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Heifer management in northern beef herds

2nd Edition

Future Beef

GOVERNMENT OF WESTERN AUSTRALIA
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Northern Territory Government

Heifer management in northern beef herds

2nd Edition

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Preface

This publication is a direct outcome of MLA-funded heifer projects conducted in northern Australia – NBP.344 *Industry initiatives to improve young breeder performance in the Northern Territory* led by Tim Schatz (Northern Territory Department of Resources) and NBP.345 *Industry initiatives to improve young breeder performance in the Pilbara and Kimberley of WA* led by Peter Smith (Department of Agriculture and Food Western Australia).

This publication uses results from previous research and pre-existing knowledge of heifer management and incorporates the findings from the research projects listed above. It also incorporates more recent projects including NBP.339 *Understanding and improving heifer fertility in the Northern Territory* also led by Tim Schatz and research results obtained in Beef CRCII project NBP.301 *Links between the genetics of beef quality and components of herd profitability in northern Australia.*

Although the publication has focussed primarily on heifer management in extensive beef herds, the principles have equal application to all beef herds across northern Australia despite any differences in scale of operations, breeds, climatic conditions or pastures types.

Heifer management in northern beef herds is a short, readable guide to best practice management written for graziers, station managers, stockmen and for students of animal husbandry.

Acknowledgments

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Most of the photographs in the publication were taken by Tim Schatz.

Foreword

The success of any team relies primarily on a sound strategy for junior development. It is no different when it comes to our breeder herd where reproductive performance is one of the major profit drivers in our business. We have to ensure that the replacement heifers coming through the ranks are fit, well prepared and given every possible chance to perform to their best ability when their turn comes to be part of the team.

In the northern Australian beef industry, the age of our male turn-off has decreased considerably over the past two decades, and this makes it even more imperative that we take every opportunity to ensure maximum reproductive output from our enterprise.

This guide is the culmination of five years of valuable MLA-funded research conducted by departmental staff on heifer productivity in the Northern Territory and Western Australia. The data collected clearly showed room for improvement in some regions and also great opportunities to improve reproductive performance in our breeder herd if we can get it right.

Importantly the general principles and recommendations carefully constructed in this publication can be used as game plan by all beef breeders irrespective of breed or region across the entire northern beef industry. I hope it provides you with some helpful guidelines that will assist and challenge the way you currently operate.

Keith Holzwart

Avago Station, Northern Territory

(Chairman of the Katherine Pastoral Industry Advisory Committee and the MLA Northern Beef Industry Committee)

Contents

Key messages for heifer management

Improving re-conception rates in first-calf heifers can significantly improve herd profitability.

General principles that can be applied to the management of replacement heifers include:

- Body condition at mating has the greatest effect on heifer fertility.
- Conservative stocking and good pasture in heifer paddocks are the cheapest ways to achieve good body condition. Supplements may be cost effective.
- Heifers should be segregated from the breeder herd, grazed on the best paddocks and may need supplements over the post-weaning dry season to reach critical mating weight.
- The majority of heifers should be at or above the critical mating weight (CMW) at the start of joining. The CMW for *Bos indicus* heifers is 320–340kg.
- *Bos indicus* heifers tend to reach puberty at heavier weights and at a later age than *Bos taurus* heifers.
- The heifer needs to have a body condition score (BCS) of 3.5 (on BCS scale of 1–5) or higher at calving to maximise the chance of getting pregnant again while rearing her calf.
- If heifers are selected before joining, this should be based on growth over the post-weaning year, and not on weight at weaning, which largely depends on age.
- Mate more heifers than are needed for replacements using young bulls evaluated for breeding soundness, 'calving ease' and 'low birth weight'.
- Select replacement heifers from those that get pregnant early in the joining period—and on temperament.
- Ideally, heifers should be mated for only three cycles (63 days). On extensive properties, pregnancy diagnosis can be used to identify heifers that conceived early in the mating period.
- Yearling mating will give good results only if heifers are heavy enough (on good country) and are of early-maturing breed types.
- The best type of heifer will be that suited to the environment and target market.
- Genetic improvement is faster through crossbreeding than through selection.
- Bull selection will have a much greater impact on herd improvement than selecting heifers or cows.
- Calf losses in first-calf heifers are often high (>20%) and mostly occur around the time of birth.
- Muster and wean first-calf heifers before the main breeder herd.
- Wean calves early, down to 100kg (3 months), or even earlier if heifer survival is at risk.
- Vaccinate all heifers against botulism and against any other diseases that could have significant economic impact.
- Maiden heifers are a good group to use if an artificial insemination program is planned.

1. Why improve heifer fertility?

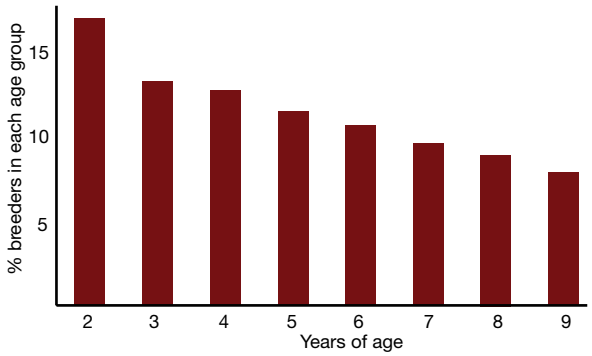
Productivity in the extensively-run beef herds over northern Australia is governed largely by the rates of reproduction, mortality and growth.

Reproductive rate has a major impact on economic performance, and its relative importance increases as age at turn-off is lowered. As many properties in the region sell steers and heifers for the live export trade at two to three years of age, weaning rate is one of their main profit drivers.

Young breeders impact on profit

In a typical breeding herd that retains 60% of its heifers each year as replacements and joins at two years of age, about 40% of the breeding herd consists of females aged two, three and four years (Figure 1.1). Although 80% of maiden heifers often conceive, around 20% lose their calves, and often only around 20% re-conceive while lactating. Thus these young animals will produce on average only one calf in their first four years of life.

Figure 1.1 Proportion of breeders in each age group



The failure of so many of first-calf heifers to get back into calf lowers overall herd branding rates.

With improved heifer fertility, fewer heifers need to be kept as replacements allowing a higher proportion of older, more productive females.

The problem – first-calf heifers failing to get back in calf.

Economic benefits

A recent survey of 15 breeder herds in the Northern Territory showed that, on average, while 75% of maiden heifers became pregnant, 20% lost their calves between pregnancy testing and branding and only about 20% got back into calf during their first lactation.

Economic modelling shows that, in an average-sized herd in the Katherine–VRD region (eg 12,600 breeders), each 5% increase in re-conception rate of the first-calf heifer would increase herd gross margin by approximately $1.20 per adult equivalent, or about $26,000 per herd.

If maiden heifers are managed to be heavier at the start of joining, their conception rates could be increased to 85% and re-conception rates during their first lactation could increase to 45%. Even with calf losses remaining the same, this would increase herd gross margin by $175,250 a year.

Within the NT pastoral industry, increasing re-conception rates of the first-calf heifers by 30% would result in an annual increase in gross margin of about $11 million—with similar proportional increases across northern Queensland and northern Western Australia.

Various terms have been used to describe heifers at different stages of their development. This publication uses the following commonly-accepted industry terms:

- maiden heifers – heifers being joined for the first time
- in-calf heifers – heifers pregnant with their first calf
- first-calf heifers – heifers from their first calving up to weaning.

2. The problem – re-conception and calf losses

First-calf heifers have the lowest fertility of any age group. They are still trying to grow as well as feed their calf—with lactation taking priority. If the pasture does not provide enough nutrients, the heifer will use its body reserves and will lose condition. Cycling is then delayed, and the heifer may not re-conceive for many months.

Although most production parameters on north Australian cattle stations have improved over the last decade, fertility in first-calf heifers often remains very low. In the recent survey of 11 properties in the Northern Territory, re-conception rates were below 10% on four properties, below 25% on eight properties, and above 50% on only two properties. However, where first-calf heifers were in good condition because of a good season, good pasture and good management, rates were above 75%.

Calf losses in first-calf heifers averaged 25% on Northern Territory cattle properties—more than 30% on a third of properties. The extent of these calf losses is rarely appreciated, or recorded. As few of the dead calves are seen, it is difficult to identify the cause, but factors include poor mothering ability, predation, dystocia and disease.

Many first-calf heifers lose too much weight during lactation to get back into calf. They must have sufficient body reserves at calving to withstand the weight loss. Early weaning will preserve condition and increase conception at the next mating.

Resumption of cycling (and PPAI)

Not cycling (anoestrus) after calving allows the mother to recuperate before another pregnancy.

The period of this anoestrus is called the post-partum anoestrus interval (PPAI); an extended PPAI results in low reproductive efficiency and hence low profitability.

PPAI

Anoestrus – no oestrus, no cycling.

Post-partum anoestrus interval – how long before the cow starts cycling again after calving.

Lactating heifers in poor condition have the longest PPAI. Duration of the PPAI is affected mainly by nutrition and lactation status, but several other factors may interact.

What affects the PPAI in heifers?

The main factors affecting the PPAI in first-calf heifers are:

Nutrition

The most important factor is body condition at calving and during lactation, which is determined by adequate nutrition prior to calving.

Poor nutrition prolongs the PPAI, with body condition at calving interacting with weight changes both before and after calving.

If heifers are in good condition, weight changes seem to have little effect on PPAI but they become significant when the animals are in moderate or poor condition.

Lactation

Lactation delays the resumption of cycling:

- directly through a hormonal feedback when the calf suckles
- indirectly through reducing the body condition of the heifer as she strives to keep growing and feed her calf.

Good-quality pastures will allow the heifer to maintain condition while feeding her calf.

Time of calving

Calving should be timed so that peak milk production, peak demand from the calf and peak pasture growth are aligned.

Heifers lactating through the dry season will generally lose considerable weight and need several months on green feed during the next wet season to regain body condition and start cycling again.

Breed

Brahmans often have longer PPAIs than *Bos taurus* when nutrition is inadequate but their performances are similar when the cows are in good condition. When they are in good condition, the Brahman PPAI can be short enough (less than three months) to allow a calf to be born within 12 months of the previous one.

With good nutrition, Brahman heifers can re-conceive within 61 to 65 days.

A heifer lactating during the dry season will lose too much condition to start cycling again.

Calving difficulty

The interval before the next oestrus is increased when the heifer has difficulty calving; this is probably associated with the stress and injuries and general recovery time after birth.

The most common cause of dystocia in first-calf heifers is a big calf unable to fit through a small, not fully developed, pelvis.

Generally *Bos indicus* calves are born small, and dystocia is less common than in the British and European breeds; however, *Bos indicus*-cross heifers can still lose 4% or more of their calves as a result of dystocia.

Presence of a bull

The absence of a bull increases the PPAI, but this is a minor effect and is rarely a problem in continuously-mated herds.

The presence of a bull will encourage the heifer to start cycling again.

The management and timing of joining heifers should be focussed on body condition and critical mating weights to enable them to get back into calf.

Aiming for re-conception

Management of heifers from weaning to joining and the timing of joining should be focussed on body condition and critical mating weights.

3. Body condition and feeding

Body condition and fertility

Pregnancy rates in maiden and first-calf heifers are strongly affected by their joining weight. Generally, pregnancy rates are higher when heifers are in better condition, while weight also has the greatest effect on when they reach puberty.

Much of heifer management is about managing body condition. Heifers should be heavy enough to get in calf early in their maiden heifer mating period, and be in good condition at calving.

To maintain growth over the post-weaning dry season so critical mating weight is acheived in two-year-olds, weaner heifers need to be stocked conservatively on good pasture, and may need supplementation.

Critical weights can be identified and used as targets to maximise fertility.

Critical Mating Weight (CMW) is the weight at the start of the joining period at which 85% or more heifers will get pregnant (diagnosed 6–8 weeks after bull removal) in a 42-day joining period.

Setting target weights

The CMW for *Bos indicus* heifers is higher than for British breeds. It ranges from 280 to 340kg depending on genotype, and is usually 320–340kg for *Bos indicus* heifers.

Conception rates in maiden heifers in northern Australia are generally adequate (more than 75%) when heifers are joined for the first time at two years of age. Re-conception after first calving is the major common problem.

Re-conception rates of first-calf heifers can be predicted from their weight and body condition score before calving (Table 3.1 and Appendix 1). Brahman heifers need to have a pre-calving weight of around 430kg (equivalent to a body condition score (BCS) of 3.5) to achieve re-conception rates of 50%.

On pastures that enable heifers to put on 90–130kg per year, heifers that are going to calve weighing more than 430kg just before the wet season must be at least 300kg going into the previous wet season—over which they were mated.

Heifers need to be in good body condition (BCS>3.5) before joining.

The dry season before first calving

Weight and condition at calving are the main factors affecting re-conception rates in first-calf heifers. Heifers should be managed to be in at least moderate condition (score 3.5 on the 1 to 5 BCS system) at calving and through lactation (Figure 3.1 and Appendix 1).

Table 3.1. Predicted pregnancy rates of lactating first-calf heifers based on pre-calving weight (includes calf weight of approximately 30kg).

Pre-calving weight (kg)[1]	Weight at 1st round weaning (kg)	Predicted pregnancy rate
350	310	15%
380	340	24%
410	370	35%
440	400	49%
470	430	62%
500	460	74%
530	490	83%

[1]See Appendix 1 for Body Condition Score targets if weights are not available.

Heifers should not lose weight over the dry season before their first calf, and preferably should gain weight. This means they should graze the better paddocks, be stocked more lightly, and may need supplementation.

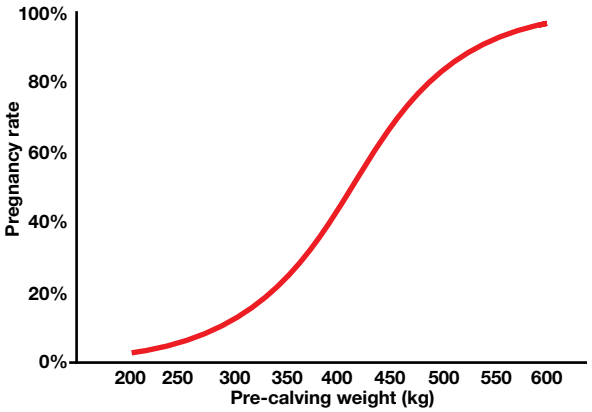


Figure 3.1. The heavier the heifer at calving, the higher the chance of becoming pregnant again during lactation.

Supplementing heifers with cotton seed meal during the post-weaning dry season has reduced average age at puberty by 5–6 weeks; feeding copra meal at 1.6kg/head/day has increased weight at calving and raised re-conception rates by 40%—but supplements may still not be economical. Factors affecting the profitability of supplementary feeding include how good the season has been, the quality of the pasture, the cost of the supplement on-farm, for how long the heifers will be fed and by how much the pregnancy rates can be increased.

Urea-based licks do not improve growth as much as true protein but may be more cost effective. Supplements should be fed for survival during droughts.

Once a pre-calving supplementation program is started, it should be continued until the season breaks and good pasture is available. If supplementation is stopped but the wet season is late, the heifers will rapidly lose weight and lose any expected benefit.

Heifers that lose weight over the dry season reach puberty later and have lower re-conception rates.

Some heifers may need protein or dry lick supplements over the dry season to reach critical mating weight.

Phosphorus supplements during the wet season in phosphorus-deficient country will give significant extra weight gains, and so improve pregnancy rates.

'Spike feeding'

Feeding a high-quality protein supplement such as copra meal for six to eight weeks before calving is referred to as spike feeding.

In north Queensland, spike feeding heifers before calving increased their re-conception rates by around 15%, but the economics will depend on the on-farm cost of feeding.

Post-calving supplementation

Feeding lactating heifers high-quality protein or energy supplements does not generally induce earlier cycling or increase re-conception rates—and may well be impractical during the wet season. Feeding phosphorus during lactation is recommended in P-deficient country.

Creep feeding

Creep feeding supplements only to the suckling calves can reduce both the suckling stimulus and the energy drain on first-calf heifers, but has not been found to reliably increase their pregnancy rates.

4. Heifer selection

Appropriate genotype

Choosing the genotype that is best suited to the local environment and the target market is one of the fundamentals of a successful cattle enterprise.

Different breeds and combinations of breeds have different traits and attributes that make them better suited to different environments (see Table 4.1). Brahman and other *Bos indicus* breeds have superior resistance to heat, ticks, intestinal parasites and buffalo fly, can walk longer distances and are more efficient at digesting low-quality pastures. However, their lower fertility under tropical conditions means that fertility rates in northern Australia are normally lower than in southern or central Australia where pure *Bos taurus* breeds can be used.

In northern Australia the most productive genotype usually requires some level of tropically-adapted content (either *Bos indicus* or tropically-adapted *Bos taurus*); the harsher the environment, the higher the tropically adapted content that is required.

Bos taurus breeds – The British breeds (eg Angus, Hereford, Shorthorn) are well known for their good meat quality and productivity in temperate environments, but are susceptible to environmental stress and ticks in the tropics.

The European *Bos taurus* breeds (eg Charolais, Simmental, Limousin) generally have a larger mature size and produce leaner carcases. Bulls of these European breeds should not normally be mated to heifers as the large calves can result in a higher incidence of dystocia.

Brahmans and high-grade Bos indicus are well suited to harsher conditions.

Some *Bos taurus* breeds better adapted to stressful environments are known collectively as Sangas or Adapted Taurines—they include Senepol, Tuli, Africander and Belmont Reds. These can be run as purebreds in some less harsh environments in northern Australia, but generally the bulls are used to increase the *Bos taurus* content in a cross without lowering its hardiness.

Composite cattle are a cross of several different breeds, and can be produced from any breeds with traits desirable in the final product. Composites retain more hybrid vigour than a cross of two breeds that have been interbred to form a stabilised breed.

Table 4.1 Attributes for different genotypes. Comparative rankings (1 = poor, 5 = very good) of different breed types for traits in temperate and tropical environments.

	Bos taurus			*Bos indicus*		Crossbred
Trait	British	European	Sanga	Indian	African	F1 British x Brahman
Growth – temperate environment	3	5	3	3	2	4
Growth – tropical environment	2	2	4	4	2	4
Fertility – temperate environment	5	4	4	3	4	5
Fertility – tropical environment	2	2	5	3	4	5
Heat tolerance	2	2	5	5	5	5
Tick resistance	1	1	3	5	5	4
Meat quality	5	4	5	3	4	4
Mature size	4	5	3	4	3	4

Brahman x Senepol heifer

Composite heifer containing Shorthorn, Brahman, Charolais and Belmont Red

Genetic improvement

Both crossbreeding and selection can be used to generate a more productive herd, but change is more rapid through crossbreeding. Genetic progress is much faster through bull selection as one bull may sire 150 calves over five years whereas few cows will have more than eight calves during their lifetime in northern Australian herds.

Cross breeding

Crossbreeding is used to combine attributes of different breeds and to produce hybrid vigour (or heterosis).

Selection

Genetic improvement of a herd is slower through selection than through crossbreeding but the gains are permanent and cumulative.

Animals for breeding are selected for better performance in a desired trait, such as growth, fertility, temperament or meat quality, where this is due to their genetic potential.

Hybrid vigour

Hybrid vigour is the improvement in performance of crossbred offspring over the average performance of the parental breeds. It is greatest in the first (F1) generation. It declines with each generation thereafter if the crossbred offspring are back-crossed to either parental breed or interbred to form a stabilised breed.

A selection program should not focus solely on one trait as this is often to the detriment of others. A selection index such as BREED OBJECT can take into account the relative importance of a number of different traits with economic importance.

Greater genetic gain is made when selection is based on objective measures rather than on physical appearance, which is often determined by factors such as nutrition and age. Examples are bulls fed grain in preparation for a sale looking more impressive than bulls that have been grazing native pasture, and bull calves selected at weaning being larger because they were born earlier and therefore are older.

BREEDPLAN provides quantitative measures for a whole range of production traits, and allows direct comparisons of bulls at a sale.

Selection for fertility

Selection for fertility can be done in any herd whether the animals are crossbred or purebred.

Selection for fertility can reduce age at puberty and increase fertility as these traits are heritable. Most selection programs will involve selecting bulls with higher fertility and identifying and culling less fertile females, but this should not be at the expense of other traits, such as growth.

Bull selection – A bull's physical appearance gives little indication of its inherent fertility and selection should be based on objective measures. This can be done by using a genetic evaluation program such as BREEDPLAN, estimated breeding values (EBVs) and fertility records of animals in a bull's pedigree.

The current EBVs for fertility traits are Days-To-Calving (DTC), Scrotal Size (SS) and soon 'age at puberty'. Bulls that have been bred in herds that select for fertility have a higher chance of being more fertile than those that are not. Semen should be tested; bulls should have more than 70% normal sperm.

Other bull traits that are correlated with higher female fertility include: scrotal size at 12 months correlated with age at first puberty in heifers; and percent normal sperm at two years of age with puberty age and shorter PPAI.

Hybrid vigour is desirable in the heifer but not in its first calf as a big calf may cause dystocia. Heterosis in the heifers but not the calves is encouraged by using cross-bred bulls over the older cows and selecting replacement heifers from these. The aim is to keep genetics similar (and heterosis in the foetus to a minimum) when selecting bulls to put over the heifers.

Well-grown stabilised-cross heifers – Santa Gertrudis

Female selection – While bulls make a greater contribution to the genetic makeup of a herd, identifying and culling less fertile heifers and cows is important in improving fertility in the herd.

The amount of selection for fertility will depend on whether herd numbers are stable. If herd numbers are being increased, fewer females can be culled.

The most obvious females to cull are those that are 'dry and empty'—not lactating and not pregnant—as they are generally in good condition, have a high sale value and will not produce another weaner for at least a year. As the proportion of 'dry and empty' females is low in many herds, greater genetic gain can be made if lactating females that are not pregnant can also be culled.

Heifer selection – Heifers should be selected on growth over the post-weaning year rather than weight at weaning as this can be biased by the calf's age. The degree of heifer selection that can be done depends on breeder herd dynamics. In an efficient herd where numbers are in a stable state, about 60% of heifers are required as replacement breeders.

Heifers should be selected on ability to get in calf early and on growth over the post-weaning year rather than on weight at weaning.

Often producers select the biggest (usually the oldest) and best-looking heifers as replacements and mate them for three to four months; however, this puts no pressure on the heifers to perform if they are well above their critical mating weight at the start of joining.

Recommendations for heifer selection include:

- Aim to have most heifers at their critical mating weight at the start of joining.
- Mate more heifers than will be needed as replacements by at least 25% to allow good selection from pregnant.
- While managing for target mating weights, include some lighter heifers. If they get pregnant, they will be the early-maturing animals.
- Pregnancy diagnose for foetal age at a designated time, and select all those heifers that got in calf earliest in the mating period—preferably within the first three cycles of joining, ie within nine weeks.
- Select primarily on foetal ageing and temperament. If there are surplus pregnant replacements, select on other traits.
- Remember that most of the genetic improvement for growth, marbling and fertility comes through the bull.
- Excess hybrid vigour may produce a calf which is too big for a heifer to deliver.

5. Heifer puberty and mating

Replacing females in the breeding herd comes at a cost. It takes about 18 months to produce a weaner heifer from the time the females were mated. Heifers then become the most inefficient class of animal in the herd; if joined at two years of age, they will have produced only one calf by the time they are age four.

Efficient mating programs aim to mate heifers for a limited period so that they enter the breeding herd and calve at the correct time to achieve maximum performance for the rest of their lives. Calving is timed so that peak lactation occurs when nutrition is at its best. Managers need to know the approximate age and weight at which heifers reach puberty so that they can ensure that replacement heifers are cycling early in the joining period. Adequate nutrition for the heifers to reach their critical mating weight will ensure that they can conceive early and have a greater chance of re-conceiving.

Puberty in heifers

Heifers are said to have reached puberty when they become capable of reproducing. Puberty involves hormonal events occurring in a specific sequence and culminating in oestrus, ovulation and commencement of regular cycling.

Signs of puberty

It is quite difficult to determine accurately when heifers reach puberty. Researchers can observe oestrus, do progesterone assays and use ultrasound technology to detect the occurrence of a corpus luteum on an ovary. On commercial properties where cattle are not observed frequently, puberty is assessed by the prevalence of mounting behaviour and by pregnancy occurring by the end of the joining period.

Mounting behaviour signifies puberty in heifers.

Onset of puberty

Factors that influence the onset of puberty in heifers include:

Body weight – Body weight is the most important factor affecting the onset of puberty in heifers. Although there is an interaction with age, heifers have to be a critical weight before reaching puberty. This critical weight varies both between and within breeds as shown in Table 5.1.

Table 5.1. Weights at which purebred and crossbred heifers show oestrus.

Breed	Percentage in oestrus		
	50%	70%	90%
	Body weights (kg)		
Angus	250	273	295
Brahman	307	330	341
Brangus	273	295	318
Charolais	318	341	352
Hereford	273	295	318
Santa Gertrudis	307	330	341
Limousin	295	318	341
Simmental	284	307	341

While some *Bos indicus*-cross heifers may reach puberty by 275kg, the average weight of Brahman heifers at puberty is 334kg; the average age is around 25 months.

Nutrition – Good nutrition and higher growth rates bring puberty at an earlier age and lighter weights. Maiden heifers may not conceive for the first time until three years of age if poorly grown due to overstocking or poor seasons.

Weaner heifers should be given good paddocks so that they do not lose weight over the dry season. Feeding high energy or protein supplements to heifers during the dry season is often not profitable due to the cost, but may be important for survival in exceptional seasons.

Body condition and frame size – While weight can be used to predict age at puberty, body condition takes into account differences in frame size—a tall thin heifer may weigh the same as a short fat one. Frame size varies within breeds and between breeds. In general, heifers with a large frame mature later.

This effect of frame size on age at puberty is multiplied by the larger effect of body condition—at a similar weight, a smaller-framed heifer is in better condition (fatter) than one with a larger frame.

Breed – *Bos indicus* heifers reach puberty at heavier weights and at a later age than *Bos taurus* heifers, with Brahman-cross heifers in between. It is difficult to give definitive ages and weights at which different breeds of heifers reach puberty as there is considerable variation within breeds. Generally breeds with a larger mature size are later maturing and the heifers will reach puberty later. But note that the plane of nutrition that heifers have been on while maturing has the greatest effect on the age and weight at which they reach puberty.

Hybrid vigour – Crossbreeding can reduce the age at puberty through the effects of heterosis.

Selection – The heritability of some fertility traits is higher than previously thought. Age at puberty in Brahman heifers has an estimated heritability of 57%, so it can be reduced through selection. In one study, pregnancy rates from yearling mating were 35% higher in heifers from a Brahman herd that had been selected for fertility than in commercial Brahman heifers. However, the impacts of age of puberty on lifetime productivity and survival rates in harsh environments are not yet known.

Month of birth – The month in which heifers are born affects when they reach puberty and their pregnancy rates as maiden heifers due mainly to the effect of growth rate. Heifers born late in the wet season have less time grazing good pasture and so grow more slowly than those born earlier. Thus they are usually lighter at joining and may not reach puberty by the end of joining.

The practical implication is that if heifers are selected before first joining, fewer late-born animals are selected as they are smaller.

Management from weaning to first joining

The growth rate of heifers between weaning and joining affects their fertility as maiden heifers. Heifers that grow well during this period reach puberty at younger ages and lighter weights, and have higher conception rates. Weaner heifers should not be allowed to lose weight over the dry season, and may need protein and energy supplements if weaned under 150kg. (See also the MLA publication *Weaner management in northern beef herds.*)

Segregating heifers

Heifers should be segregated from the rest of the herd from weaning until at least the start of their first joining period; if possible, they should remain segregated until their first calf is weaned. This allows heifers to be targeted for specific management, such as supplementation, and allows pregnancies to be timed so that calving occurs at the most desirable time of year.

The most economical ways of ensuring good growth in young heifers are the use of moderate to low stocking rates, running heifers in better paddocks and maybe supplementation. Wet-season phosphorus supplementation is recommended in phosphorus-deficient country.

Setting target weights

Conception rates in maiden heifers in northern Australia are generally adequate (more than 75%) when heifers are joined for the first time at two years of age. However, rates can be low if the heifers are below a critical mating weight (CMW)—and re-conception rates are nearly always low.

The Critical Mating Weight (CMW) for *Bos indicus* heifers is 320–340kg.

The critical mating weight is a target for the start of joining to ensure that most heifers get pregnant early in the joining period. As it may well be difficult to weigh heifers at the start of mating (in the wet season), they could be weighed before the rains start. A target weight of 250kg in October–November should result in pregnancy rates of 80%—assuming the heifers continue to grow at least 0.6kg/day.

Timing of first joining period

The first joining period should be set so that heifers will be lactating when nutritional conditions are at their best. First-calf heifers have a high nutritional demand as they are growing and lactating at the same time. If this high nutritional demand is not met, the heifers will lose condition rapidly and will have low re-conception rates. If they are trying to feed their calf during the dry season, heifers can lose so much body condition that both mother and calf may die.

Where bulls can be managed and stock can be mustered over the wet season, the main goal is to have replacement heifers at or above their critical mating weight when the bulls are put in with the heifers. The start of joining for heifers should be the same as for the main breeder herd or earlier.

In the tropical north, the pasture is most nutritious during the early wet season. Joining for heifers and cows should be designed so that calving occurs just before this. Thus joining should start about ten months before the wet season is expected to start.

The joining period should ideally be limited to three full heat periods (63 days). Getting 85–90% of the heifers in calf over 63 days is about the maximum possible with conception rates of 60–75% per cycle.

On most northern extensive properties this is difficult to implement, but bulls do not have to be removed if pregnancy testing and foetal ageing are used to identify those females that fell pregnant early in the joining period.

A limited (controlled) joining period is recommended for maiden heifers to prevent out-of-season calving and lactation.

More heifers should be mated than will be required (over-mating), and some lighter heifers can be included to identify those reaching puberety at an early age. If bull control is not good, it is better that these become pregnant at the right time of year rather than later and out-of-season. Only those that are pregnant in the desired window should be kept as replacements.

Bull factors in heifer management

On many extensive properties in northern Australia, bull control is difficult because of the terrain or lack of secure paddocks. However, mating heifers for a limited period means that calving occurs at the desired time, and allows their breeding career to get off to the best start possible.

Maiden heifers should be kept separate from bulls until the start of joining and then control mated. With good control of bulls, the most appropriate bulls can be selected for mating to heifers.

Bull Breeding Soundness Examination (BBSE) – Bulls should be examined for physical soundness and semen quality before mating.

As relocation can temporarily affect a bull's semen quality, purchased bulls should be given at least three months time to acclimatise before mating. It is good practice to purchase bulls as yearlings and let them grow out for 12 months prior to joining.

Bull percentage – For semen-tested bulls, a bull percentage of 2.5% is sufficient, but up to 4% where they have not been tested.

Birth weight of calves – As dystocia is more common in heifers than older cows, bulls should be selected for low calf birth weight and ease of calving using EBVs. Crossbreeding for hybrid vigour, especially with large-framed European breeds, should be avoided.

Age of bulls – Young bulls should be used for mating with heifers because they are:

- easier to control and less territorial than older bulls
- less likely to carry sexually-transmitted diseases than older bulls
- lighter and less likely to injure smaller heifers.

Disease control – Bulls can spread sexually transmitted diseases (STDs), and heifers are more susceptible to crashes in pregnancy rates caused by STDs as they have not gained immunity to them. Young bulls are less likely to carry STDs, but all bulls should be vaccinated against vibrio.

Purchased bulls should have a known history of pestivirus vaccination or be certified that they are not a 'carrier animal'. If the heifer mob is completely naive and at high risk of pestivirus infection, they should be vaccinated.

Mating

After ovulation, the egg is swept into the infundibulum, passes into the oviduct and moves towards the uterus. Conception occurs when the egg and sperm meet about a third of the way along the oviduct (Figure 5.1).

The embryo develops rapidly through various stages, and attaches loosely to the uterine wall after about 14 days. Foetal and maternal membrane development begins after 35 days.

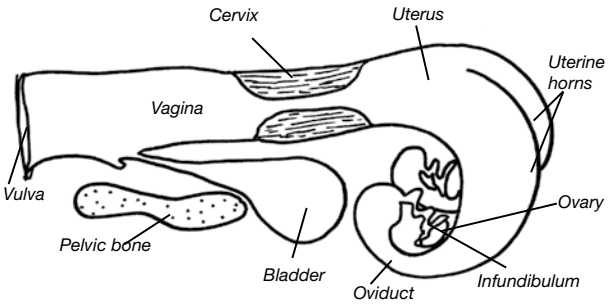


Figure 5.1. Reproductive organs of the cow

In extensively managed beef herds, around 25% of embryos are lost by day 42 and, combined with fertilisation failure, this results in a conception rate per cycle of 65–70% in healthy cattle.

The length of gestation period varies between and within breeds with Brahman and other *Bos indicus* breeds averaging 293 days and Brahman-cross cows averaging 282 days.

Heifers and HGPs

Hormonal Growth Promotants (HGPs) are not registered for use in heifers for breeding, and should not be used.

Both oestrogen and androgen implants can impair development and function of the ovaries and development of mammary glands. If the heifer is pregnant and in the first trimester, the calf may be aborted. Implanting HGPs in breeding females can significantly reduce pregnancy rates, and increase the incidence of prolapse.

Heifer management using foetal ageing – an example

If your wet season generally starts in early November, ideally the bulls should go out with the maiden heifers in mid-January and the CMW of the heifers should be 330kg by that date. In reality, the bulls are often put out with the heifers in November when the heifers are around 260kg and are expected to put on another 70kg before mid-January.

The critical decision now becomes the predicted date on which the last maiden heifer should calve. To avoid excessive costs of mustering to remove the bulls, the process can be managed by foetal ageing at the pregnancy test.

Thus, if the proposed start of joining is mid-January, all heifers were above their target weight of 330kg by then and the mating period was nine weeks, all heifers that are at least eight weeks pregnant when tested in late May would be potential replacement heifers.

By over-mating the heifers, achieving the CMW, and using pregnancy as the key selection criteria, sufficient heifers with the right stage of pregnancy should be available as replacements.

Heifers that are lighter than target joining weights can still be joined as some of them could be early-maturing and reach puberty and conceive at lighter weights. Setting a strict limit to the joining period prevents any heifers calving late in the wet season or early in the dry season, and identifies earlier maturing animals.

Yearling mating

Yearling mating refers to the practice of joining replacement heifers at 12–15 months of age to calve by the time they are two years old.

If yearling mating is achievable with minimal feeding costs, it has the potential to greatly improve profitability as the females have more calves over their lifetime.

In northern Australian terminology, 'yearling mating' usually includes heifers that are mated in the first wet season after weaning.

These are usually the oldest weaner heifers and, especially where heifers come from continuously mated herds, they may range from 12 to 18 months of age at the start of joining.

The success of a yearling mating program depends almost entirely on the heifers' weaning weight and growth rate between weaning and the joining period (Tables 5.2 and 5.3). In other words, it is limited to the better country as heifers must have good nutrition to reach a target weight of around 300kg by the start of joining.

Table 5.2. Examples of growth rates needed for yearling mating

Weaning weight (kg)	Target weight (kg)	Desired gain (kg/day)
190	330	0.75
200	300	0.55

Table 5.3. The effect of pre-joining weight on pregnancy rates in yearling-mated Brahman heifers.

Pre-joining weight (in late November)	Predicted pregnancy rate
220kg	16%
240kg	24%
260kg	34%
280kg	46%
300kg	58%
320kg	69%
340kg	78%

Successful yearling mating is possible only with good growth rates associated with improved pastures, cheap supplements or an early start to the wet season.

To achieve good conception rates from yearling mating, heifers need to be early-maturing and to grow at more than 0.5kg/day between weaning and joining.

Current high-grade Brahman heifers on most properties in northern Australia are too late maturing to give good pregnancy rates from yearling mating, but this can be improved through selection for fertility or crossbreeding with earlier-maturing breeds.

In northern Australia, potential problems from yearling joining include:

- More dystocia because of the smaller pelvic size. Use only bulls of known low birth weight.
- More mortalities from the loss of body condition due to the additional stress of lactating while growing.
- Lighter calves because the young heifers produce less milk.
- Longer inter-calving intervals due to the loss of condition and failure to re-conceive.
- Stunting of cow if yearling mating is followed by yearly calving.

In general, if significant amounts of additional supplements are needed to reach critical mating weight for yearling mating, it is best to calculate the benefit and cost of the practice as the low number of extra pregnancies will not justify the extra expense and the performance of the first-calf heifers will also be poor.

However, where bull control is poor, yearling mating may be considered to ensure that any early-maturing heifers do conceive at the right time of year and so do not calve out-of-season.

Best management practice for heifers

- Know the critical mating weight of your own breed of cattle.
- Aim to have most heifers at or above the critical mating weight at the start of joining but do not exclude those that are just under weight.
- Over-mate your replacement heifers with bulls that have passed a BBSE.
- Aim to mate for only three cycles, ie 63 days, or use pregnancy diagnosis to identify heifers that conceived early in the mating period.
- Select from heifers that got pregnant in the desired period.
- Apart from temperament, select heifers on age at puberty as this is associated with higher subsequent fertility.

6. Calving and calf losses

Calf losses can include any loss that occurs from when a foetus is detectable by manual pregnancy diagnosis to when the calf is weaned.

Most calf loss occurs around calving and within the first few weeks after birth. It is usually higher in heifers (around 20% in northern Australia) than in older, more experienced cows (around 10%).

Performance recording on commercial properties in the Northern Territory has found that calf loss in first-calf heifers ranged from 4% to 39%, with an average loss rate of 22%.

Calf loss often goes unnoticed until weaning as few carcasses are seen; it is often not until pregnant heifers are individually identified and good records are kept that the scale of the problem becomes apparent. 'Dry' heifers often turn out to have lost their calf.

Calf losses are rarely noticed in extensive herds.

Charolais cross heifers offer productivity and some degree of hardiness but putting Charolais bulls over heifers can increase dystocia.

Causes of calf loss

Causes of calf loss include:

Dystocia. The most common cause of dystocia in maiden heifers is a big calf unable to fit through a small pelvis. Calf size is affected by the length of gestation, birth weight, nutrition during pregnancy and sex (with male calves being larger).

Other causes of dystocia include abnormal presentation of the foetus, dead foetus and uterine inertia.

A well-grown heifer may have a pelvic size that is 85–90 percent of mature cow size at 24 months of age; a poorly grown heifer may be only 60% of the mature cow size. Dystocia is more of a problem in *Bos taurus* heifers, and when British breeds are crossed with large European breeds; Brahmans are considered to be one of the breeds least prone to dystocia

Calving (parturition)

In the final stages of gestation, the foetus grows to the point where its size approaches the space limitations of the uterus, and it is believed that this pressure stresses the foetus and initiates birth.

Hormonal changes result in the removal of the 'progesterone block' and start uterine contractions. The cow produces relaxin which acts to increase elasticity of the pelvic ligaments and loosen the supportive tissues of the birth canal, while higher levels of oestrogens promote secretions that lubricate the birth canal.

As the pressure inside the uterus increases, the foetus rotates so that it is in position to be born with the front feet and head coming out first (in a normal birth). If the calf does not position itself properly, there can be a problem with calving (dystocia).

but it is reported to be increasing with more selection for growth rate. Dystocia is more common in heifers than in mature cows as the calf may be too big for the heifer's pelvis. It can cause considerable loss when heifers are mated as yearlings unless preventative management is implemented.

In extensive beef systems where calving difficulties are rarely seen, increased heifer losses could indicate a problem with dystocia.

Sire selection and ensuring heifers are well grown by the time they calve are the main management practices to reduce dystocia.

Handling at the wrong time – Mustering heifers during calving or when calves are small can lead to significant calf losses due to mis-mothering and dehydration.

Poor mothering – Maternal instincts vary in heifers; some stay in close proximity to their calves, others leave them for long periods. Mis-mothering seems more prevalent in large paddocks where the heifer has to walk long distances between feed and water. Lack of experience in raising calves may be another reason for higher calf loss in first-calf heifers.

Calves are often left with a carer cow while the mothers go foraging.

Predation – The level of predation can vary markedly between years; it is often difficult to quantify as most calf carcasses are never seen on large properties. Chewed ears and tails seen at weaning indicate a problem with dingoes or wild dogs. Many properties use control programs to try to limit the predation by dingoes and wild dogs.

Disease – Heifers and young cows are more affected by STDs as they have not developed any immunity. Diseases that can cause calf loss between pregnancy testing and weaning in northern Australia are leptospirosis, *Neospora caninum*, pestivirus, neo-natal scours, tetanus and Akabane virus. Vaccines are available for most of these diseases.

Predation by wild dogs

Nutritional deficiency – Heifers often experience a period of under-nutrition during pregnancy when pasture conditions are at their worst in the late dry season. Under-nutrition affects the amount and quality of colostrum that is available.

There are also some specific nutritional deficiencies that can increase calf losses in northern Australia. Vitamin A deficiency has been reported to cause calf losses of up to 40% on open black soil plains during an extended drought where no green feed was available. Phosphorus deficiency is common and can lead to bone chewing and subsequently botulism in heifers. Phosphorus supplementation and vaccination programs can greatly reduce the impact of botulism.

Heat stress – High temperatures increase the incidence of embryonic mortality and can kill calves through heatstroke and dehydration.

In P-deficient country, phosphorus supplement should be fed during the wet season to improve the phosphorus body reserves of the heifer.

The problem is greater with cattle that have a higher *Bos taurus* content although extreme heat waves during summer can lead to calf loss in *Bos indicus* cattle.

Bottle teats and mastitis – Bottle teats (gross enlargement of the teats) are a significant cause of calf loss in older cows, but rarely in heifers. Breeders with bottle teats should be culled.

Reducing the risk of dystocia

Several strategies can reduce the risk of dystocia in heifers, but the most important are ensuring that heifers are well grown and selecting the right sort of bull.

Bull type

If possible, choose a bull with appropriate BREEDPLAN figures, ie an EBV for 'calving ease' and 'low birth weight'. Avoid bulls with high EBVs for birth weight and those of breeds known to produce large calves. If no quantitative data is available, a sibling sire from the weaner calves can be selected that was small at birth but which grew well up to the time of weaning. Bulls of breeds known for small calves (eg Wagyu) can also be used if suited to the local environment.

Nutrition during pregnancy

Nutrition during the pregnancy affects the heifer's strength and the size of the calf.

Poor nutrition may reduce the amount of energy available for labour. Undernourished heifers are more likely to become exhausted and have prolonged deliveries.

The diet during the second trimester should be relatively low in protein. Although it is rarely a problem in northern Australia, heifers (and cows) should not be allowed to become too fat before calving as excessive fat deposits reduce the size of the birth canal.

However, extreme reductions in nutrient intake during the last stages of pregnancy will reduce the size of the calf but also the growth rate of the heifer.

Poor pasture quality in late pregnancy may reduce the amount and quality of colostrum.

Exercise and muscle tone

On properties with smaller paddocks, extra exercise from walking longer distances between feed and water in the month before calving may improve muscle tone, which can reduce dystocia.

Pelvimetry

In pelvimetry, the internal dimensions of the heifer are measured (height by width) and the pelvic area calculated.

Pelvimetry can be used to identify heifers that may be prone to dystocia.

Reducing dystocia risk

Reduce the risk of dystocia in heifers by:

- selecting sires to be mated with heifers using EBVs for calving ease and birth weight, or at least those that have low to moderate growth.
- ensuring replacement heifers are well grown and above their critical mating weight.
- using a half-sib sire or a breed with known low calf birth weights.
- managing nutrition during pregnancy to ensure heifers do not become too fat—but do not starve them in late pregnancy.
- using pelvimetry at pregnancy diagnosis and cull heifers with low pelvic areas.
- selecting bulls with big pelvic areas (long-term solution if data is available).

Assisting delivery of a calf

Bos indicus cows usually calve unassisted because the calves are small. Most dystocia occurs in heifers because the birth canal is not fully developed and the calf is too big.

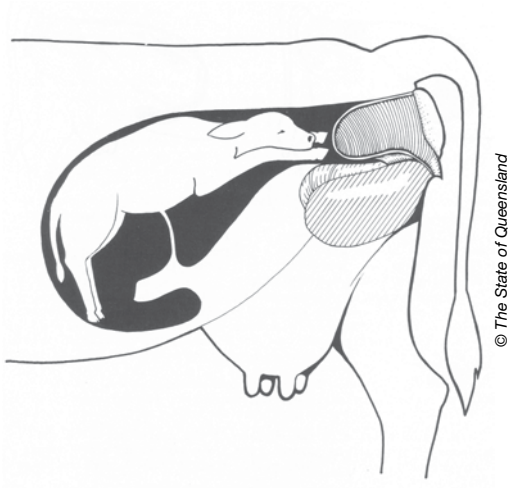
In smaller and more intensive herds that can be observed regularly, the heifer may sometimes need help if she and the calf are to survive. If veterinary assistance is not available, graziers and stockmen can aid delivery to improve the outcome and the well-being of the animals.

Signs before calving

Bos indicus females calve about 290 days (285–295 days) after conception.

When calving is imminent, the udder starts to fill and the teats become distended. The vulva expands and becomes 'loose', may discharge mucus and will change in colour.

The heifer becomes restless, arches her back and strains. Her waters break, and the calf's two front legs should appear if the birth is proceeding normally and the calf is the right way up.



Normal position of calf

The heifer should not be disturbed but allowed to calve naturally.

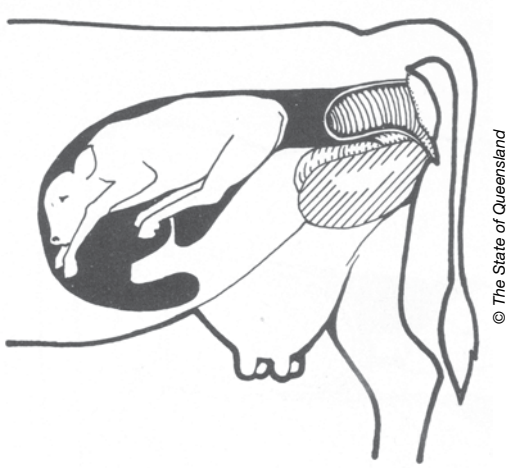
Check progress every 30 minutes during calving, but leave her alone if the calf is coming out. Interfere only if there is no progress and veterinary assistance is not available.

Assisting calving

- Check the birth canal; the cervix must be fully dilated.

Hygiene, lubrication and patience
Before helping the heifer, wash your arms and her vulva with clean soapy water.

- Make sure the calf is in the correct position before applying traction. Most calves are born 'front first' with the two front feet preceding the head. If the calf is backwards, the extended hind legs must come first.



Abnormal position – breech birth

- Do not apply traction if the head or a limb is twisted back and caught.
- Apply the ropes correctly. A noose above the fetlock and a half-hitch at the pastern running along the anterior surface of the leg minimises damage.
- *Anterior presentation.* If the fetlocks can be pulled 10–15cm beyond the vulva with one person on each leg, the points of the shoulders will then be past the birth canal and the calf can be delivered. If not, further traction will only cause pain and damage the heifer. Seek veterinary assistance or euthanase.
- *Posterior presentation.* If the hocks can be pulled past the vulva with one person on each leg, the hips of the calf have entered the birth canal and it can be delivered with traction. If not, seek veterinary advice or euthanase as above.
- Pull the calf downwards. Rotate the calf if its stifle joints become jammed at the pelvis.

7. Weaning

Weaning, and especially early weaning, are for the benefit of the heifer rather than the calf. Lactation generally increases the time it takes for heifers to resume cycling again after calving, especially if body condition was low at calving.

When the calf is weaned, lactation ceases and cycling will often resume. However, to produce a calf every 12 months a heifer or cow needs to re-conceive within three months of calving—well before weaning—and this is only possible if the animal is already in good condition (at least BCS 3.5 on a 1–5 scale).

It is more cost effective to maintain heifer body condition through weaning and appropriate stocking rates than to try to recover lost condition through supplementary feeding. If its condition gets too low, the cow will not start cycling again until she has had a couple of months on good pasture in the wet season.

Weaning age

The timing of weaning is a trade-off between reducing the weight loss from lactating heifers and increasing the weight of their calves. With seasonal mating, even weaning the calf at three months of age is too late if the heifer has lost too much weight to re-conceive while the bull was available, but it will help her to recover before the next mating season.

Weaning strategies

- First-calf heifers should be one of the first groups mustered for weaning.
- Calves can be weaned early down to 100kg (about 3 months old), even lighter if heifer survival is at risk.
- Calves weaned when below 100kg need special high-protein high-energy supplement such as calf pellets, protein meal and molasses supplement.
- Weaners between 100kg and 150kg need protein meal if the pasture quality is too low; older weaners may maintain weight with a NPN-based supplement.

Timing of mating is a trade-off between reducing the weight loss of the lactating heifer and increasing the weight of the calf; it depends greatly on the amount and quality of the pasture available.

Temporary weaning ('shanging') – The concept of temporarily weaning calves to induce breeders to cycle again is neither reliable nor manageable. It involves complete removal (out of sight and hearing) of calf from dam for 48 hours. This concept results in a high risk of mis-mothering.

Weaned calves weighing less than 100kg need high protein and high energy supplements.

8. Diseases

Heifers can be affected by several diseases in northern Australia; some can cause abortion. The most significant diseases include botulism, vibriosis (BVC), pestivirus and leptospirosis.

Botulism

Botulism is probably the most economically important disease in northern Australia as it can cause significant stock losses. Botulism is caused by toxins from *Clostridium botulinum* types C and D, with animals infected through eating carcasses and chewing bones. These behaviours are more common in phosphorus-deficient country and during drought.

Heifer affected by botulism

Phosphorus supplements can reduce bone chewing but all cattle in northern Australia should be vaccinated against botulism at weaning. Effective botulism vaccination programs require booster vaccinations either annually or every three years depending on the type of vaccine used.

Vibriosis

Vibrio is widespread throughout northern Australia.

It is a venereal disease of the reproductive tract caused by a species of *Campylobacter*. Vibrio is more of a problem in heifers than older cows in an endemic situation as they have usually not yet acquired immunity to the disease. It can cause delayed conception patterns and early abortion in pregnant females.

Phosphorus supplements can reduce the risk of botulism but all weaners should be vaccinated and given a regular booster.

Vaccinating heifers before joining can significantly improve conception rates in maiden heifers (by 11%), but the situation on each property depends on the prevalence of the disease and the risk of heifers coming in contact with infected bulls. Station managers can test for the disease and the benefit of vaccination by doing a simple trial—vaccinate every second heifer before joining and record the performance of all heifers.

The current recommendation is to vaccinate young heifers with two vaccinations (around four weeks apart) to give immunity (for one year). However, giving one injection to heifers that are more than 18 months old is also effective, and is easier to implement when heifers are joined for the first time at two years of age. Another injection one to two years later appears to give fairly long-lasting immunity. (Always read the vaccine instructions.)

Leptospirosis

Lepto is widespread amongst cattle in Australia, and can cause abortion in pregnant females, and weakness and even death in calves. While abortion storms may occur, significant loss from lepto on extensive cattle properties in northern Australia is not common. A vaccine is available if an outbreak occurs.

Vaccines can be stand-alone or combined with others vaccines for clostridial diseases

(eg 7-in-1 vaccine includes lepto). Both types require two initial injections at least four weeks apart followed by an annual booster.

Pestivirus or Bovine Viral Diarrhoea Virus (BVDV)

Pestivirus is a common viral infection in many northern Australian herds. It can cause abortions, still births, reduced weight gain and congenital abnormalities in extensive herds.

Calves born from cows that were infected between the 30th and 125th days of pregnancy are persistently infected (known as a PI); they usually show signs of ill thrift and have reduced life expectancy. They are the main cause of spread of the disease.

Pestivirus is transmitted by any body fluid—saliva, nasal secretions, urine, semen and discharged foetal membranes—and so is easily spread.

Large 'crashes' can occur when the disease is introduced to naïve females that are in early pregnancy. The risks are higher when stock control and segregation programs are effective because heifers are more likely to be naive without having been exposed to the disease through mixing with other animals.

It is difficult to quantify the impact of pestivirus in extensive situations.

In herds where the prevalence of pestivirus is low, there is a risk that purchased bulls may introduce it to the herd and cause a 'crash'. Purchased bulls should either be tested to show that they are not a carrier animal (PI) or have been vaccinated.

A vaccine is available for pestivirus. It requires two initial doses (4–6 weeks apart) followed by an annual booster.

The prevalence of pestivirus varies from herd to herd so blood samples from heifers should be tested to see whether vaccination would be beneficial. In some herds, pestivirus has been found to be so widespread that most animals have been exposed to the disease and gained immunity before they reach breeding age.

Once animals have been infected naturally, they gain immunity for life and there is no benefit in vaccinating them. However, vaccination can be economically worthwhile if there are large numbers of susceptible animals in the herd.

More information on pestivirus can be found at www.bvdvaustralia.com.au.

Bovine ephemeral fever (Three-day sickness)

Three-day sickness is a viral disease spread by biting midges and mosquitoes. It can cause early abortion (up to three months) and even death although most animals recover fully. It can also result in losses and mis-mothering if heifers are infected during calving or when they have young calves at foot.

Ephemeral fever (three-day sickness) can cause early abortion in heifers.

Classical symptoms of the disease are fever and lameness (infected animals often lie down) lasting for about three days. After an infection, most animals maintain their immunity.

A vaccine is available; vaccinating bulls to prevent infertility during mating periods may be beneficial where three-day sickness is a problem.

Trichomoniasis, Neospora caninum and **Akabane virus –** These are known to cause calf losses in northern Australia, but are thought to be less serious than the other diseases mentioned. Less is known about their prevalence and impact. Trichomoniasis is a venereal disease and is more likely to be a problem in herds where old bulls are mated with heifers.

9. Artificial insemination in maiden heifers

Maiden heifers are a good group for running an artificial insemination (AI) program when planning genetic improvement by breeding bulls using elite semen with the best EBVs.

An AI program should be conducted at the normal joining starting time.

Positives

- Maiden heifers should represent the most genetically advanced group of females in the herd as each generation is better than the previous when genetic progress is being made through selection.
- There are no calves at foot, unlike lactating breeders, so management (eg synchronisation programs) and handling is easier, and the AI program can occur in the wet season.
- As long as the heifers are above their critical mating weights and in good condition, pregnancy rates will be optimised.

Negatives

- There is no opportunity to select for fertility in heifers as their performance is not known.
- Maiden heifers are more prone to diseases such as Bovine Viral Diarrhoea Virus (BVDV), ephemeral fever and Akabane due to lack of previous exposure.
- Maiden heifers can display poor mothering abilities.
- Dystocia is more common in heifers.
- Heifers are generally more excitable and more easily stressed with handling.

There are a number of ways AI programs can be run. The choice of breeding program depends on the time and resources available—in one, insemination is based on visual signs of standing heat, others have fixed time insemination.

Both types of programs need certain conditions and management procedures to be undertaken before the AI program.

Heifers selected for AI must be above their critical mating weight and in condition score 3.5 (1–5) or higher.

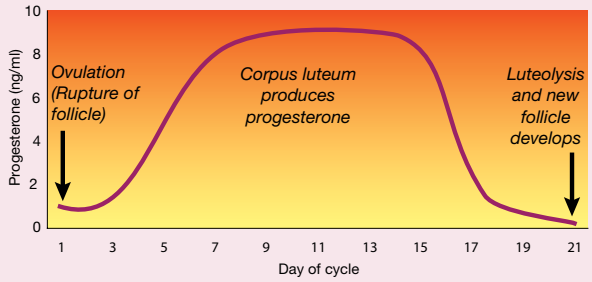
- All heifers must be above their critical mating weight and in condition score 3.5 (scale 1–5) or higher to ensure they are cycling.
- Cycling can be checked by ultrasonic examination of the ovaries to see if there is a corpus luteum present (optional).
- Assess the risk of the various diseases and vaccinate accordingly. Although heifers in an AI program should not require a vaccination against vibriosis, it is still advisable in high-risk environments as cover-up bulls will be used after the AI program.
- Heifers should be prepared with handling well before the program – yard feeding and education through the race and crush.

Visual signs of standing heat – heat mount indicators

Synchronising oestrus

The cycling heifer will come on heat approximately every 21 days until she becomes pregnant. After the follicle ruptures and the egg is released on day 1, a corpus luteum (CL) develops. The CL produces progesterone. If fertilisation fails to occur, the uterus produces prostaglandin around day 15 and this causes the CL to break down and another follicle starts to emerge.

Figure 9.1. The reproductive cycle



In every group of heifers, there will be heifers at every stage of the oestrous cycle—if there were 21 heifers in a group, one could come on heat every day. Thus an artificial insemination program which inseminated heifers as they came on heat naturally would take three weeks to complete. As this is often impractical, synchronisation programs can be used to bring all heifers on heat within a few days.

There are a number of methods of oestrus synchronisation for AI programs.

Prostaglandin

Prostaglandin causes the CL to break down so that the heifer comes into heat in 3–5 days. It works only when a CL is present, ie on heifers that are in days 6–16 of their oestrus cycle.

Prostaglandin can be used in two different AI programs:

Program 1

Day 1: Inject all the heifers with prostaglandin and inseminate all the heifers that come into heat over the next five days (most will come on heat two days after injection)—this will include the heifers that had a CL (days 6–15) and the heifers which would have come into heat naturally. However, about a quarter of the heifers will not show signs of heat as these were in days 1–5 of the cycle when the first dose of prostaglandin was administered (and no CL was present). Also heat is difficult to detect in some *Bos indicus* heifers.

Day 8: Give a second injection to those heifers that did not come on heat after the first injection; these were the heifers that were in days 1–5 when the first dose of prostaglandin was administered. Inseminate them as they come on heat over the next 3–5 days.

Program 2

Day 1: Inject all heifers with prostaglandin.

Day 10: Inject all heifers once more. Most heifers should now come on heat in the next 3–5 days. Inseminate them as they come on heat.

Progesterone

Oestrus can also be synchronised using controlled-release progesterone implants/devices that are normally inserted in the vagina. This delays the heat cycle for all heifers that have a CL and allows the others in days 15–21 and days 1–5 of the heat cycle to advance into the CL phase. The intra-vaginal devices are removed about day 8 and all the heifers are inseminated on a date set by the drug regime being implemented.

Pregnancy rates from blanket insemination programs may appear lower than from natural heat detection where some heifers may not eventually be inseminated. Pregnancy rates over the whole mob may well be similar for both systems, and blanket insemination saves time and the cost of heat-detection devices.

With either system, mop-up bulls (BBSE tested and at 3 per 100 heifers) should be put in with the heifers two weeks later. At 9–12 weeks after the AI program, an experienced pregnancy tester should be able to distinguish between those pregnant by AI and those by natural service.

Appendix 1
Body condition and predicted pregnancy rates for lactating first-calf heifers

About 80% of well-grown maiden heifers mated for up to four months can be expected to become pregnant, but it is usually difficult to get them to reconceive during lactation.

Pregnancy rates in lactating first-calf heifers are usually the lowest of any class of females.

Heifers need to be in good condition before calving to have sufficient body reserves to provide milk for their calf and to become pregnant again while lactating.

The predicted pregnancy rate for lactating first-calf Brahman heifers for each pre-calving body condition score (BCS), with its associated body weight, is shown in Table A.1.1.

Table A.1.1. The effect of body condition score (BCS), and associated pre-calving weight, on predicted pregnancy rates for lactating first-calf heifers.

Pre-calving BCS (1-5 system)	Pre-calving weight (kg) (uncorrected*)	Predicted pregnancy rate
1 (poor)	335	12%
2 (backward)	395	30%
3 (moderate)	450	55%
4 (forward)	510	77%
5 (fat)	570	90%

*These weights are for heifers weighed about two months before calving (ie seven months pregnant), and have not been corrected for stage of pregnancy. To calculate the heifer's own body weight, subtract the weight of the foetus (about 30kg at seven months of pregnancy) from the weight of the pregnant animal.

BCS 3 (moderate)

Heifers in BCS 3 before calving should have a more than 55% chance of re-conception during lactation if nutrition is adequate

BCS 4 (forward)

Heifers in BCS 4 before calving should achieve re-conception rates of around 75% during lactation if nutrition is adequate.

Appendix 2
Heifers in the Northern Territory

Surveys of the Northern Territory pastoral industry during the Meat & Livestock Australia heifer research projects (MLA projects NBP.344 and NBP.345) give the most recent summary of current industry management practices and attitudes to heifer management.

Surveys in 2004 and 2009

Managers of cattle stations in the Northern Territory were surveyed in 2004 and again in 2009—before and after the MLA project on heifer management.

The 2004 survey showed that most properties joined maiden heifers at two years of age; only 10% joined as yearlings or as three-year olds. Most segregated their heifers until after their first joining (Table A.2.1); those that did not segregate said that they did not have enough paddocks. In 2004, re-conception rates in first-calf heifers were estimated to average 63%. By 2009 at the end of project, re-conception rates in first-lactation heifers were more realistically estimated at 42% illustrating that managers had become more aware of the problem of low fertility in first-calf heifers.

Table A.2.1. Percentage of properties that segregate heifers from breeders

Region	% of properties segregating heifers
Darwin	65%
Katherine	78%
Barkly	82%
Alice Springs	58%

Replacements

On average, properties keep about 60% of their heifers as replacements, and these are selected on temperament, conformation and type just before the first joining as two-year-olds. Most managers nominated a target joining weight for heifers of around 290kg but few properties actually weigh their heifers (around 20% in the Barkly and Katherine regions, 10% in the Top End and 5% in the Alice Springs region).

Joining

Most properties use continuous mating after bulls are introduced to heifers for the first time. Maiden heifers were more likely to be control-mated—with bulls removed after a set joining period—than were breeders (Table A.2.2). When heifers were mated for the first time, it was most common to use young bulls (three-year-old) at a rate of 4%.

Continuous mating in the breeder herds was used because of a shortage of paddocks and labour, and because it was too difficult to control the bulls. Where controlled mating was practised, the mating period was most commonly about five months.

Weaning

All properties, except about 6% in the Alice Springs district, weaned. Most properties weaned their heifers into their normal mustering program in April–May, but some tried to wean them earlier.

Heifer management

The 2004 and 2009 surveys showed some change in attitudes towards heifer management, and in the proportion of properties that used different vaccinations and supplementation regimes.

By 2009, most managers were aware of the importance of body weight and condition in determining heifer fertility (Tables A.2.3 and A.2.4), while nominating nutrition and season as the most important factors.

When asked to score different management strategies for increasing heifer fertility, managers rated most strategies in Table A.2.4 highly. Exceptions were fertility testing of bulls, bull control (preventing out-of-season pregnancies) in the Barkly and Alice Springs districts, and using lighter stocking rates to increase fertility (except for in the Alice Springs district where this was seen to be quite important).

Table A.2.2. The percentage of properties in each region that identify an issue as the major factor affecting fertility of maiden heifers (2004)

	Weight / Condition	Nutrition / Season	Genetics	Disease	Supplementation	Bull %
Top End	14%	57%		14%		14%
Katherine	67%	22%	11%			
Victoria River Downs	60%	40%				
Sturt Plateau	36%	27%	18%		18%	
Barkly	25%	75%				
Alice Springs	67%		17%	17%		
Overall average	45%	39%	8%	6%	4%	2%

Table A.2.3. The percentage of properties in each region that identify an issue as the major factor affecting fertility of first-calf heifers (2009)

	Weight / Condition	Nutrition / Season	Weaning	Genetics	Disease	Supplementation	Bull %
Top End	14%	71%					14%
Katherine	78%	22%					
Victoria River Downs	40%	30%	30%				
Sturt Plateau	18%	55%		9%		18%	
Barkly	25%	75%					
Alice Springs	50%		17%	17%	17%		
Overall average	37%	45%	8%	4%	4%	4%	2%

Table A.2.4. Importance of different management strategies in improving fertility. (Average of scores given by managers in each region where 1 = strongly disagree, 3 = neutral, 5 = strongly agree)

	Darwin	Katherine	Barkly	Alice Springs	Overall
Segregation of heifers from breeders	3.6 –	4.3 =	4.5 +	4.5 +	4.2
Bull control (prevent out of season preg.)	4.1 –	4.0 =	3.1 –	3.0 +	3.8
Supplementation to increase weight	3.9 –	4.3 =	4.1 +	4.5 +	4.3
Use of better paddocks to increase weight	4.0 –	4.1 =	4.5 +	4.8 +	4.3
Vaccination against disease	3.1 –	4.4 +	3.9 –	4.3 +	4.2
Timing of weaning	4.4 =	4.5 +	4.4 =	4.0 +	4.4
Early weaning of calves from heifers	3.6 =	4.3 =	4.4 +	4.8 +	4.2
Bull fertility testing	3.9 –	3.7 –	3.9 =	3.5 =	3.7
Bull % used when mating heifers	4.0 –	4.3 =	4.1 =	4.0 =	4.2
Genetics / selection for fertility	4.4 +	4.5 =	4.6 +	4.0 =	4.4
Using lighter stocking rates to increase weights	2.9	3.6	3.6	4.7	3.7

Note: +, – and = are used to show where the 2009 results were higher (+), lower (–) or the same (=) as the 2004 survey results.

Managers in the regions with the highest and most seasonal rainfall (the Top End) rated bull control (or preventing out-of-season pregnancies) more highly than those with lower and less seasonal rainfall.

Supplementation

Around 70% of all properties supplement maiden and first-lactation heifers, either just during the dry season or throughout the year. Wet-season supplements are fed by 53% of properties to maiden heifers and by 58% of properties to first-calf heifers (again either just during the wet season or all year round). The percentage of properties that supplement maiden heifers at different times of year is shown in Table A.2.5.

Vaccination

Most properties vaccinate against botulism, but few against other diseases (Table A.2.6). More started vaccinating against vibriosis over the course of the heifer project; this may have followed the finding on one demonstration site that vaccinating maiden heifers against vibrio increased conception rates by 11%.

Table A.2.5. Percentage of properties that supplement maiden heifers at different times of year

	All year	Dry season / Winter	Wet season / Summer	Depends on season	Never	Only if essential for survival
Top End	71%		14%	14%		
Katherine	67%	22%		11%		
Victoria River Downs	10%	50%		10%	30%	
Sturt Plateau	82%		9%	9%		
Barkly	25%	13%		25%	25%	13%
Alice Springs	33%	17%	17%	33%		
Overall average	47%	21%	6%	15%	9%	2%

Table A.2.6. Percentage of properties that give certain vaccinations to their heifers

	Botulism	7-in-1	5-in-2	Vibriosis	Pestivirus (BVDV)	No vaccinations
Top End	57%	29%		43%	14%	14%
Katherine	100%	11%	11%		11%	
Victoria River Downs	100%	30%		30%		
Sturt Plateau	91%	27%	9%	45%	9%	
Barkly	75%			13%		13%
Alice Springs	67%			50%	17%	33%
Overall average	85%	17%	4%	28%	8%	8%

Appendix 3
Heifers in northern Western Australia

A project to improve the performance of heifers and young breeders in the Pilbara and Kimberley regions of WA was carried out between 2005 and 2009. This project was similar to part of the work conducted in the Northern Territory (See Appendix 2).

The Western Australia project benchmarked the performance of heifers and young breeders under current management systems and, in consultation with pastoralists, developed, demonstrated and evaluated a practical system to improve their performance.

The key findings from four Pilbara herds included:

- Weaner heifer weights averaged 189kg (143–218kg).
- Growth rates of heifers over the 12 months following weaning averaged 108kg (79–124kg).
- Conception rates in the year following weaning averaged 44% (22–64%). This indicates that many heifers are reaching puberty early and hence the futility of bull control in extensive systems.
- Heifers that conceived were heavier at pregnancy testing (337kg) than empty heifers (301kg).
- Conception rates of first-calf heifers during lactation averaged 48%.
- Calf losses after confirmed pregnancy ranged from 16% to 22% for heifers pregnant for the first time.
- 'Missing' rates (animals missing at two consecutive musters) ranged from 2% to 18%.
- Missing rates (missing at three consecutive annual musters) of females calving for the first time during the failed 2004–05 growing season were 18% compared to 9% for heifers not calving at that time. This confirmed the need for a 'heifer paddock' to facilitate targeted management practices as part of any improved young breeder management.

The heifer and young breeder management system developed and demonstrated at Warrawagine Station in the Pilbara included:

- segregating heifers and young breeders from the breeder herd until they weaned their first calf
- mustering this group and weaning calves twice each year
- pregnancy testing and culling all dry and empty females in the second year following weaning (nominal three-year olds).

Segregating this group provided an opportunity for any appropriate supplementation (phosphorus during the wet season and possibly urea during the dry season) to maintain body condition and so to improve conception rates during lactation.

Some key animal performance data recorded from a group of about 1,500 year-No. 5 heifers first mated in 2007 at Warrawagine Station included:

- heifer conception rates of 78% of dry heifers tested in September 2007 (note that 22% of this whole age group were not tested as they were already lactating)
- conception rate during first lactation was 48% (one year of data only)
- botulism vaccination reduced missing rates from 14% to 7% over three years. This emphasises the importance of botulism vaccination on phosphorus-deficient country.

The co-operation and support of the Mills family of Warrawagine Station and many Pilbara and Kimberley pastoralists during this project is gratefully acknowledged.

A full report of the WA project can be seen at:
www.mla.com.au/Research-and-development – then search for 'NBP.345' or 'young breeder WA'.

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