. This interval is highly variable and is influenced by lactation level (lactational anoestrus frequently observed in *Bos indicus* cows), suckling and nutrition (much longer in poorly fed cows).

Pregnancy In the progressive stages of pregnancy the embryo leaves the fallopian tubes (oviduct) and enters the uterus at about day six or seven, attaching to the uterine wall a few days later. Ultrasound examination of the reproductive tract from about 21 days after mating will detect the presence of fluid in the uterus. Over the next 10–15 days fluid increases and the developing foetus can be identified.

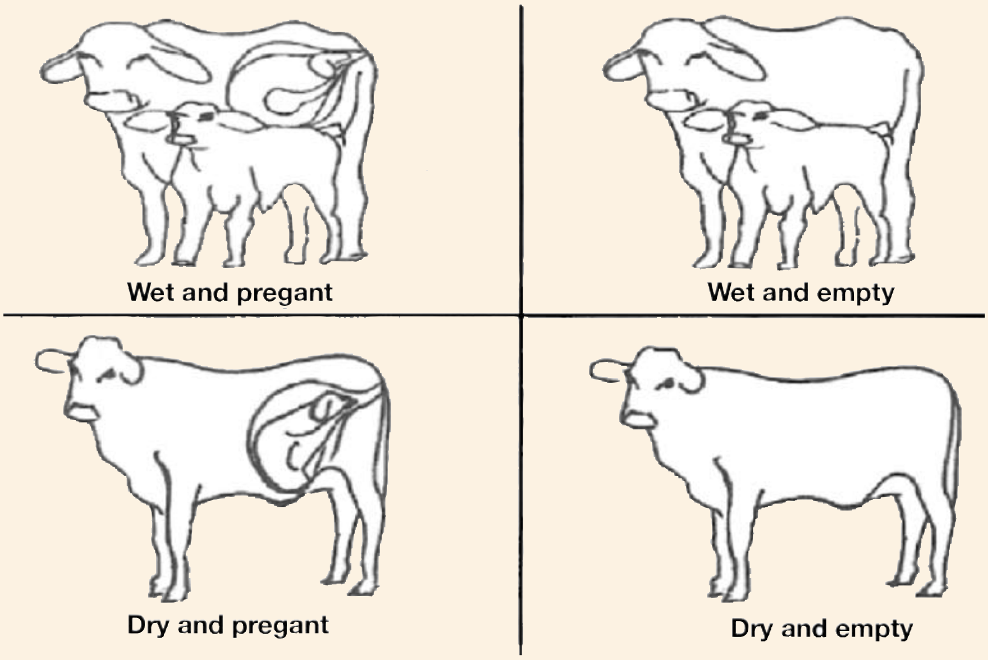
The embryo develops in one horn of the uterus and the placenta then enlarges and spreads to both horns. The caruncles in the uterine wall attach at the site of the 'cotyledons' scattered around the placenta. From about six weeks after mating, rectal palpation by experienced operators will enable an accurate diagnosis of pregnancy (or non-pregnancy) and stage of pregnancy. These diagnoses are based on physical changes and progressive increases in size of the uterus and foetus, position in the pelvic cavity and later in the abdomen, and on palpation of the placenta and foetal parts and size.

The duration of pregnancy in cattle (gestation period) ranges from 270 to 295 days (average of 282 days). However, there are some breed and sire-within-breed variations. *Bos indicus* cattle normally have a longer gestation period—about 290 days.

Longer-than-average gestation periods may result in larger calves at birth, and in some cases this leads to calving difficulty. The timing of calving is also partly heritable. This means that gestation length (and hence calf size) can be slowly altered by selection.

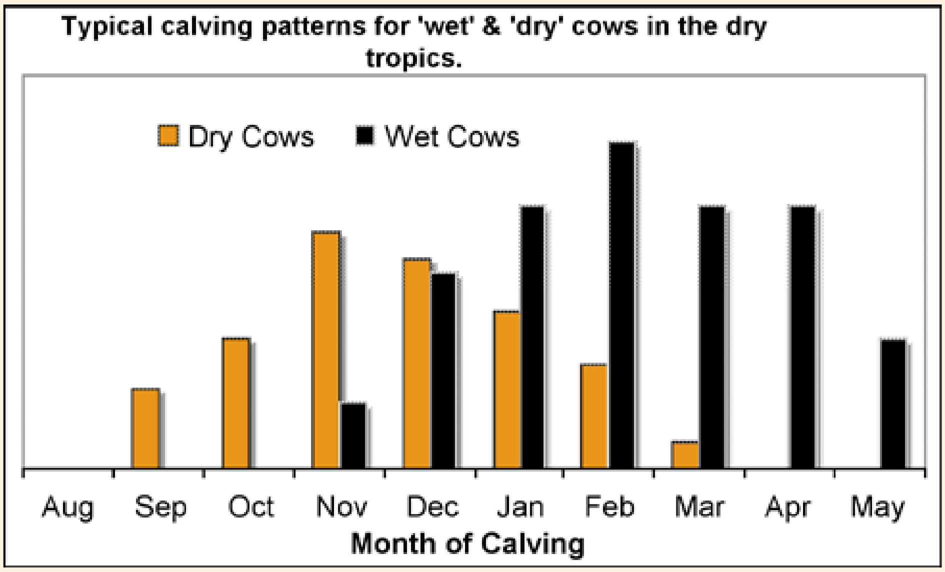
Pregnancy testing of the breeding herd each year is the most cost-effective tool a grazier can implement to adequately manage herd fertility. Figure 3 illustrates that in northern Australia, in a continuously mated herd or in herds with extended joining periods, there will be four basic categories of breeders: wet and pregnant (usually store condition or below); wet and empty (usually store condition or below); dry and pregnant (usually forward store); dry and empty. (usually forward store to fat).

Figure 3. Basic categories of breeders



In continuous mating herds in the north Australia, the dry cows tend to conceive early in the season as they are in better body condition and the lactating (wet) cows conceive as illustrated by the graph below (Figure 4).

Figure 4. Monthly calving patterns of cows wet and dry in subtropical areas of Australia.



To get the most out of pregnancy diagnosis, insist on a full fertility profile based on foetal aging. From this an 'expected time of calving' graph can be constructed that will identify areas of economic loss in the herd—a valuable management tool. Pregnancy testing may be carried out for a number of other reasons, including:

- identification of animals that are not pregnant at a certain time for culling and disposal
- estimating stage of pregnancy for purposes of breeder herd segregation or selling of stock
- assessing nutritional requirements of animals in relation to the season
- estimating future management requirements, stock numbers and turnoff rates and times for different classes of stock.

The options for retaining or culling will range from:

- retaining all pregnant females
- retaining only lactating pregnant females
- retaining only those pregnant or lactating females that are expected to wean a calf within a defined period.

Depending on the location and climatic variation, the percentage of females categorised as being 'wet and pregnant' will vary widely, from about 80 per cent, but down to 20 per cent in the harsher environments.

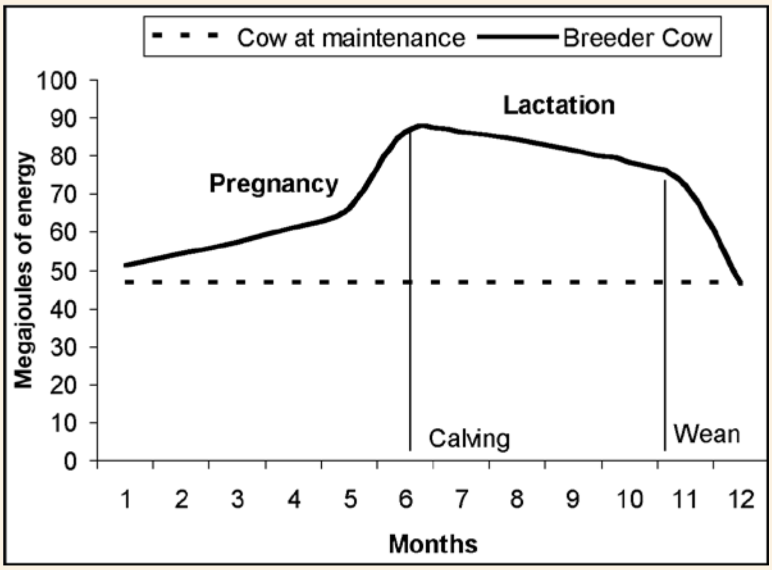
The opportunities to retain only pregnant females in the breeder herd are greatly reduced in harder environments. Providing the breeder mortality rates are low, management efforts will concentrate on increasing the percentage of wet-and-pregnant breeders in the herd.

Post calving About 35–45 days after calving the reproductive tract and ovaries of a cow should return to normal and reproductive cycles recommence. However, in many northern herds this period is prolonged; some cows do not recommence cyclic activity for up to 7 months after calving. In some breeds it is even longer. The condition is known as post partum anoestrus (PPA) (ovarian inactivity), and it is a major factor influencing the level of fertility in many northern herds.

If a breeder cow is to achieve the ultimate goal of conceiving each year (and calve at the right time) she must recommence cycling and become pregnant within 85 days of calving (85 days + 280 days gestation length = 365 days).

Nutrition is the most important non-genetic factor influencing conception in beef cows. The feed and energy requirements for cows escalate during late pregnancy as energy is needed for maintenance, foetal development and mammary gland development. After calving, energy needs of the breeder remain very high due to maintenance, growth (in first calf heifers), milk production and recommencement of reproductive activities. The energy requirements of the breeder cow can be illustrated in the graph shown in Figure 5.

Figure 5. Monthly energy requirement for a breeder cow.

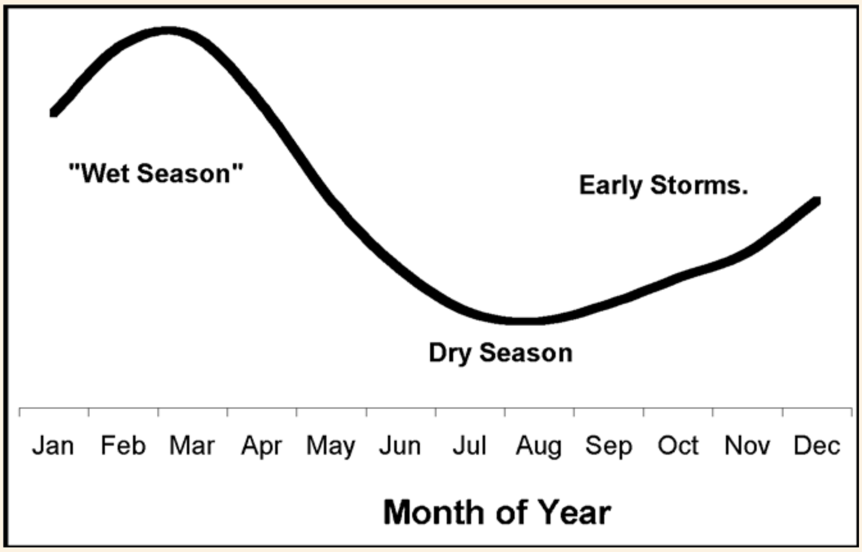


In all breeder cows, there is a conflict between high milk production capacity and reproductive performance. The nutritional stress placed on the cow in producing milk for her calf can often affect her ability to cycle and get back in calf within the required timeframe.

Annual reproduction cycle Timing of activities and events must be planned to coincide with environmental influences, such as rainfall and (to a lesser extent) temperature, to ensure that pasture growth meets the nutritional requirements of the breeding herd. The exact timing of different activities will depend on location, seasonal conditions and management systems.

The typical pasture quality curve for a summer rainfall, as shown in Figure 6, describes what is normal in most northern regions of Australia.

Figure 6. Likely pasture quality curve for northern Australia

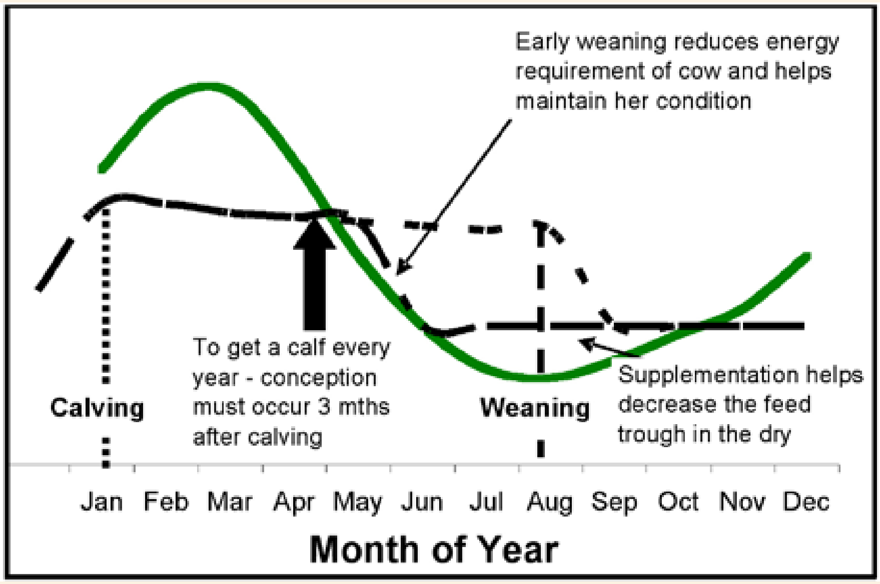


Demands for protein in breeding cows mimic the demands for energy, i.e. increasing slowly during pregnancy with the greatest demands in the few months post-calving, after which the calf is weaned and lactation declines. **At peak lactation a cow will need to consume up to twice the energy she does as a dry cow, and up to three times the protein.** Ideally, this demand should be matched by pasture quantity and quality and/or supplementary feed. There is a small window of opportunity for functional breeder cows to conceive within 85 days post-calving and after recommencement of cyclical activity.

By superimposing the two graphs, the problems confronting cattle breeders in the north of Australia become quite apparent. The average gestation period is 280 days. Assuming a beef cow has a minimum ‘calving to first heat’ interval of about 55 days, i.e. 335 days in total, this leaves only about 30 days, or just 1.3 heat periods in which to conceive if the ultimate aim is to achieve a calf every 12 months—a very small window of opportunity in which to operate.

If this critical period is synchronised with the feed-availability curve, then the chances of achieving this goal are enhanced—the normal situation in reliable rainfall areas. However, if the planned conception time coincides with a nutritional trough, then there is little chance that the cow will get back into calf within 85 days or three months of calving and the inter-calving interval will exceed 12 months. In addition, the timing of calving and lactation to coincide with peak pasture conditions will minimise the need for supplements to meet this nutritional demand.

Figure 7. Breeder energy requirements in relation to pasture nutrition available, indicating the difficulty of failing energy at joining



Managing the breeding herd

Under the often harsh conditions experienced in northern Australia, the discrepancy between nutritional demand on one hand and nutritional availability on the other can place the lactating cow under such stress that she has difficulty in maintaining nutrient supply for reproductive functions—with a consequent reduction in fertility. In extreme cases she may even die as hormonal regulation directs energy towards lactation at the expense of body maintenance.

In younger growing cattle, growth rates are naturally correlated with pasture quality and availability. Heifers have to reach a threshold body weight to conceive. Thus growth rates are the key determinant on age at first joining.

The single most important determining factor in reproductive management and getting a cow back in calf is the condition score of the breeder cow at calving. The most cost-effective method of doing this is to match the nutrient requirements of the cow with the availability of the pastures—not always easy, but it is a goal worth striving for.

Body condition scoring

The best practical assessment of nutritional needs of reproducing beef cows is through assessing changes in body condition scores. Table 4 describes a five-point scale for condition scoring. Table 5 demonstrates the likely conception rates at various levels of body condition. A cow needs to be in condition score three or better at calving in order to have the best possible chance of conceiving again within 85 days of the calf's birth. Cows at the extremes of the condition score range (emaciated; fat) will have lower fertility than those cows in the mid-range.

An assessment of body condition score in conjunction with an assessment of available nutrition will allow strategies to be developed to meet nutritional requirements. Options to achieve this include: 1) supplementation; 2) grazing management and adjustment of stocking rates; 3) paddock rotation; and 4) weaning to reduce nutritional demand of the breeder.

Table 4. Body condition scoring (BCS) system for beef cattle

BCS	Description
1.0	**Emaciated –** Bone structure of shoulder, ribs, back, hooks and pins sharp to touch and easily visible. Little evidence of fat deposits or muscling. 
2.0	**Thin –** Beginning of fat cover over the loin, back and fore ribs. Backbone still highly visible. Processes of the spine can be identified individually by touch and may still be visible. Spaces between the processes are less pronounced. 
3.0	**Moderate –** 12th and 13th ribs are not visible to the eye unless animal has been shrunk. The transverse spinous processes can only be felt with firm pressure to feel rounded – not noticeable to the eye. Spaces between the processes not visible and only distinguishable with firm pressure. Areas on each side of the tailhead are fairly well filled but not mounded. 
4.0	**Good –** Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over ribs and round tailhead. 'Rounds' or 'pones' becoming obvious. Some fat around vulva and in pelvis. 
5.0	**Fat –** Cow has lost definition. Contours disappear across back and sides as cow takes on a smooth, block-like appearance. Tailhead and hips buried in fatty tissue and look blocky; 'rounds' or 'pones' of fat are protruding. Bone structure no longer visible and barely palpable. Large fatty deposits may even impair animal's mobility. 

Source: Adapted from Kunkle et al, 2003. Photo sourced and reproduced with permission from NSW Agriculture. McKieman, B., *Visual and manual assessment of fatness in cattle*, NSW Agfact.

Table 5. How pregnancy rate of lactating breeders changes as body condition increases

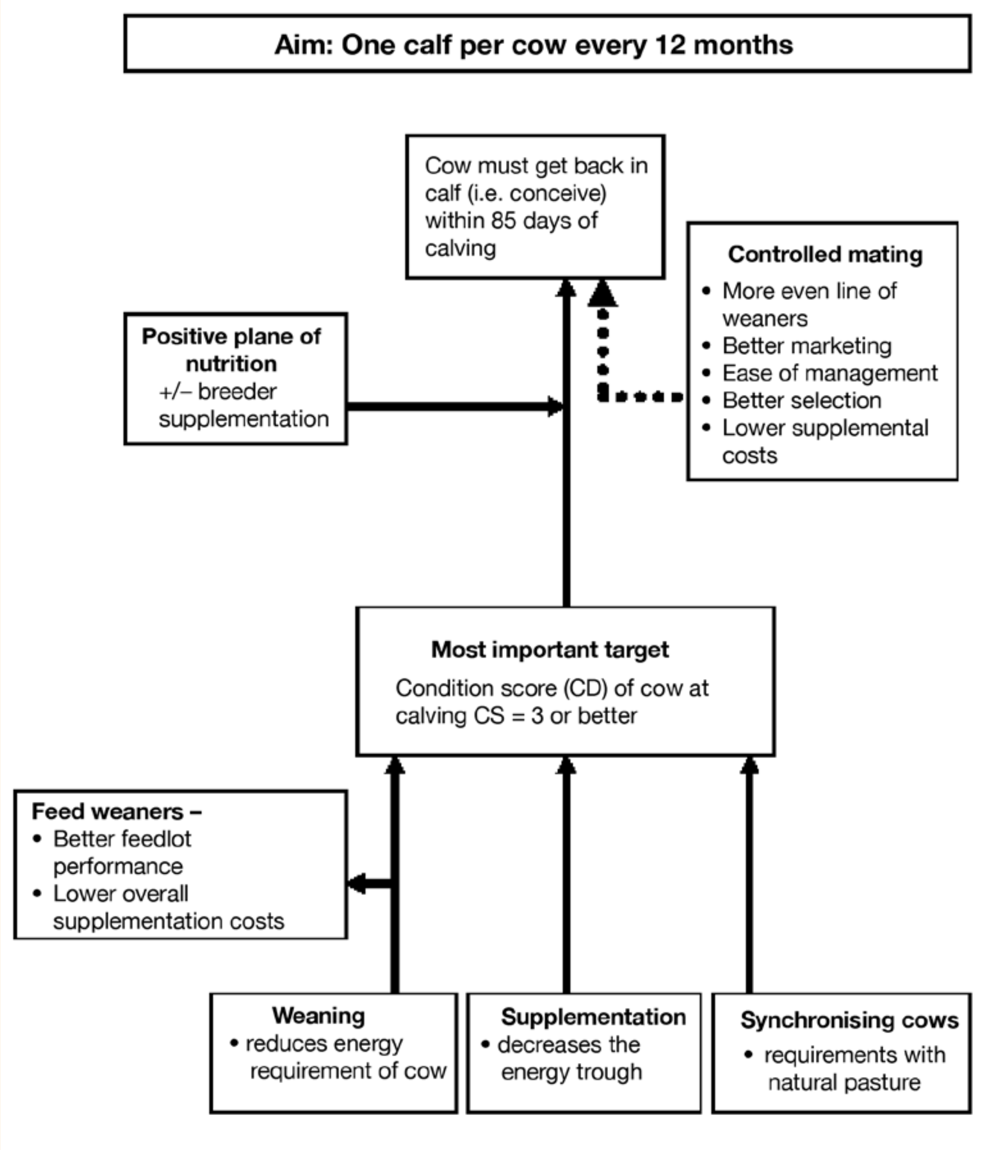
Liveweight/Body condition score (example for typical crossbred breeders)		Expected pregnancy rate (%) (in coming year)
300 kg	Poor	0–40
330 kg	Backward store	20–50
360 kg	Store	40–80
390 kg	Forward store	60–90
420 kg	Prime	80–95

Breeder energy requirements

Maintenance of condition scores of breeder cows at 3 and above at parturition should be the most important goal and management tool for producers. There are two practical techniques available. One is to reduce the nutritional trough by the use of supplements. In northern Australia, protein supplements, and especially non-protein nitrogen (NPN) supplements such as urea-based mixes, are the most economical means available.

The second form of 'supplementation' is weaning. Avoiding excessive loss of condition from the breeder cow during her current lactation will help to ensure she is in reasonable condition at calving. In many areas early weaning is the most practical form of supplementation of the breeder cow. Weaning the calf will reduce the energy requirement of the dam by almost half—but it also means that special supplements containing 'by-pass protein' will be needed to sustain the young weaner so it suffers no disadvantage from having its milk supply terminated. Figure 8 depicts the determining factors in reproductive management. In most circumstances it is cheaper to feed the weaner than to supply supplement to the lactating cow.

Figure 8. Determining factors in reproductive management



Over 20% of the weaners in this mob of 50 are late calves—representing a loss of approximately $2000—they never catch up.

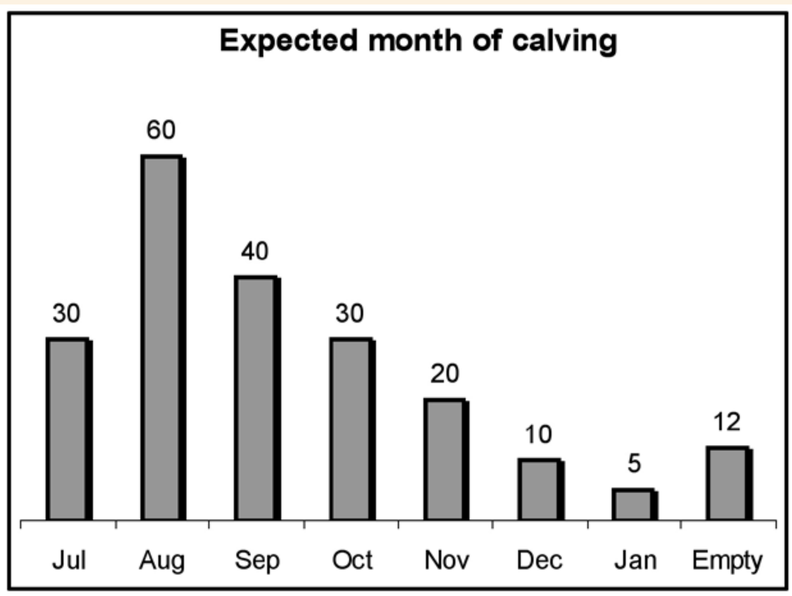
Controlled Mating

Seasonal or controlled mating involves limiting the mating period by removing bulls from the breeding herd. It is often used in more favoured areas with more reliable seasonal conditions and 100% bull control. If it can be incorporated into a breeder management system it allows:

- timing of calving and weaning to seasons where conditions are most likely to be favourable (minimising dry-season lactation)
- more even lines of weaners to be produced
- easier management, including better scheduling of mustering times
- pregnancy testing to be carried out at a time which affords maximum benefit in terms of accuracy and animal welfare
- comparison of growth rates of weaners without the need to allow for out-of-season calves.

Figure 9 below illustrates the type of information that can be obtained if the stage of pregnancy is known. For an August calving herd in southern Queensland, a calf born in December will weigh over 100 kg less than one born in August and be worth around $200 less. Being able to condense the calving pattern can increase the value of sales by anywhere from $2000 to $8000 in a 100-cow breeder herd, depending on the number of late calves in the herd.

Figure 9. Information available if the stage of pregnancy is known



Controlled mating is really the ultimate goal in breeder cow management, if it can be achieved economically. The following hints may help.

- Removal of bulls on a particular day is not essential IF pregnancy testing with foetal aging is performed at the appropriate time of the year. This will provide a safety net in case of bull failure, and the producer doesn't have the worry of bull security for such a long period of the year.
- A good heifer management program to ensure heifers are aligned with the main breeder herd right from the start will help ensure a compact calving.
- Implement a good bull testing (BBSE) program.
- Gradually change from a continuous calving pattern to a compact joining period over a number of years—do not try to change in just one or two seasons.
- Early weaning and breeder supplementation may be required in drought years.

Heifer management is the key

A heifer that calves late initially will always calve late or will miss out on getting back in calf.

Heifers that are to calve at 2 years of age (yearling mating) should be:

- *mated to calve 2–3 weeks ahead of the mature cows*. Heifers with a calf at foot are always the hardest to get back in calf and mating a little earlier as maidens gives them an extra cycle in which to get pregnant again.
- *mated for only 6–9 weeks*. If they are above their critical mating weight, in good condition, on reasonable feed and with bulls of satisfactory mating potential, then over 80 per cent should conceive during that period. It is best practice to over-mate by about 25 per cent and perform the final cull on the outcome of the pregnancy test.
- *at or above the critical mating weight*, i.e. approximately 280 kg liveweight for early-maturing breeds and up to 325 kg liveweight for late-maturing breeds. This may require supplementation in some years or a special paddock after weaning so they achieve their targets.
- *pregnancy-tested 12 weeks after the start of mating*. If replacement numbers are sufficient, then cull those that do not become pregnant in the first six weeks.

- *fed for good growth through to calving*, but watch that they do not become too fat—Condition Score 3 (forward score) is ideal.

Calving problems are always worse in maiden heifers—they can be minimised by choosing low birth weight bulls, taking pelvic measurements of the heifers and monitoring the plane of nutrition during pregnancy. 'Spike-feeding' maiden heifers with additional protein in the later stages of their pregnancy will improve conception rates after they calve.

Yearling mating is not always practical or economical where pasture conditions are not good enough to attain critical mating weights by 15 months of age.

First calvers and mature breeders Once the calving pattern has been set, there are techniques available to help maintain it. Some of these include the following:

- **first-calf heifers are the most difficult breeders to get back in calf as they are still growing as well as producing milk etc.**
- aim to have cows calve out in Condition Score 3 or above (If they calve at less than 2.5 then the calving-to-conception period will be extended. In some years early weaning can be used to help maintain the condition on the back of a pregnant cow.)
- if the spring is dry, then a protein supplement can be fed to help improve conception rates
- have in place an adequate vibriosis/leptospirosis program
- ensure adequate 'bull power'.

Breeder management in continuously mated herds

In harsher areas the benefits of seasonal mating (other than for heifers) are not as apparent, though it will minimise dry-season mating, with majority of cows calving and lactating during the pasture growing season. In these situations a 6–8 month mating may be a better alternative to a continuous mating system. However, for many large extensive herds, restriction of mating by bull removal has practical difficulties, and may not be applicable.

Another approach, which is being employed more commonly, is to apply breeder-herd segregation strategies. In some ways this can be seen as the extensive northern beef herd equivalent of seasonal mating, though it may not be useful in all situations, and requires pregnancy diagnosis to be done routinely.

On many extensive properties the breeding herd is segregated in paddocks by age (or groups of ages). The principle in a segregated breeding herd is that cows are segregated according to their ability to annually produce a calf at the best time of the year. If a cow falls out of this pattern (e.g. late calf), foetal aging at pregnancy diagnosis enables the cow to be segregated into a different herd, which calves at a different time.

While traditionally cows are culled largely on age, the situation is a little different in segregated herds. Since culling emphasis is on fertility and functionality rather than just age, those remaining in the herd are very productive, and have the best genetic attributes. The advantages of this strategy are:

- easier management, since segregated mobs have similar age groups of calves, making mustering easier, with less likelihood of mismothering during mustering of big paddocks, and less likelihood of a calf being born in the yards and then mismothered
- enhancing overall herd fertility by concentrating on culling of non-productive groups rather than just older groups
- decreasing calf losses and breeder mortality rates through better nutrition of the most productive cows
- better use of pasture resources, by concentrating more productive groups on better country
- targeting supplements to herds that have the most need and where responses are likely to be best, e.g. first-calf cows
- segregation and seasonal mating of heifers, enabling some concentration of calving patterns throughout life, regardless of the type of environment.

Possible disadvantages of this strategy are:

- logistical difficulties in application
- lack of appreciation of the aims of the strategy
- the need for pregnancy diagnosis as a tool for segregation
- additional initial work in putting the practice into place.

However, experience on many large northern properties indicates this is a useful strategy to enhance fertility and reduce breeder mortalities.

Breeding and selection for improved beef production

The value of genetics

Investing thought, time and money in the genetics of the herd is worthwhile because genetic improvement is:

- cheap—because it involves buying a sire that will add genetic improvement and the only extra is the marginal cost of the superior sire over the average
- permanent—passed on from one generation to the next
- cumulative—the improvement made this year will be in addition to the improvements made last year.

When obtaining a bull, the buyer is acquiring a 'package of genes'. An animal's genes largely determine the appearance or performance of an animal.

The *genotype* of an animal is its genetic makeup. It contributes to its *phenotype*, which is the sum of observable, measurable traits of an animal—for example, coat colour and growth rate. The other major contributor to an animal's phenotype is the *environment*, which comprises all the non-genetic factors that influence the animal, such as nutrition, climate and health status.

Thus the phenotype is the result of the combined interaction of genotype and the environment.

Dominance Genes occur in pairs, one obtained from each parent. Complete dominance occurs when one member of a gene pair masks the effect of the other member of the gene pair. Typical examples in cattle are the polled trait, where polled is completely dominant over horned, and black/red coat colour, where black is completely dominant over red.

Partial dominance occurs when there is an intermediate outcome between the two effects. Red, roan and white in Shorthorns is an example.

Variation In an animal breeding context, variation usually refers to the difference among individuals within a population. Variation exists for almost all traits, although some traits exhibit greater variation than others. With greater variation in a trait there is more scope for change by selection.

Heritability Heritability (h2) is defined as the proportion of superiority in a trait that is transmitted to the offspring. This means the difference can be attributed to gene differences, not environmental factors. The higher the heritability of a trait, the greater the proportion of the parental genetic merit passed on to the offspring. Table 6 summarises the h2 values for a range of traits.

Table 6. Heritability (h2) values for a range of traits

Trait	Heritability description	Heritability % (BREEDPLAN)	
		Temperate (AA)	Tropical (BB)
Reproduction			
Conception	Low	0–5	5–20
Days to calving	Low	0–10 (7)	0–10 (9)
Calving ease (heifers)	Low–medium	15–50	na
Semen quality	Low–medium	25–40	6–44
Scrotal size (18 months)	Medium–high	20–50 (39)	26–36 (39)
Serving capacity (18 months)	Low–high	15–60	na
Mounts and serves	Low–medium	na	3–62
Maternal ability	Medium	20–40	na
Gestation length	Medium	15–25 (20)	(20)
Growth and conformation			
Birth weight	Medium	35–45 (38)	35–45 (45)
200-day weight	Medium	20–30 (18)	16–40 (28)
400-day weight	Medium	(25)	(37)
600-day weight	Medium	(31)	(42)
Mature cow weight	High	50–70 (40)	25–40 (39)
Milk yield	Medium	20–25 (9)	(3)
Hip height (400 days)	Medium–high	59–66	na
Front feet claw set	Low–medium	29	na
Rear legs – side view	Low–medium	18	na
Rear feet angle	Low–medium	32	na
Dry season gain	Medium	na	17–30
Wet season gain	Low	na	18
Weight gain – birth to weaning	Medium	25–30	30–40
Condition score	Medium	44	na
Carcase			
Rib fat (12/13th rib)	Medium	(22)	(22)
P8 rump fat	Medium–high	29 (27)	18 (27)
Intramuscular fat (IMF%)	Medium–high	15 (12)	30 (12)
Eye muscle area (EMA)	Medium	20-25 (26)	(26)
Dressing percentage	Medium–high	15	37
Tenderness	High	4–25	16–30
Retail beef yield (RBY%)	High	29 (36)	36 (36)
Carcase weight/day of age	Medium	25–45 (41)	(29)
Muscle score (400 days)	Medium–high	38–47	47

Table 6 cont.

Trait	Heritability description	Heritability % (BREEDPLAN)	
		Temperate (AA)	Tropical (BB)
Other traits			
Cancer eye susceptibility	Medium	20–40	na
Eye pigmentation	High	45–60 (45)	na
Temperament score	Medium–high	25–50 (27)	25–50
Tick resistance	Medium	na	20–42
Worm resistance	Medium	na	25–36
Buffalo fly resistance	Medium	na	20–30
Pelvic height (400 days)	Medium–high	34	na
Pelvic width (400 days	Medium–high	41	na
Pelvic area (400 days)	Medium–high	42	na

*BREEDPLAN heritability values for AA (Angus) and BB (Brahman) na – not available.

Source: Bertram, J. (ed.), 2003, *Bull Selection: An aid for beef producers on Buying Better Bulls*, Queensland Department of Primary Industries (QDPI).

Rate of genetic improvement Factors influencing rate of improvement in a trait are:

- heritability
- variation
- intensity of selection and/or selection differential
- generation interval
- accuracy of selection.

As already stated, heritability and variation are the two characteristics or traits that influence the potential for genetic improvement. Genetic improvement will be most rapid for a trait with high heritability and high variation. However moderate progress can be made for a trait with low heritability and high variation, and high heritability with low variation. But if both are low there is little chance of genetic improvement.

Selection differential This is the difference between the mean of those selected to be parents and the mean of all potential parents. The smaller the number of animals selected, the higher the selection differential and the greater the difference between average of the animals selected and the average of the entire group.

Generation interval This is the average age of the parents when their offspring are born or in simple terms, the time interval between the same stage in the life cycle of two successive generations. A short generation interval means that a larger proportion of young animals are introduced each year, leading to a larger culling rate for older animals. However, introducing more animals results in a lower intensity of selection and therefore lower selection differential. On the other hand, if genetic progress is being made, the younger animals as a group should be superior to the older animals. A balance needs to be achieved in the conflict between shorter generation interval and selection intensity.

Visual selection This process has limited use in achieving improvement in most production traits and it has minimal value in selecting for carcase traits. It can only be used to assess phenotype, and this also happens in isolation from knowledge of the environmental effects that the animal has undergone. Therefore, the chance of accurately assessing the genetic value is virtually zero.

Estimated Breeding Values (EBVs) These are measures of genetic differences between animals, expressed as the unit for each trait in positive or negative terms. Dedicated software called best linear unbiased prediction (BLUP) uses computer technology to find the best fit for all the pieces of information, for all the traits in question and all the animals in the analysis simultaneously. The solution provides the best estimate of the genetic merit of the animal(s).

The EBV should always be compared with the EBV for the current breed average. If the EBV for the animal in question is lower than the breed average then that animal could be considered below average genetically for that trait in that breed at that time.

BREEDPLAN This is a program that provides a genetic description of cattle for a range of traits in the major areas of growth, carcase performance and fertility. Where common sire linkages occur with other groups, comparisons can be made across groups. Group BREEDPLAN allows for comparison of animals across herds—most reported EBVs are Group BREEDPLAN. However some smaller breeders and herds not aligned with a breed society may report EBVs that are comparable only within a herd.

While EBVs are based on all available pedigree and performance records provided by breeders in Australia (and New Zealand for many breeds); BREEDPLAN EBVs have proved a good guide to the performance of animals in a commercial herd enterprise. A breed society Group BREEDPLAN publication offers an EBV comparison to estimate the difference in output from two sires. The difference in weight gain from a bull selected from the top 10% of the breed compared to the bottom 10% can be calculated.

Index selection (BreedObject) In recent years researchers have integrated genetics and economics to define genetic improvement in economic terms. The result is an index that describes profitability of animals based on the summation of their individual traits or EBVs. A selection index is an amalgamation of all available EBVs using appropriate weighting calculated for individual beef producers in different environments, targeting different markets.

BreedObject can be used to customise a selection index for the producer's particular situation. After completing a questionnaire on production costs, performance levels and market targets, the producer can obtain information on the relative economic values of different traits, and the index weighting factors to be applied to the EBVs for potential candidate animals.

Gene markers These provide a means of assessing the true genetic merit of an animal, by 'marking' the presence of an individual gene. They give the industry the potential to identify and select animals for specific traits at an early age. Specific markers identify the actual piece of DNA that affects the trait of interest, while other markers only identify DNA sequences that are close to and related to the trait.

Breeding systems

Discussions to date have concentrated on systems that allow genetic improvement within a breed by selecting the superior animals as parents of the next generation. However, a broader consideration of the changes (improvement) that can be made by genetic manipulation requires a focus on more breeds. So apart from the choice of animals within a breed, a producer needs to choose the breed and then choose the breeding system.

In broad terms there are three basic systems, shown below, but there are options within each of these systems.

1. pure breeding or straight breeding
2. crossbreeding
3. development of new breeds, i.e. composites.

Heterosis and hybrid vigour Heterosis is the increase in production achieved when mating one or more pure breeds. To calculate heterosis:

% heterosis = (average crossbred progeny–average of the parents)/(average of parents) x 100%

Regardless of the breeding program, goals must be set and the following points remembered:

1. any breeding must be a planned, systematic mating of animals
2. mating the best to the best will usually produce the best. This applies equally to pure breeding and crossbreeding
3. inferior parents should have no greater place in a crossbreeding program than they would have in a pure breeding program
4. hybrid vigour has its greatest application where the production traits to be improved are lowly heritable or environmentally limited. Remember hybrid vigour is not the only advantage gained by crossbreeding—making use of between-breed differences can be just as important
5. unless the crossbreds outperform the purebreds there is little point in crossbreeding.

In any mating system, the fertility of the stock is of prime importance if the genetic potential of the animals is to be realised in future generations. In general, the sire and dam are of equal importance. But in a herd the selection of sires is of greater importance and exerts a greater influence on herd genetic improvement.

Developing a breeding objective

Breeding for future markets requires the development of a vision of future customer requirements and the implementation of a planned breeding program that balances these requirements with on-farm production targets.

Unfortunately, many beef producers only achieve a fraction of the potential economic gains achievable through effective genetic selection. In many cases, producers have not adequately identified appropriate breeding objectives to exploit their production situation and market opportunities.

Seven steps in developing a breeding objective:

1. list customer requirements
2. list traits of economic importance
3. list current performance levels
4. list future herd production targets
5. list breeding goals

6. list selection criteria

7. prioritise selection criteria.

Identifying animals to meet the breeding objective Producers need to identify the economic traits important to them and the factors that will best influence these traits. Then the next step is to identify the animals that can introduce to their herds the improved characteristics.

Selection of desired characteristics Selection of appropriate bulls and females involves a focus on the capacity of those animals to provide and deliver desired characteristics to the herd. If a particular trait is to be included in a breeding program it must be reasonably heritable, economically important and measurable (either directly or indirectly).

Implementing the breeding program

Producers need an action plan to ensure that their breeding objectives are realised. The plan must be manageable in terms of terms of the personnel involved and the property concerned. Constraints of human resources need to be fully appreciated.

Devise a list of goals that can realistically be achieved and establish a timetable for their implementation. Be prepared to invest extra time in learning more about the subjects briefly outlined in this booklet. This will ensure that no opportunities are missed and gains are optimised for cattle enterprises in northern Australia.

Answers to Quick Quiz

1) d, 2) c, 3) b, 4) a, 5) c, 6) b.

If you scored 5+—Congratulations! Your neighbours should listen carefully to your advice.

If you scored 4—Well done! But there could be areas where you need to improve your knowledge.

If you scored 3 or less—Good try! You had a go and are willing to learn more. Read on!

Need more information?

Contact details for the EDGE*network* are:

Northern Territory

Department of Business, Industry and Resource Development
Trudi Oxley — Tel: (08) 8973 9763

Queensland

Queensland Department of Primary Industries and Fisheries
Joanne Cotter — Tel: (07) 4161 3700
Symbio Alliance
Alison Rowlands — Tel: (07) 3340 5722

Western Australia

Kondinin
Kareena Waters — Tel: 1800 200 798

EDGEnetwork®

Meat & Livestock Australia — Tel: 1800 993 343

Notes

Notes

Level 1 165 Walker Street North Sydney NSW 2060
Ph +61 2 9463 9180 Fax +61 2 9463 9123 www.mla.com.au

MEAT & LIVESTOCK AUSTRALIA