Technical synopsis: CashCow findings

Insights into the productivity and performance of northern breeding herds

MEAT & LIVESTOCK AUSTRALIA

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Insights into the productivity and performance of northern breeding herds

This synopsis was drawn from the CashCow final report (B.NBP.0382 – Northern Australian beef fertility project), which was prepared by the project team of Michael McGowan, Kieren McCosker, Geoffry Fordyce, Dave Smith, Peter O'Rourke, Nigel Perkins, Tamsin Barnes, Louise Marquart, Sandi Jephcott, John Morton, Tom Newsome, Don Menzies and Brian Burns. The final report can be found on the Meat & Livestock Australia website at **www.mla.com.au/cashcow**.

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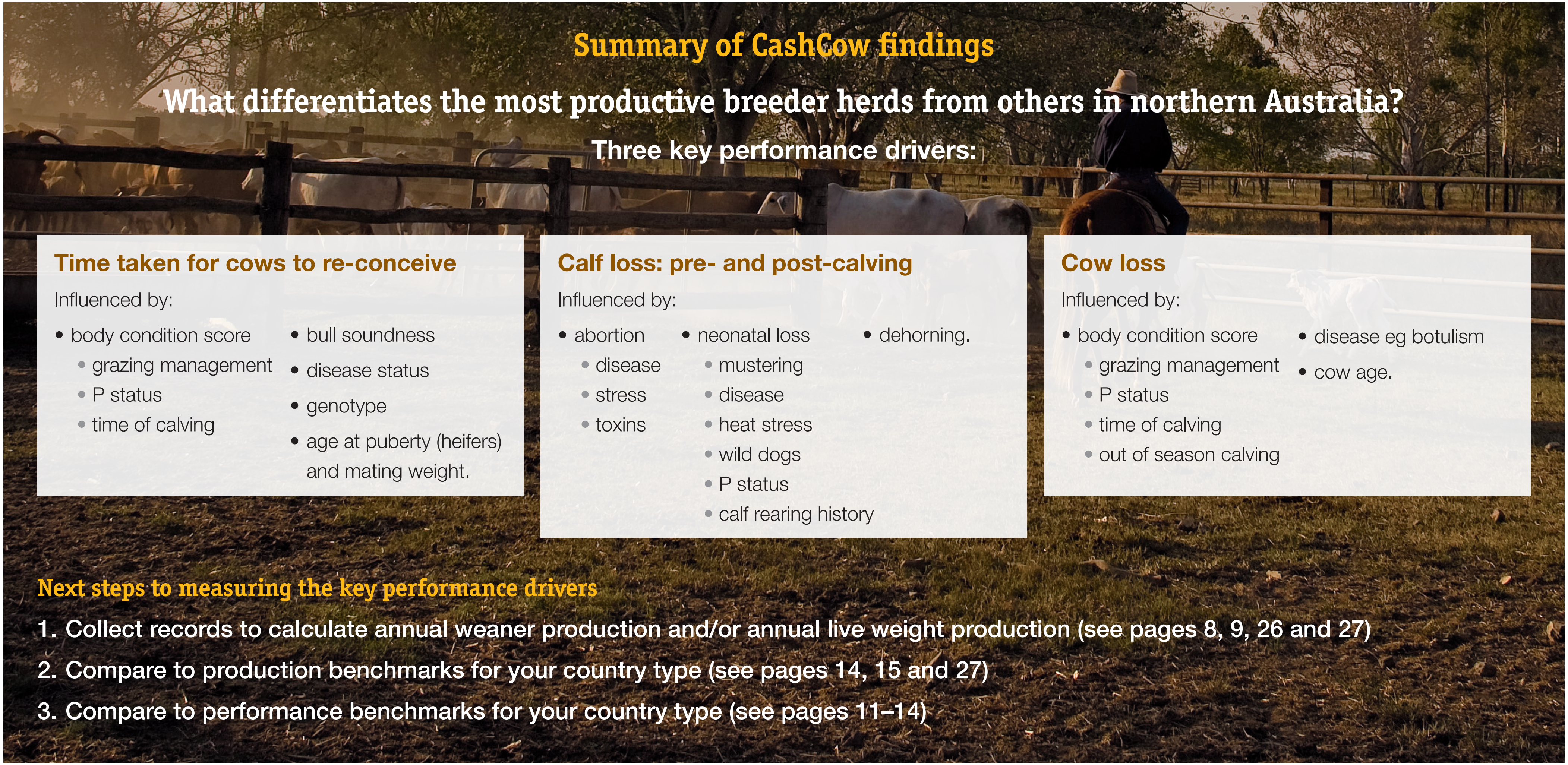
Contents

1. Purpose of this synopsis

The CashCow project (Northern Australian beef fertility – B.NBP.0382) has produced much useful data, benchmarks and insights about the productivity and performance of breeding herds in northern Australia. All of this has been captured in the project's final report and will also be communicated by the project team through research papers submitted to various scientific journals.

The purpose of this synopsis is to provide those involved with research, advisory services or beef production in northern Australia with a technical overview of the key data sets and insights from the project. It will also help inform development of products and activities designed to increase adoption of management practices that increase profits for beef producers.

1. Purpose of this synopsis



Summary of CashCow findings

What differentiates the most productive breeder herds from others in northern Australia?

Three key performance drivers:

Time taken for cows to re-conceive

Influenced by:

- body condition score
  - grazing management
  - P status
  - time of calving
- bull soundness
- disease status
- genotype
- age at puberty (heifers) and mating weight.

Calf loss: pre- and post-calving

Influenced by:

- abortion
  - disease
  - stress
  - toxins
- neonatal loss
  - mustering
  - disease
  - heat stress
  - wild dogs
  - P status
  - calf rearing history
- dehorning.

Cow loss

Influenced by:

- body condition score
  - grazing management
  - P status
  - time of calving
  - out of season calving
- disease eg botulism
- cow age.

Next steps to measuring the key performance drivers

1. Collect records to calculate annual weaner production and/or annual live weight production (see pages 8, 9, 26 and 27)
2. Compare to production benchmarks for your country type (see pages 14, 15 and 27)
3. Compare to performance benchmarks for your country type (see pages 11–14)

The above findings from CashCow concur with those of the northern beef situation analysis which identified the top 25% producers influence their herd productivity by:

1. Reproduction rate
2. Mortality
3. Turnoff rate

These findings are outlined in MLA's publication *Improving the performance of northern beef enterprises* **www.mla.com.au/northernperformance**

1. Purpose of this synopsis

Tools and resources

Attend

- Breeding EDGE – assists northern producers to develop a breeding program or improve their existing one. It uses reproductive and genetic knowledge and technologies to achieve desired production targets.
- Nutrition EDGE – gives a comprehensive look at ruminant nutrition. The topics covered include minerals and managing deficiencies, pasture growth and quality, and grazing management.
- Grazing Land Management – allows producers to assess the condition of paddocks, understand more about the grazing ecosystem, match stocking rate to carrying capacity and determine the financial impact of grazing management options.
- Business EDGE – enhances producer knowledge and skills in basic financial and business management to improve beef business efficiency and profitability.

Go to **www.futurebeef.com.au** for event details.

Read

- *CashCow final report* **www.mla.com.au/cashcow**
- *Improving the performance of northern beef enterprises* **www.mla.com.au/northernperformance**
- *Heifer management in northern beef herds manual* **www.mla.com.au/heifermanual**
- *Weaner management in northern beef herds manual* **www.mla.com.au/weanermanual**
- *Managing the breeder herd – Practical steps to breeding livestock in northern Australia* **www.mla.com.au/breederherd**

Calculate

- The breeder mortality calculator assists cattle producers in using their own property records to determine levels of breeder mortality in their herds. **www.mla.com.au/breedermortality**

2. Introduction

Reproduction rate is one of the key profit drivers for beef cattle enterprises in northern Australia. Previous research and extension has provided a significant legacy, however, there is a general perception that many properties still have significant potential for cost-effective improvement of reproduction rates.

Reproductive efficiency has been a difficult term for industry to define and measure with consistency, especially in herds with extended or year-long joining. In simple terms, it can be described as the natural rate of increase in herd numbers. Its most common measure has been weaning rate (calves weaned divided by the number of cows), but the reported rates often do not stipulate how the denominator was defined (eg was it the number of cows exposed to the bull or those retained after pregnancy testing?) or how it caters for extended joining times, the sale of cull cows or the addition of replacement heifers. Weaner output is not determined solely by the ability of the female to conceive, as losses may arise from embryonic loss (prior to pregnancy testing), abortions and calf losses right through to weaning. In addition, sale of culled or surplus cows is a significant source of income, so analysis of the productivity of the cow herd needs to also account for the weights of cull cows sold and those that die in the paddock.

Useful benchmarks for cow herds in the varied environments of northern Australia are absent, largely due to a lack of representative data on the components of reproduction.

The CashCow project monitored commercial mobs of cattle to measure their rates of conception, the time to reconceive after calving, calf loss and cow loss, as well as evaluating various measures of cow herd productivity in terms of kilograms of beef produced. It then related variation in performance between mobs, and between broad regions, to various environmental and management factors. These outputs will improve producers' capacity to identify the potential for increasing cow herd productivity and allow them to assess how this can be most cost-effectively achieved.

In summary, CashCow is an MLA-supported project conducted on commercial beef herds right across the northern Australia. The project:

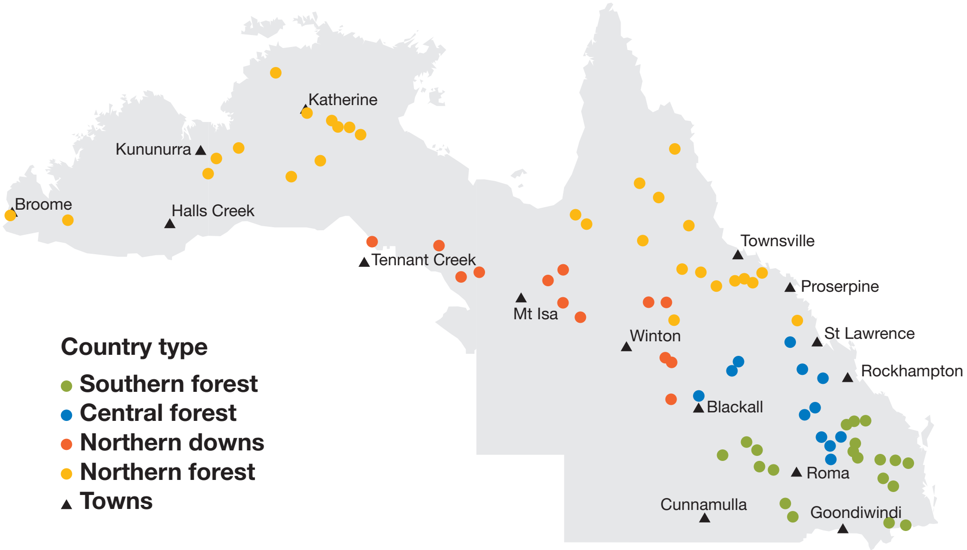
- measured reproductive performance including conception, calf loss and cow loss
- defined new terminology to measure mob production and mob performance
- analysed the variation in performance and identified factors explaining the variation
- defined what is realistically achievable for broad country types.

3. Methodology

The CashCow project took an epidemiological approach, similar to the dairy industry's InCalf project. It took measurements from commercial mobs of cattle over a four-year period. Seventy-two properties, distributed across the major beef breeding regions of northern Australia (see map) participated in the project. It involved about 78,000 cows managed in 142 breeding mobs. Cattle in each breeding mob were monitored for three or four consecutive years (2008–11) using a crush-side electronic data capture system.

The 72 properties were grouped into four broad country types based on vegetation type and subjective assessment of production potential (see figure 1). Data collection began in 2008 with 13 pilot herds to test the systems and procedures; the majority of mobs (118) were enrolled in 2009. Additional maiden heifer mobs were recruited in 2010 (9 mobs) and 2011 (2 mobs).

Figure 1: Locations of properties participating in CashCow



The four broad country-type categories are based on their geographical location and perceived beef production potential:

- Southern Forest: eucalypt woodland country with a range of soil types and landforms; in the study, all such sites were south of Rockhampton.
- Central Forest: mixed country types within the Queensland Brigalow Belt.
- Northern Downs: typically heavy clay soils on open plains.
- Northern Forest: eucalypt woodland country with a range of soil types and landforms; in the study, all such sites were north of an east-west line through St Lawrence.

The number of mobs enrolled from each country type is shown in Table 1.

Table 1: Number of mobs enrolled in each country type by cow age class/cohort of female

Country type	2008 Heifers	2009 Heifers	2010 Heifers	2011 Heifers	2009 Cows	TOTAL
Southern Forest	3	13	1	1	22	40
Central Forest	3	8	1	0	13	25
Northern Downs	4	8	2	1	13	28
Northern Forest	3	14	5	0	27	49
Total	**13**	**43**	**9**	**2**	**75**	**142**

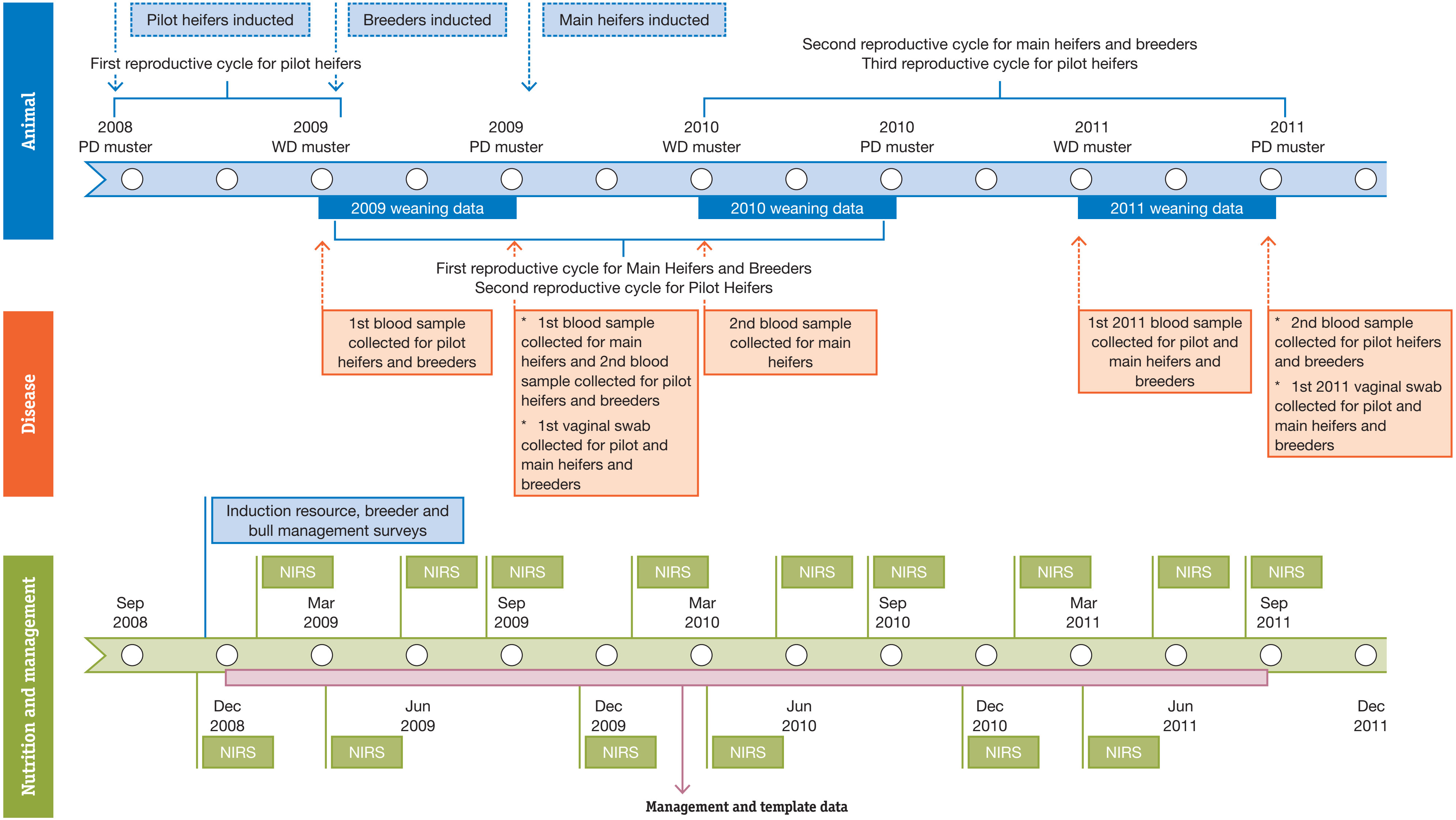
Animal data: All animals enrolled in the project were identified with an NLIS ear tag and a CashCow management tag. Pregnancy status and foetal age were assessed by accredited veterinarians.

Each cow was recorded for pregnancy status and foetal age (once per year), lactation status (twice per year – wet or dry), body condition score (twice per year – scale of 1–5). Liveweights were recorded (where scales were available) along with hip height and Bos indicus content. Blood samples were collected from a sub-sample of females (10–30) within each enrolled mob at the time of the wet/dry muster and then again from the same females at the pregnancy diagnosis muster. These samples were taken in 2009 and 2011 to establish evidence of previous incidence of infection with pestivirus, vibriosis, neospora, three day sickness (BEF), Q fever and leptospirosis.

The weaner data recorded included weight, sex and horn status. Where a mob was part of a large group of cows, a random sample of weaners was weighed to ascertain average weight of the weaners.

3. Methodology

*Figure 2: The timing of events and measurements during CashCow**



* It is important to note that timing of measurements such as body condition score (BCS) is crucial to interpreting and applying the insights from CashCow. The CashCow Final Report refers to measurements at the wet/dry muster (Feb–Apr at most sites) and at the pregnancy diagnosis muster (Jul–Sep at most sites). As properties will vary as to when they undertake pregnancy diagnosis, this synthesis report refers to the actual timing of the CashCow measurements, eg BCS data is reported as being at Feb–Apr or Jul–Sep, not as BCS at weaning muster or PD muster.

3. Methodology

Management, environmental and nutritional data: the box below summarises the various data and samples collected. Animal data was collected by trained data collectors (weaner weights are an exception where producers collected some of that data when necessary). Property data was mostly collected by the cooperating producers. Pasture quantity and land condition was assessed based on Stocktake principles. Temperature was collected from the Bureau of Meteorology (BOM) website and distance to water was mapped using satellite imagery. Producers collected dung samples for analysis by Near Infrared Reflectance Spectroscopy (NIRS) to estimate dietary dry matter digestibility (DMD) and crude protein (CP) content. A questionnaire for each cooperating producer was developed to collect other key information, such as rainfall, pests (including wild dogs) and known disease incursion, herd size and fence security. The survey included mustering technique, supplementary feeding, vaccination programs, selection, joining, weaning, culling and genetic improvement policies. Animal, property and management data were used to help explain variation in performance between mobs.

Table 2: Data collected by CashCow

Animal data	Property data	Management information
Pregnancy status	Land condition	Supplementation
Weight	Pasture assessment	Bull management
Condition score	Weaner weights	Vaccinations
Lactation status	Rainfall	Mustering dates
Hip height	Temperature	Wild dog control
Age	Dung samples	Mustering techniques
Bos indicus content	Distance to water	Genetic selection
Udder structure	Culls	Joining dates
Disease prevalence		Weaning management

3.1 Data analysis

The measures used to define the performance of the CashCow mobs were:

- pregnancy rate within four months of calving (referred to as 'P4M'; percentage of cows most likely to wean a calf in consecutive years) [1]
- annual pregnancy rate
- percentage foetal/calf loss
- annual percentage of pregnant cows missing (an estimate of mortality rate).

Three productivity measures were calculated for each mob in each year:

- **Annual weaner production (kg/cow/year)**, which is the kilograms of weaner produced per cow retained. This was calculated as follows:

  Lactation rate (calves weaned/retained cows) X the average weaner weight

  For example: 100 retained cows, 75% lactation rate, average weaning weight of 200kg

  ((100x0.75) x 200)/100 = 150kg/cow/year

This measure is easy to calculate, but results from year to year can be highly variable where cows are calving every second year (ie high number of weaners one year, followed by low number the next year).

- **Annual liveweight production (kg/cow/year)**, which goes one step further than annual weaner production as it encapsulates the body weight changes and the mortality/missing rate of the cows. This was calculated as follows:

  Annual weaner production + (Average cow liveweight at end of cattle year x (1 – Cow mortality rate)) – Average cow liveweight at start of cattle year

  For example: 100 cows,75% lactation rate, average weaning weight of 200kg, 2% cow loss. Cows weighed 400kg last year and 420kg this year.

150 + (420 x 0.98) – 400

= 162kg/cow/year

1 Note that P3M (cows with a 12-month inter-calving interval) did not provide sufficient data for meaningful analyses.

3. Methodology

Compared to annual weaner production, annual liveweight production is a more stable indicator of 'kilograms of beef produced' as cows that didn't wean a calf will still put on weight themselves. This index is more difficult to produce as livestock schedules, transactions and cow liveweights need to be recorded annually.

- **Liveweight production ratio (kg/kg of cattle/year)**, which calculated as:

Annual liveweight production (per cow)/Average liveweight of a cow-calf unit over the year
The denominator = (Average weight of a cow during the year) + ((average weight of a weaner between birth and weaning) x (proportion of the year that a weaner is on the ground))

*= ((SW + EW) / 2) + ((LR * (WW +35) / 2)* ((WW – 35) /330)*
Where:
SW = Average cow liveweight at start of cattle year
EW = Average cow liveweight at end of cattle year
LR = Lactation rate
WW = Average weaner weight

For example: 100 cows,75% lactation rate, average weaning weight of 200kg, 2% cow loss. Cows weighed 400kg last year and 420kg this year.

162 / ((420 – 400)/2) + ((0.75 x (200 + 35)/2) x ((200 – 35)/330))
= 162 / (410 + (88.1 x 0.5)
= 162 / (410 + 44.0)
= 0.36

In this example, there was a 36kg net increase in liveweight for every 100kg of cattle grazing that paddock over a one year period.

This is a more complex measure but provides an indication of biological production efficiency. The denominator (total liveweight grazing the paddock(s) for the year) is an indicator of pasture demand.

For each measure of performance, the association with 80 factors (including management, environmental, nutritional, and infectious disease) was assessed by screening one factor at a time. The factors identified as being associated with variation in performance between mobs were combined into a multi-factor analysis. This helped identify which factors, alone and in combination, were most useful in helping explain variation in mob performance. Analyses focused on four age cohorts – heifers, first lactation cows, mature cows and old cows (further defined in appendix), and also on the four regions or broad country types – Southern Forest, Central Forest, Northern Forest and Northern Downs.

The cow age classes were defined as follows:

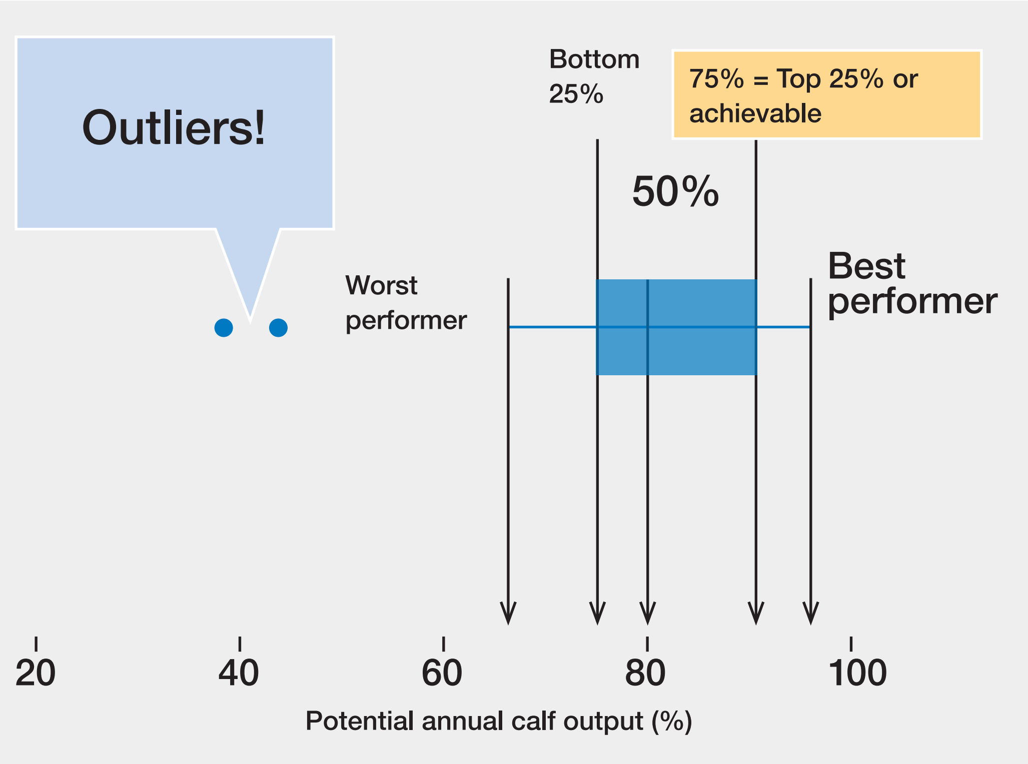
- first lactation cow: cow during the period when the majority of her cohort is experiencing their first lactation
- second lactation cow: cow during the period when the majority of her cohort is experiencing their second lactation
- mature cow: cow after the time when her cohort has weaned their second age group of calves
- aged cow: cows older than nine years.

Production and performance measures are described in quartile ranges. These benchmarks can be used to judge how a particular mob of cows is performing in relation to the four broad CashCow country types. Once several years of a particular mob's data are collected, it can be used to benchmark trends over time.

3. Methodology

The variation in performance of mobs was expressed either in tables with the median (50th percentile) value and the 25th to 75th percentile range, or with 'box and whiskers' diagrams. In the latter, the central line in the 'box' is the median (50th percentile or middle) performance value. The left edge of the box is the 25th percentile performance value (25% of values recorded were less than this value) and the right edge is the 75th percentile value (25% of values recorded were higher than this value). The extremities of the 'whiskers' (the lines extending left and right from the box in figure 3) represent what could be considered the typical range of performance values recorded. Values that are numerically quite different to the rest of the data recorded (outliers) have been represented with dots.

Figure 3: Graphical presentation of results – 'the box and whiskers diagram'



4. Findings

The findings of the CashCow project are in four main forms:

- Performance benchmarks in each of the four broad regions for:
  - proportion pregnant within four months of calving (P4M)
  - annual pregnancy rates
  - foetal and calf loss
  - cow mortality/missing rate
- Productivity benchmarks in each of the four broad regions for:
  - weaner production
  - liveweight production
  - liveweight production ratio
- Factors that help explain variation in reproductive performance, including a range of management, environmental and nutritional factors.
- Descriptive data on liveweights of cows, *Bos indicus* content of herds and disease incidence.

Each of the four performance measures were derived for a specific mob of cows on the cooperating property, not for the whole cow herd on the property.

4.1 Achievable performance

CashCow established varying levels of reproductive performance for the four broad country types. The average performance for each mob, within each country types, was ranked from highest to lowest, and the values corresponding to the 25th percentile, 50th percentile and 75th percentile was derived.

The assumption was made that, for each broad country type, the 75th percentile for pregnant within four months and annual pregnancy rate, and the 25th percentile for calf loss and cow loss, were performance indicators that were possible targets to achieve but additional input costs always need to be considered when improved performance is attempted. It is recognised, that some of the variation in performance within a broad country type was due to seasonal variation and variation in soil type.

4.1.1 Pregnant within four months of calving (P4M)

P4M provides an indication of the probability of weaning a calf in consecutive years. Relatively high levels of P4M are required for properties to employ controlled mating (typically for up to three months). In other situations, mating for up to seven months or on a continual basis is conducted.

Median rates of P4M in mature cows were 68%–77% in all broad country types, except for Northern Forest, where it was only 17%.

First lactation cows performed the worst – median rates of P4M were < 50% in all regions and down to 11% in Northern Forest.

Table 3: First lactation cows – P4M%

Country type	No. of mob-years	Percentage P4M (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	15	22	**37**	80
Central Forest	11	33	**49**	68
Northern Downs	12	27	**45**	69
Northern Forest	15	6	**11**	18
Overall	*53*	*16*	***35***	*62*

* 75th Percentile = achieved by the top 25% of producers in the study.

4. Findings

Table 4: Second lactation cows – P4M% (First lactation cows that reconceived withing 4 months of calving)

Country type	No. of mob-years	Percentage P4M (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	12	52	66	84
Central Forest	10	56	64	74
Northern Downs	7	60	62	67
Northern Forest	11	0	6	45
Overall	*40*	*46*	*61*	*69*

* 75th Percentile = achieved by the top 25% of producers in the study.

Table 5: Mature and aged cows – P4M%

Country type	No. of mob-years	Percentage P4M (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	36	39	74	85
Central Forest	22	56	77	84
Northern Downs	21	60	68	76
Northern Forest	44	7	17	31
Overall	*123*	*18*	*55*	*77*

* 75th Percentile = achieved by the top 25% of producers in the study.

4.1.2 Annual pregnancy rates

The annual pregnancy rate is not a very discerning indicator of fertility. For example, the median rates found in CashCow were modest – high in all regions and cow classes except for all classes of female in the Northern Forest. In general, a low rate of annual pregnancy points to a major issue, such as disease or a major climatic event.

In continuously mated herds, a high annual pregnancy rate simply indicates that a high proportion of cows will get pregnant eventually. Annual pregnancy rate also does not pick up slippage in the inter-calving interval.

Table 6: Heifers – annual pregnancy %

Country type	No. of mob-years	Annual pregnancy (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	17	75	89	93
Central Forest	11	75	80	87
Northern Downs	14	77	87	94
Northern Forest	20	40	67	81
Overall	*62*	*65*	*80*	*90*

* 75th Percentile = achieved by the top 25% of producers in the study.

Table 7: First lactation cows – annual pregnancy%

Country type	No. of mob-years	Annual pregnancy (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	15	68	84	91
Central Forest	11	67	78	85
Northern Downs	12	47	75	86
Northern Forest	15	21	43	72
Overall	*53*	*48*	*77*	*86*

* 75th Percentile = achieved by the top 25% of producers in the study.

Table 8: Mature and aged cows – annual pregnancy%

Country type	No. of mob-years	Annual pregnancy (%)		
		25th percentile	Median	75th Percentile*
Southern Forest	57	77	87	93
Central Forest	37	79	88	92
Northern Downs	36	75	82	91
Northern Forest	76	56	66	74
Overall	*206*	*66*	*79*	*90*

* 75th Percentile = achieved by the top 25% of producers in the study.

4. Findings

4.1.3 Foetal/calf loss

Losses between pregnancy testing and weaning includes losses due to abortion, neonatal calf losses and losses before weaning. It often does not include losses from husbandry practices performed during/after the weaning process. The huge variation detected in the CashCow project suggests that this is one area that can be controlled and managed for improved performance. If a producer is concerned about the number of weaners being produced from a mob, pregnancy testing indicates if the problem is due to low rates of pregnancy and/or elevated levels of foetal/calf loss.

Losses between pregnancy testing and weaning were significant in the CashCow project. The worst losses were in maiden heifers, and the Northern Forest had the highest losses across all cow classes.

Table 9: First lactation cows – foetal/calf loss %

Country type	No. of mob-years	Foetal/calf loss (%)		
		25th percentile*	Median	75th Percentile
Southern Forest	14	3.9	**8.9**	13.6
Central Forest	11	3.7	**10.2**	17.7
Northern Downs	12	7.3	**14.9**	20.0
Northern Forest	14	10.8	**16.4**	19.1
Overall	*51*	*5.1*	***11.1***	*17.9*

* 25th percentile = achieved by the top 25% of producers in the study.

Table 10: Second lactation cows – foetal/calf loss %

Country type	No. of mob-years	Foetal/Calf Loss (%)		
		25th percentile*	Median	75th Percentile
Southern Forest	12	0.7	**4.6**	7.1
Central Forest	10	3.5	**7.3**	11.3
Northern Downs	9	4.3	**4.7**	9.3
Northern Forest	6	5.4	**9.5**	13.6
Overall	*37*	*3.3*	***6.5***	*10.5*

* 25th percentile = achieved by the top 25% of producers in the study.

Table 11: Mature and aged cows – foetal/calf loss %

Country type	No. of mob-years	Foetal/Calf Loss (%)		
		25th percentile*	Median	75th Percentile
Southern Forest	33	2.2	**4.6**	8.5
Central Forest	22	3.8	**6.2**	9.1
Northern Downs	22	3.3	**6.9**	14.7
Northern Forest	41	9.4	**13.5**	19.2
Overall	*118*	*4.1*	***8.1***	*14.3*

* 25th percentile = achieved by the top 25% of producers in the study.

4.1.4 Pregnant cow mortality/missing rate

This was determined from the number of pregnant cows missing at consecutive musters. As expected, mortality/missing rates were generally highest in the Northern Forest. Rates were relatively high for other country types, but it should be remembered that this estimate of 'mortality' includes any concurrent loss of both NLIS tags and management tags and where cows have ended up in a different paddock.

Table 12: First lactation cows – pregnant cow mortality/missing %

Country type	No. of mob-years	Percentage of pregnant cows missing (%)		
		25th percentile (Achievable*)	Median	75th Percentile
Southern Forest	12	3.3	**7.2**	10.1
Central Forest	11	3.2	**11.8**	16.6
Northern Downs	11	3.8	**6.7**	9.4
Northern Forest	8	5.6	**7.7**	9.0
Overall	*42*	*4.2*	***8.0***	*11.8*

* Achievable = the realistic goal most producers could aim to achieve.

Table 13: Mature and aged cows – pregnant cow mortality/missing %

Country type	No. of mob-years	Percentage of pregnant cows missing (%)		
		25th percentile (Achievable*)	Median	75th Percentile
Southern Forest	16	2.8	**7.6**	13.3
Central Forest	11	1.1	**6.2**	10.8
Northern Downs	11	3.5	**6.8**	12.5
Northern Forest	17	6.2	**12.2**	18.2
Overall	*55*	*3.5*	***7.1***	*14.4*

* Achievable = the realistic goal most producers could aim to achieve.

4.2 Achievable production

The performance benchmarks discussed in the previous section represent specific components of reproduction. They are important in their own right in determining where losses are occurring and where gains can be made. However, none of them singularly encompasses the total productivity of the cow operation.

The tables below show that country type had a major effect on mob productivity (weaner production, liveweight production) and efficiency (liveweight production ratio), reflecting the impact of soil fertility and other environmental factors, such as length of growing season. As with performance measures, there was significant variation in productivity within each country type, which is no doubt associated with management, infectious disease and/or other factors.

Table 14: Annual weaner production (kg/retained cow)

Country-type	No of mobs	25th percentile	Median	75th percentile
Southern Forest	33	164.0	**191.0**	240.0
Central Forest	33	160.7	**194.6**	220.1
Northern Downs	29	134.9	**163.0**	182.6
Northern Forest	59	74.0	**93.3**	112.4
Total	*154*	*99.8*	***150.0***	*188.5*

Table 15: Annual liveweight production (kg/retained cow)

Country-type	No of mobs	25th percentile	Median	75th percentile
Southern Forest	28	155.6	**187.5**	250.3
Central Forest	28	142.7	**197.3**	254.9
Northern Downs	17	129.3	**141.2**	188.8
Northern Forest	29	70.9	**88.8**	122.4
Total	*102*	*115.0*	***149.7***	*213.4*

4. Findings

Table 16: Liveweight production ratio

Country-type	No of mobs	25th percentile	Median	75th percentile
Southern Forest	28	0.23	**0.28**	0.35
Central Forest	28	0.20	**0.30**	0.37
Northern Downs	17	0.21	**0.23**	0.29
Northern Forest	29	0.04	**0.14**	0.20
Total	*102*	*0.17*	***0.23***	*0.33*

The strength of association between measures of reproductive performance (e.g. P4M, foetal/calf loss) and measures of production (e.g. annual liveweight production) were assessed using simple linear regression models. The regression coefficient represents the rate of change in each measure of liveweight production per unit change in each measure of reproductive performance. For example, variation in P4M explained nearly 60% of the variation in annual weaner production, and a 6.3% increase in P4M was associated with a 10 kg/cow/year increase in weaner production.

Table 17: Proportion of total variance in production (var) explained by each measure of performance and the change in performance per unit change in production derived from uni-variable analyses.

	Liveweight production ratio (kg/kg cattle/yr)		Liveweight production (kg/cow/yr)		Weaner production (kg/cow/yr)	
	var	/0.01	var	/10 kg	var	/10 kg
P4M	0.18	5.8%	0.43	5.7%	0.57	6.3%
Pregnant annually	0.27	2.8%	0.40	3.9%	0.61	4.5%
Pregnancy-weaning foetal/calf loss	0.16	-1.8%	0.20	-2.7%	0.34	-3.6%
Cow mortality/missing	0.42	-0.9%	0.18	-2.1%	0.11	-3.4%
Average weaner weight	0.56	5.1 kg	0.70	7.1 kg	0.69	8.2 kg
Cow liveweight change	0.26	5.6 kg/yr	0.29	9.9 kg/yr		

The implication of higher or lower levels of productivity on profit could not be calculated in this project as the mob-specific costs for producing each kg of gain were not available. If we assume a similar cost of production at the mob level within the country types, then profit would improve with production. As this is not likely the case, a study is under way to help define those situations where there are cost-effective opportunities to lift cow production.

Improving mob productivity is clearly dependent on improving one of more of the components of mob performance. CashCow investigated the factors affecting mob performance.

4.3 Factors affecting mob performance

A major part of this project was examining factors that could help explain variation in cow performance, after accounting for year and country type effects. These were estimated using statistical models and there are three important points to note.

First, statistical associations do not imply actual cause – the project team had to look at the biological plausibility of the influence of each factor that had a statistical association.

Second, some factors important in cow performance may not be expressed in this study if there was insufficient variation in that factor. As a hypothetical example, botulism vaccination will not emerge as important in this type of study if the vast majority of herds were vaccinated. Some factors may also be measured too coarsely to be influential in the analysis. For example, while intake of digestible energy drives animal production (all other things being equal), 'spot' estimates of dietary digestibility may not adequately represent what the animals consumed.

Third, the performance estimates in this section will often vary somewhat from the raw data, as they are derived from statistical models. The models predict the average impacts of a factor, such as country type, with all other factors having been taken into account.

The major factors affecting performance of cows and mobs that were part of this project, and the predicted impact of each factor on performance are summarised below.
All percentage differences quoted below are absolute differences, not relative. Also, the percentage differences are across all country types unless otherwise stated.

4. Findings

The focus is on P4M, foetal/calf loss and cow loss; annual pregnancy rate is not considered in detail as it is a relatively blunt measure of performance.

4.3.1 Factors affecting P4M

The main factors that accounted for at least some of the variation in P4M were:

- cow age class
- previous calving period
- body condition score (BCS) (at July-September)
- body condition change (from July-September to February–April)
- nutritional measures of protein and P status
- Brahman content
- seroprevalence (positive blood test) of pestivirus (bovine viral diarrhoea virus).

Effect of cow age class on P4M

P4M was significantly lower for first-lactation cows compared with second-lactation, mature, and aged cows (16.1%, 11.2% and 3.5 lower, respectively). This is not unexpected; however, understanding the differences of productivity between the different age cohorts as females progress through the herd allows management to target the most vulnerable age groups.

Table 18: Effect of cow age class on P4M

Cow age class	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
First lactation cows	34.6[A]	28.2	41.0
Second lactation cows	39.5[B]	32.1	46.9
Mature cows	47.2[C]	40.2	54.2
Aged cows	50.7[D]	43.3	58.2

* Means not sharing a common superscript letter are significantly different (P<0.05).

Previous calving period

The predicted month of calving was calculated using estimated foetal age at the date of pregnancy testing and projecting forward using an assumed gestation length of 287 days. P4M was significantly lower (20 to 50%) in cows that had calved in July-September, compared to December–March, and this was consistent across country types. In northern Australia, cows that lactate through the wet season when the feed quality is at its best have the best chance of producing a calf in consecutive years. The implications of this for areas of southern Queensland, where July-September calving is common so as to maximise weaner weights, needs further analysis.

Table 19: Previous calving period

Previous calving period	Mean P4M* (%)	95% Confidence interval	
		Lower	Upper
Jul–Sep	14.8[A]	11.1	18.4
Oct–Nov	45.5[B]	38.6	52.4
Dec–Jan	63.6[C]	57.1	70.1
Feb–Mar	55.1[D #]	47.8	62.4
Apr–Jun	43.4[B #]	35.1	51.8

* Means not sharing a common superscript are significantly different (P<0.05).

Limited observations recorded in Southern or Central Forest

Body condition score (BCS) in previous July-September period

The percentage P4M for cows in poor body condition in the previous July-September (BCS<2.5 using a 1 to 5 scoring system) was 8%, 14%, 18% and 22% lower (P<0.05) than cows in fair (BCS 2.5), moderate (BCS 3.0), good (BCS 3.5), and very good to fat (BCS 4–5) condition, respectively.

However, the impact of BCS was much lower (average of 2% difference between BCS categories) for cows in the Northern Forest. The overall impact of BCS is consistent with previous studies. The lower association for Northern Forest cows between BCS in the previous July-September and P4M appears to be due to the much higher loss of BCS during late gestation and early lactation by cows in the Northern Forest that were in better body condition in July-September relative to that lost by cows in other country types or by Northern Forest cows in low BCS in July-September.

Table 20: Percentage P4M by the predicted interaction between country type and body condition score category at the pregnancy diagnosis muster based on marginal means generated from the final multivariable model.

Body condition score category	Mean percentage P4M* (%)			
	Southern Forest	Central Forest	Northern Downs	Northern Forest
1.0-2.0	59.7A	45.6A	29.6A	7.1A
	(45.1–74.3)	(30.5–60.6)	(16.8–42.3)	(3.5–10.7)
2.5	61.7A	55.4B	39.4B	10.8B
	(47.4–76.0)	(41.2–69.6)	(24.8–53.9)	(6.2–15.4)
3.0	71.1B	58.8B	45.8C	12.4B
	(59.2–83.0)	(45.6–72.0)	(30.9–60.7)	(7.5–17.3)
3.5	74.2B	64.0C	57.5D	10.9B
	(63.1–85.2)	(51.4–76.6)	(42.8–72.2)	(6.4–15.3)
4.0-5.0	78.8C	64.7C	60.1D	12.6B
	(69.1–88.5)	(52.3–88.5)	(45.7–74.6)	(7.5–17.7)

* Within country types, means not sharing a common superscript are significantly different (P<0.05).

Note: The lower and upper 95% confidence interval has been reported in parentheses.

Table 21: Effect of body condition score in July-September on P4M

Body condition score in Jul–Sep	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
1.0-2.0	30.9A	24.3	27.4
2.5	38.6B	31.6	45.6
3.0	44.6C	37.5	51.6
3.5	48.9D	41.7	56.1
4.0-5.0	52.4E	42.3	59.6

* Means not sharing a common superscript are significantly different (P<0.05).

Table 22: Effect of change in body condition score between July-September and February-April on P4M

Change in body condition score between Jul–Sep and Feb–Apr	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
Maintained or lost condition	38.9A	38.9	45.6
Gained condition	47.0B	39.9	54.1

* Means not sharing a common superscript are significantly different (P<0.05).

4. Findings

Nutritional measures of protein and phosphorous status

The ratio of Crude Protein:Dry Matter Digestibility as determined by faecal NIRS (CP:DMD) provides a measure of protein adequacy in the diet. P4M was 7.5% lower in cows grazing wet season pastures where the ratio of CP:DMD is <0.125. Provision of a protein supplement is usually indicated when the CP:DMD ratio is <0.125. However, protein deficiency is not commonly detected over the wet season.

Table 23: Effect of protein adequacy on P4M

Average Wet season CP:DMD category	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
≤0.125	39.2[A]	32.0	46.3
>0.125	46.7[B]	39.9	53.5

* Means sharing a common superscript are significantly different (P<0.05).

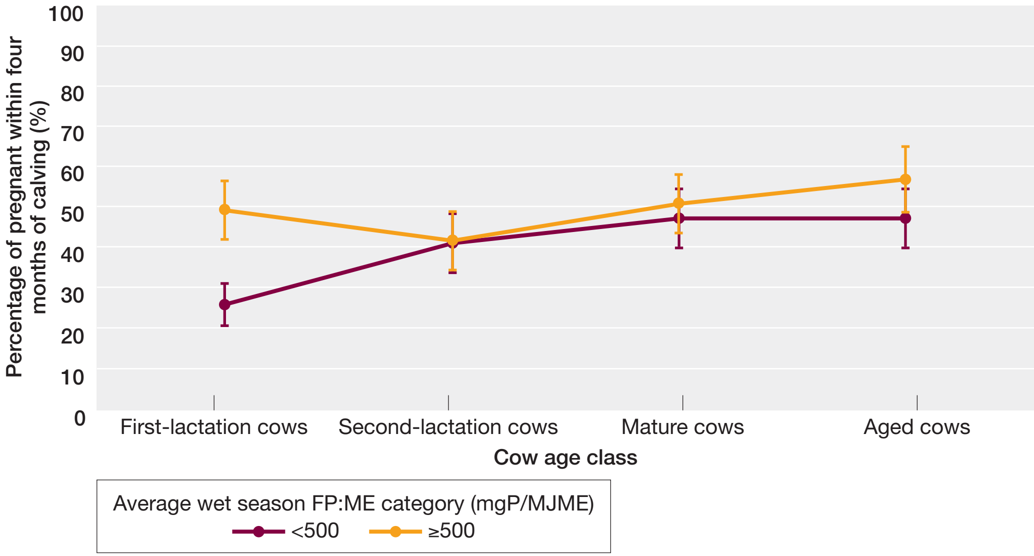
Cows that were grazing pastures with a higher proportion of P, relative to metabolisable energy, during the wet season (faecel P:diet ME ratio >500) were predicted to have a 10.2% higher P4M.

Table 24: Effect of higher proportion of P on P4M

Average wet season FP:ME category	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
<500	37.8[A]	31.1	44.6
≥500	48.1[B]	40.9	55.3

* Means not sharing a common superscript are significantly different (P<0.05).

Figure 4: Effect of Faecal P: Metabolisable Energy ratios on P4M in various age groups of breeders.



For each age class, except second-lactation cows, cows with an average wet season faecal P to metabolisable energy ratio of <500 g P/MJME had lower percentages P4M than those whose ratio was ≥500 g P/MJME. All differences were statistically significant, except for the second-lactation cows. The large difference in performance of first-lactation cows could be because most of these cows were undergoing skeletal growth at the same time as the foetus is undergoing skeletal mineralisation and the high loss of P associated with subsequent lactation for periods of 3–8 months. Interestingly, the effect was not apparent with the second-lactation cows.

The value of faecal P to ME ratio as a measure of the wet season P status of breeding cattle has been challenged by recent field work in the Northern Territory, but the CashCow findings provide strong evidence of at least a biological association between this measure and reproductive performance of cattle.

4. Findings

Brahman content

This was tested using data only from those country types that contained all three levels of genotype (<50% *Bos indicus*, 50–75% *Bos indicus* and >75% *Bos indicus*). This meant that the Northern Forest was omitted from the analysis. Genotype category was a significant predictor of P4M. Cows that were <50% *Bos indicus* had significantly higher percentage P4M compared to either 50–75% *Bos indicus* or >75% *Bos indicus*. This is consistent with Beef CRC studies comparing Brahman with Tropical Composite genotypes, and reflects the longer period of lactation anoestrous in the former.

Table 25: Effect of Bos indicus content on P4M

Genotype	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
<50% *Bos indicus*	68.3	56.2	80.3
50–75% *Bos indicus*	52.9	42.7	63.0
>75% *Bos indicus*	50.7[D]	43.3	58.2

* Means not sharing a common superscript letter are significantly different (P<0.05).

Seroprevalence of bovine viral diarrhoea virus (pestivirus)

In mobs with a high seroprevalence (>80% positive from infection at some time in the past) of bovine viral diarrhoea virus (BVDV), the mean percentage of P4M was 23% lower (P<0.05) than in mobs with a low seroprevalence (<20% seropositive). However, in mobs with a moderate or high prevalence of recent infection (ie in previous one to nine months), P4M was not significantly lower than in mobs with a low level of recent infection.

Table 26: Effect of pestivirus on P4M

BVDV seroprevalence*	Mean percentage P4M* (%)	95% Confidence interval	
		Lower	Upper
Low	57.3[A]	43.8	70.9
Moderate	43.2[AB]	26.2	60.1
High	34.3[B]	17.0	51.6

* Seroprevalence category defined as Low: <20%; Moderate: 20-80%; High: >80% seropositive.

This is somewhat counterintuitive, as the accepted pathogenesis of the disease is that infection around the time of mating and early gestation will reduce pregnancy rate (infection disrupts ovulation and causes early embryonic loss and abortions). In some cases, it was clear from the serological test results that at the time cows were sampled they were in the midst of an outbreak of BVDV – in these cases, there was a high proportion of samples with an AGID[2] result ≥3, but often the seroprevalence was only 50 to 60%.

4.3.2 Factors affecting foetal/calf losses

Apart from country type *per se*, the factors which statistically accounted for at least some of the variation in foetal/calf loss included:

- cow lactation status in the previous year
- cow hip height
- mustering efficiency
- mustering around time of calving
- heat stress
- measures of P and protein status
- infectious diseases.

Cow lactation status in the previous year

Cows that did not lactate in one year were predicted to have 3.6% higher foetal/calf losses in the subsequent year. Previous research suggests that contributing factors include teat and udder abnormalities and calf vigour at birth.

Table 27: Effect of lactation status in the previous year on P4M

Lactated previous reproductive cycle	Mean loss (%)	95% Confidence interval	
		Lower	Upper
No	15.0	10.02	19.92
Yes	11.4	7.54	15.23

* Means sharing a common superscript are significantly different (P<0.05).

2 Agar gel immunodiffusion test to measure antibodies against bovine pestivirus – results ≥3 indicate exposure in 1-9 months prior to the sample being taken.

4. Findings

Cow hip height

Foetal/calf loss was 3.7% higher in taller cows (hip height >140cm) compared with shorter cows (hip height <125cm). There was also some association between cow hip height and P4M. However, this does not prove that large frame size is genetically linked to lower fertility. Recent unpublished analysis of Beef CRC data indicate that cow frame size is not genetically linked to fertility, and that phenotypic effects such as those observed in CashCow may simply reflect that females that skip a lactation are larger and heavier as a consequence, and that if more than one lactation is missed, this effect can be cumulative.

Table 28: Effect of cow hip height on P4M

Hip Height	Mean loss (%)	95% Confidence interval	
		Lower	Upper
≤125cm	11.31	6.99	15.63
125–140cm	13.12	8.87	17.37
>140cm	15.02	10.16	19.88

Mustering efficiency

Losses in situations where mustering efficiency was reported to be <90% were 9% greater (or 2.2 times more likely) than where mustering efficiency was reported to be >90%. It is most likely that the increased losses related to factors that make mustering more or less difficult, such as ruggedness of the terrain, time taken for the muster and distance to yards. In such conditions, there is a much bigger chance of cows and calves being separated.

Table 29: Predicted percentage foetal/calf loss by mustering efficiency category

Mustering efficiency	Mean loss (%)	95% Confidence interval	
		Lower	Upper
>90%	9.20	7.21	11.20
≤90%	18.24	7.93	28.56

Mustering around time of calving

Mustering first-lactation cows within two months of calving was associated with 9% higher foetal/calf loss. The data confirms what would be expected in relation to this area, and the message is, “avoid handling first-lactation cows around calving”.

Table 30: Effect of mustering different cow classes on foetal/calf loss

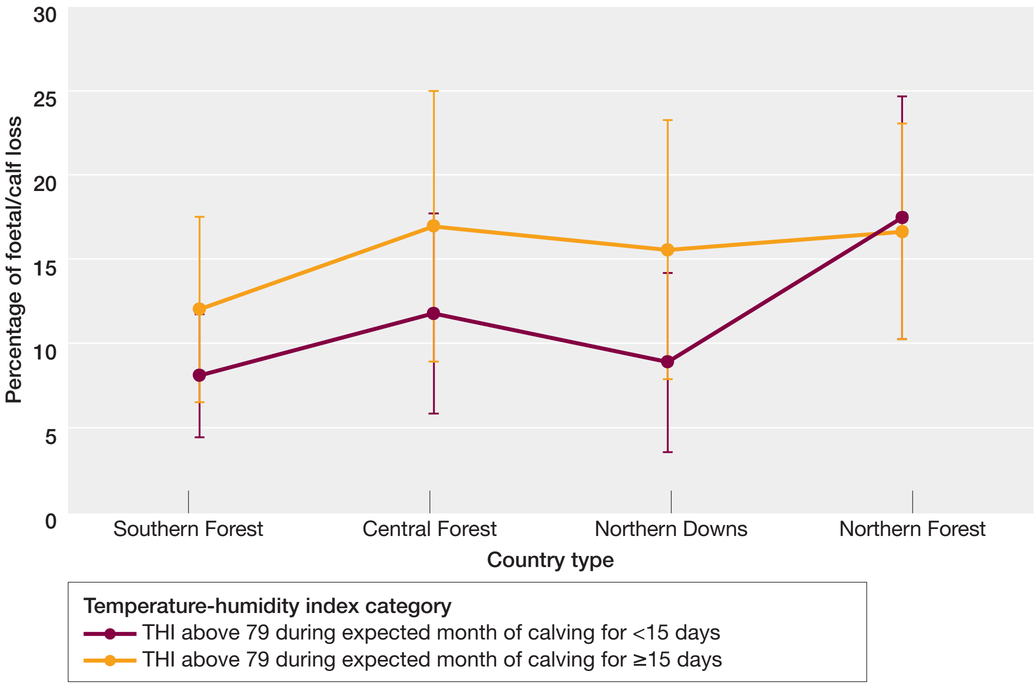
Cow age class	Mustered around calving	Mean loss (%)	95% Confidence interval	
			Lower	Upper
First lactation	No	12.82	8.47	17.17
First lactation	Yes	21.66	13.91	29.41
Second lactation	No	11.73	7.64	15.82
Second lactation	Yes	10.37	5.19	15.54
Mature cows	No	10.83	7.18	14.47
Mature cows	Yes	13.28	8.57	17.99
Aged cows	No	12.12	7.80	16.45
Aged cows	Yes	14.04	7.56	20.51

4. Findings

Heat stress

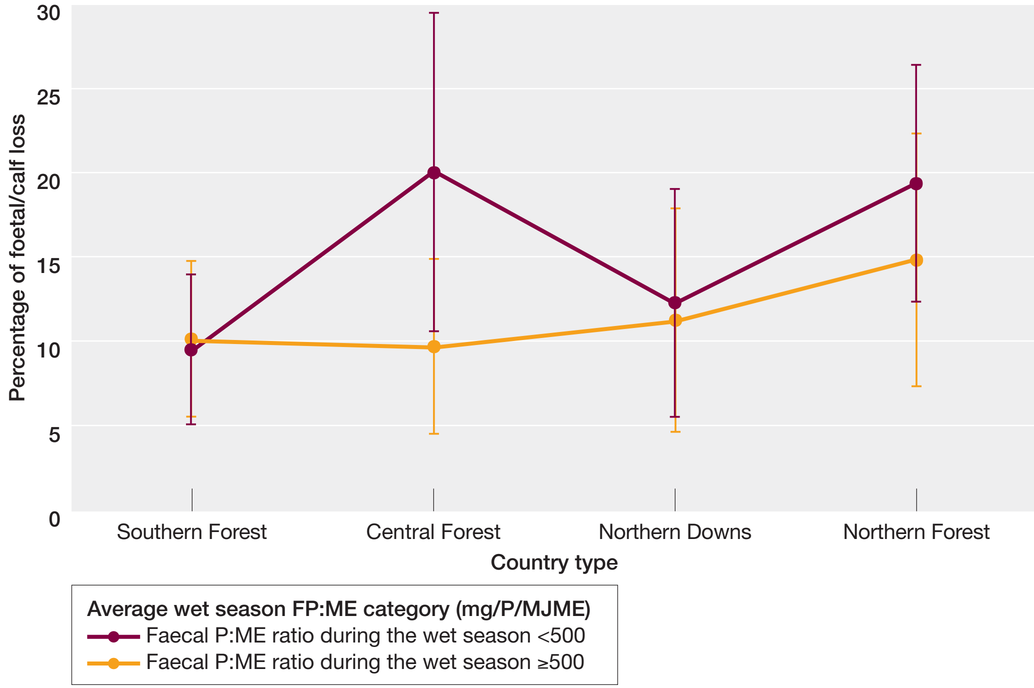
A temperature-humidity index (THI) threshold of 79 has been used in previous research to indicate heat stress in beef cattle. When the temperature-humidity index exceeded 79 for at least two weeks during the month of expected calving, calf losses were 4–7% higher in all country types except for Northern Forest, where there was no effect. Relatively high calf loss in the Northern Forest for both THI categories may simply indicate that, in this country type, there was inadequate relief from heat stress during the calving period.

Figure 5: Effect of heat stress on foetal/calf loss Measures of P and protein status



Foetal/calf loss was up to 9% higher in the Central and Northern Forest when P:ME ratio was lower than 500, but there was no similar effect in Southern Forest or Northern Downs. The reason for this inconsistency across country types is unclear.

Figure 6: Effect of P and protein status on foetal/calf loss



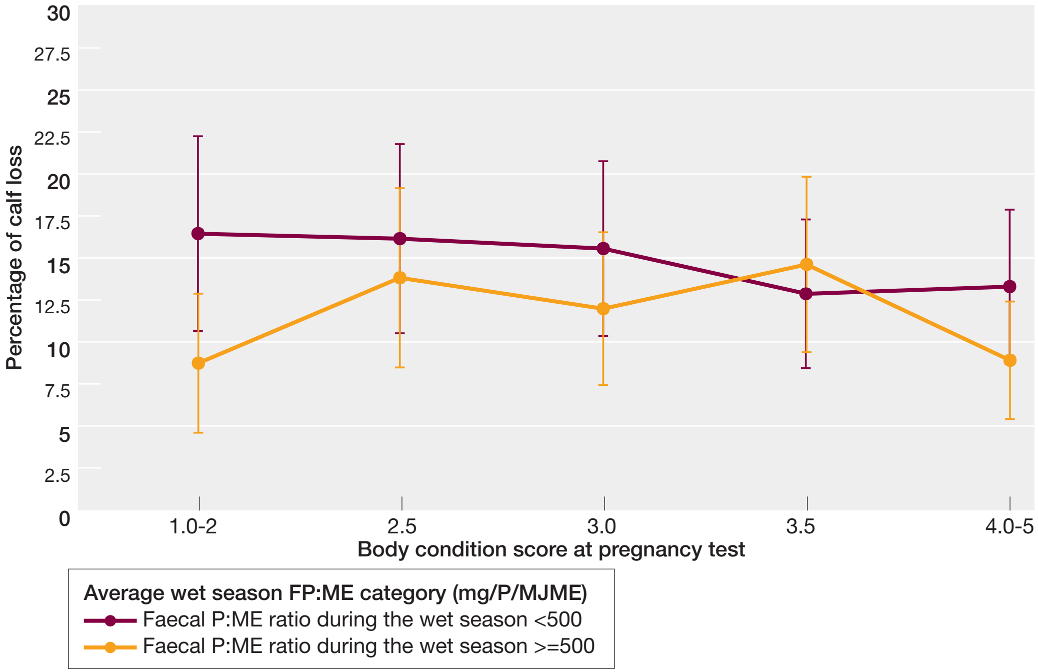
4. Findings

There was also an apparent interaction between P status and body condition score (measured in July-September). Overall, foetal/calf loss was 3.4 percentage points lower when the P:ME ratio was >500mg/kg, although the effect was variable and was not statistically significant for cows of BCS 3.5. The reasons for this are not currently clear.

Table 31: Predicted percentage foetal/calf loss by body condition score at the time of the PD muster and the average wet season faecal phosphorous to metabolisable energy ratio

BCS at PD muster	Wet season Faecal P:ME	Mean loss (%)	95% Confidence interval	
			Lower	Upper
1–2	<500	16.59	10.79	22.40
1–2	≥500	8.85	4.71	13.00
2.5	<500	16.23	10.69	21.76
2.5	≥500	13.86	8.56	19.16
3.0	<500	15.66	10.52	20.79
3.0	≥500	12.07	7.62	16.52
3.5	<500	12.85	8.42	17.29
3.5	≥500	14.64	9.51	19.77
4–5	<500	13.32	8.78	17.85
4–5	≥500	9.03	5.54	12.53

Figure 7: Effect of Faecal P: Metabolisable energy ratio on calf loss at various body condition scores.



Foetal/calf loss was 4% higher in cows that grazed pastures with a low crude protein to dry matter digestibility ratio (CP:DMD<0.125) during the dry season prior to calving.

Infectious diseases

Significantly higher foetal/calf losses occurred in mobs with either a high prevalence of recent infection with pestivirus (8%) or widespread evidence of vibriosis (7%). Recent infections with pestivirus or infection with vibriosis would have normally been expected to be associated with low P4M rates as both cause conception failure and early embryonic loss but this was not observed and requires further investigation to understand. Regardless, these findings suggest that both diseases are having a significant impact on calf output. *Neospora caninum*, a common protozoan that is associated with abortion in intensive cattle industries, had no significant impact on calf loss.

Table 32: Effect of recent prevalence of pestivirus on foetal/calf loss

Prevalence* of recent pestivirus	Mean loss (%)	95% Confidence interval	
		Lower	Upper
Low	11.45	6.51	16.39
Moderate	12.08	7.00	17.16
High	20.84	12.49	29.19

Table 33: Effect of recent prevalence of vibriosis sp.veneralis on foetal/calf loss

Prevalence* of vibriosis	Mean loss (%)	95% Confidence interval	
		Lower	Upper
Low to moderate	12.92	8.41	17.44
High	19.91	10.79	29.02

4.3.3 Factors affecting cow mortality/missing

(Estimated from pregnant cows missing at consecutive musters)

Apart from country type *per se*, the factors that accounted for at least some of the variation in cow mortality/missing rate included:

- body condition score interacting with dry season pasture biomass
- number of days from onset of wet season to follow-up rain.

Body condition score interacting with dry season pasture biomass

Body condition score, assessed in July–September, affected mortality/missing rate in pregnant cows in its own right, with a 7.8% increase with cows in condition score 1–2 versus those in condition score 4–5.

Table 34: Effect of body condition score on mortality/missing rate in pregnant cows

Body condition score category in July–September	Mean percentage pregnant cows missing * (%)	95% Confidence interval	
		Lower	Upper
1.0–2.0	17.7[D]	13.3	22.1
2.5	14.1[C]	10.7	17.5
3.0	11.0[B]	8.5	13.6
3.5	9.3[A]	7.1	11.4
4.0–5.0	9.9[AB]	7.7	12.1

* Means not sharing a common superscript are significantly different (P<0.05).

The minimum dry season biomass also affected the mortality/missing rate in pregnant cows in its own right, with a higher percentage of pregnant cows missing where minimum observed pasture biomass was <2,000kg/ha during the dry season compared to where it was ≥2,000kg/ha. After adjustment for all other factors in the model, having at least two tonnes of available pasture biomass in the early dry season increased survival rates of pregnant cows by 5.4%.

4. Findings

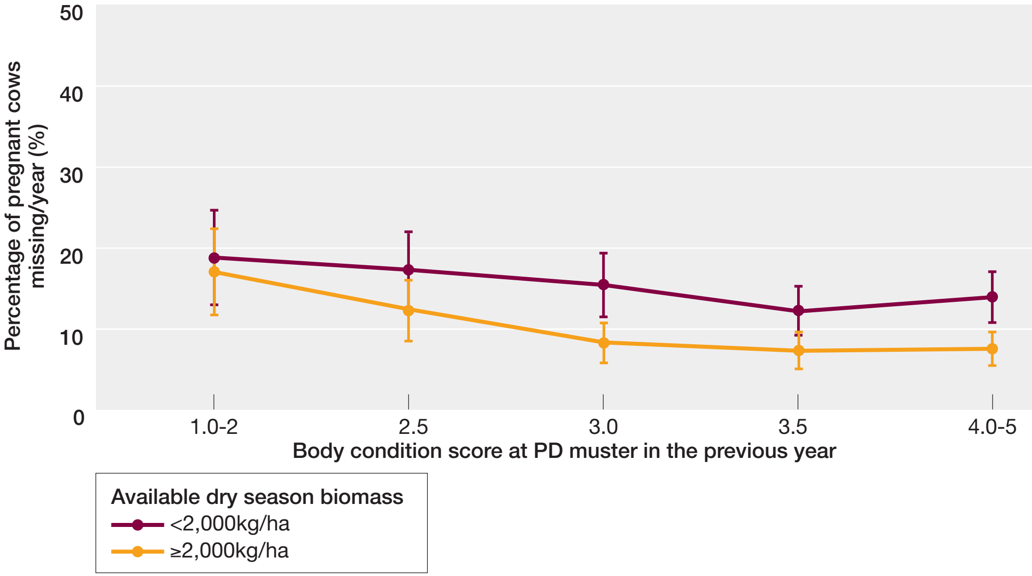
Table 35: Effect of dry season biomass availability on mortality/missing rate in pregnant cows

Minimum available dry season biomass	Mean percentage pregnant cows missing * (%)	95% Confidence interval	
		Lower	Upper
<2,000kg/ha	15.0[A]	11.7	18.4
≥2,000kg/ha	9.6[B]	7.0	12.2

* Means not sharing a common superscript are significantly different (P<0.05).

The two factors also interacted, with higher dry season biomass moderating the effect of body condition score.

Figure 8: Effect of dry season biomass on body condition score and mortality/missing rate in pregnant cows



Number of days from onset of wet season to follow-up rain

The wet season onset was defined as the date when a total of 50 mm of rainfall had fallen in 14 days or fewer, starting from any day after 1 September (but before 31 March). The number of days following the wet season onset until another major rainfall event was derived, again defining a major rainfall event as a total of 50 mm within 14 days. The two categories investigated were <30 days and ≥30 days between onset of wet season and follow-up rainfall. The percentage of pregnant cows missing was four percentage points higher when follow-up rainfall to the wet season onset was ≥30 days.

5. Using CashCow outputs to improve management and herd profitability

Cashcow data provide regional benchmarks for productivity and performance measures, providing guidelines to what is realistically achievable for different areas of northern Australia. Using this information provides a platform for breeder herd diagnostics. By initially using key the productivity measures to answer the most basic business question "Do I have a problem?", performance measures and the risk factors that drive them can be interrogated where productivity is below achievable or acceptable levels.

It is accepted that a degree of caution is needed when using broad regional benchmarks; however, it does give a starting point to compare how a breeding herd is going relative to others in similar country.

CashCow outputs are, therefore, useful in two ways:

1. **Helping compare the productivity and performance of the cow herd against what other properties are achieving on the same broad country type (benchmarking).**

CashCow describes the range, average and 'achievable' values for:

- herd or mob production
  - weaner production
  - annual liveweight production

- herd or mob performance
  - pregnant within four months (P4M)
  - annual pregnancy rate
  - calf loss between pregnancy test and weaning
  - cow loss.

Benchmarking is a guide to the potential for improvement (from some change in management) but it is important to note that:

- Only a portion of the apparent potential may be achievable by change in practice, as there will be residual environmental influences in the CashCow data for each broad country type (especially due to variation in soil fertility among CashCow sites within each broad country type). In other words, not all properties with the broad country types will have equal biological potential to support cattle reproduction.

- Profit from a cow herd may not be related to reproduction in a simple direct fashion, as the costs of achieving a certain level of production will vary from case to case. CashCow did not isolate the costs associated with the particular mob of cows being monitored. This means that, while the 75th percentile has been nominated to be the 'achievable' level for a given enterprise, for either performance or production, this level may not be the most profitable for a particular herd. So, while there are generalised messages that can be derived from CashCow (and other similar projects), every business is unique and requires its own analysis of the costs and benefits from changing practice.

2. **Helping identify those management and husbandry factors that may be constraining components of herd productivity, such as**

   - body condition score
   - breed
   - time of calving
   - diseases
   - phosphorus status.

The level of recording of useful herd data in the northern industry is generally considered poor. The majority of the production and performance indicators (except P4M) can be derived from mob-based records. That is, breeder herd recording can be as basic as recording once per year:

- cattle numbers by class (heifer, first lactation cow, older cows) by average weight annually
- number of weaners by average weight
- number of stock sold and purchased by class and average weight.

This system can be expanded by including pregnancy testing (foetal ageing) and lactation status (wet/dry) to calculate P4M; and body condition score at pregnancy testing.

This basic data can provide an enormous amount of intelligence to understand how a breeding herd is performing. This can also be expanded to include male cattle and some simple financial figures to provide information on the whole business.

As record keeping is not typically a strong point of many northern beef enterprises, many producers will not have sufficient records to start calculating the CashCow measures.

Examples are provided below of how a producer can integrate CashCow outputs into decision making, including situations where there are limited or no records with which to work. Some surrogate measures will be discussed in these cases.

5.1 Getting started

5.1.1 What to do if records are scarce

The need for records should not hold anyone back from starting to get a better handle on performance and production of the herd. In any herd, one can get started by simply assessing:

- the proportion of wet or lactating cows in the mob – the number of wet cows should roughly equal the number of weaners produced
- the condition score of the lactating cows and the condition score of the non-lactating/dry cows
- the average weight of the weaners and the range in weaner weights.

These very basic observations can help indicate the opportunities for improving production, and can focus effort on collecting the additional data required to verify the initial observations.

5.1.2 Getting a handle on herd productivity

Annual weaner production is the most accessible productivity benchmark because:

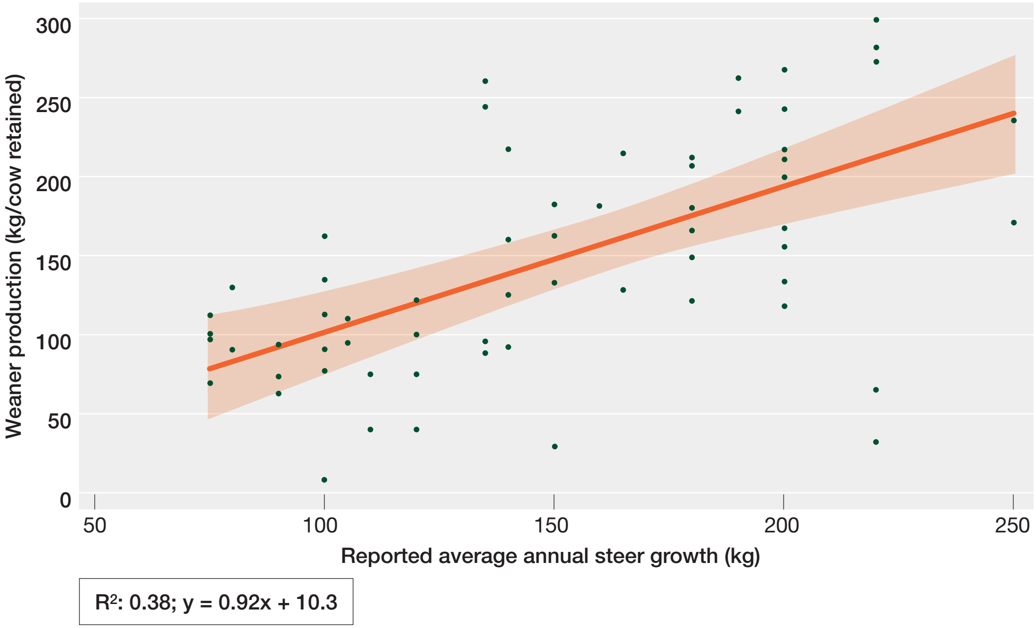
- It is closely correlated with total annual beef production per cow retained. The annual beef production/cow retained figure is a more complex equation and requires additional data such as weights of cows at the major weaning muster.
- It is influenced by aspects of mob performance – P4M, annual pregnancy rate, and calf loss between pregnancy testing and weaning. (A high % P4M is indicative of a tight calving window (controlled mating system) and a heavier more uniform crop of weaners.)
- If cow numbers are accurate and mustering efficiency is high, then it also encapsulates breeder cow mortality/missing rates.

The disadvantage of using annual weaner production is its relatively high volatility (it will require at least three to four years of data to be useful) and that it does not account for cow weight gain or cow mortality.

A potential surrogate for average annual weaner production is the annual liveweight gain (LWG) of steers grazing on the same country types as where the cows run. Estimates of steer LWG from CashCow co-operators were related linearly to measured weaner production (see Figure on the next page) but there is a lot of ‘noise’ in the relationship. It is not surprising that there should be a relationship of sorts, as both measures are driven by factors such as stocking rate, rainfall and P status. However, steer LWG is obviously not influenced by many of the factors that influence reproduction. Caution should be exercised in using this surrogate, but it can provide a starting point.

5. Using CashCow outputs to improve management and herd profitability

Figure 9: Correlation between annual steer growth and weaner production



Annual liveweight production requires more records to calculate but is more comprehensive and less variable over time than annual weaner production. Just a couple of years of data will provide a useful starting point for analysis.

The following guidelines refer to the use of data on annual weaner production; the same general process can be applied when using data on annual liveweight production.

5.2 Relating herd productivity to the benchmarks and identifying causes of reduced productivity

The first step is to ensure the CashCow data is relevant to the country types on which cows are being run. Simply check that the country types of the breeder country are consistent with one of the broad country types used to categorise the CashCow data.

If the CashCow data are relevant to a given herd, it is feasible to compare annual weaner production to the relevant benchmarks derived from CashCow. Where weaner production is below the 'achievable' benchmark (assumed to be the 75th percentile), it is likely that production can be significantly improved. Where production is at or above the 75th percentile, there is likely to be less potential for improvement but there could be still be significant scope for improving the efficiency of this production and so reduce cost of production.

Where production is 'below' the achievable benchmark, there are three possible factors at work:

- number of weaners produced
- average weight of weaners
- loss of cows.

The following prompts will help define the aspects of performance that are most likely implicated in the current level of production and have the most potential for improvement.

5.2.1 Is the number of weaners a contributing factor?

- Pregnancy testing will indicate the conception rate. Compare the conception rate to the appropriate benchmarks for annual pregnancy rate.
- If only pregnant animals were retained in the mob the previous year, then the extent of calf loss between pregnancy testing and weaning can be calculated from the number of dry (non-lactating) cows in the mob. Compare this with the 25th percentile for calf loss for the appropriate country type.

The checklist for possible causes of **reduced conception rates** include:

- body condition score, which is a function of season, grazing management, time of calving and weaning practice
- bull soundness (important for all, but especially with single sire mating)
- diseases – Pestivirus, Vibriosis, 3 Day Sickness, Trichomoniasis; take samples from non-pregnant cows and from bulls
- P status – do a blood test for plasma inorganic P on growing animals at the end of the wet season
- genotype
- for heifers – age at puberty and mating weight are critical.

Low conception rates are a particular issue for first calf cows, especially on the less productive country types. Further to the additional nutrient requirements of these still-growing cows, a major reason for their poor performance is that they did not conceive as heifers until late in the breeding season.

The checklist for possible causes of **elevated rates of calf loss** (between pregnancy testing and weaning) include:

- abortion
  - diseases – Leptospirosis, Vibriosis, Pestvirus, Neopsora, Akabane
  - non-infectious causes such as stress
  - toxins
- neonatal calf loss
  - mustering strategies
  - disease
  - heat stress
  - wild Dogs
  - P status
  - calf rearing history
- calf, or weaner losses, from dehorning.

5.2.2 Is the average weight of weaners a contributing factor?

The average weaning weight expected for each country type, based on CashCow data, is shown in Table 36.

Table 36: Average weaning weight expected from each country type

Country type	Average (kg)	Likely range across years and paddocks (kg)
Southern Forest	233kg	219–246
Central Forest	226kg	211–240
Northern Downs	200kg	185–215
Northern Forest	163kg	151–174

If average weaner weights are relatively low, the most likely causes are:

- Low rates of P4M, which produce an extended period of calving. This is the most common cause of low weaner weights. An extended calving time is unavoidable in a herd with continuous joining period as a proportion of cows will calve in the dry season. The CashCow data clearly shows that time of calving is one of the biggest factors affecting P4M. A high proportion of late weaners will drag down the average weaning weight while a compact calving period ensures that average weaning weights are maximised.
- Other sources of nutritional stress, which could be due to grazing management or a very poor season. When the BCS of cows is 2 or less, they invariably aren't getting enough feed to match their nutritional requirements and their milk production will be reduced.

5. Using CashCow outputs to improve management and herd profitability

5.2.3 Is loss of cows a contributing factor?

In smaller, more intensive operations, where mustering efficiency is good and boundary fences are secure, the head count at the muster is usually sufficient to ascertain the annual percentage loss of cows. However, where mustering efficiency is <90%, where tag loss is occurring and where the topography of the paddock creates mustering challenges, then a 'bang tail muster' or a post-muster aerial inspection is needed to get a handle on stock numbers. The process for doing a bang tail muster and estimating cow loss is provided in the appendix.

If the estimated average annual cow loss if greater than the 25th percentile, the possible causes include:

- poor body condition due to grazing management, P status, time of calving, out-of-season calving
- age of cow
- dry season pasture biomass
- diseases – botulism, tick fever
- delayed start to wet season or delayed follow-up rain after the onset of the wet season.

5.3 Will it pay to improve herd production?

Once the most likely cause(s) of reduced productivity has/have been identified, a key question remains: "Will there be a positive economic return if the cause(s) is addressed?".

Obviously, this requires an accurate identification of the cause of the problem, estimates of the likely productivity benefit, and the costs of achieving this. In the first instance, likely impacts on profit can be assessed by gross margin analysis. Once the most promising option and approach is identified, likely impacts on profitability can be assessed by investment analysis.

There are a number of tools for doing such analyses. An important requirement of analyses for improving herd productivity is the capacity to represent the current herd structure, and then to account for change in structures that occur once management changes are implemented. BREEDCOW is a well-established tool for conducting the gross margin analysis of before and after a potential change in management, and an associated program called DYNAMA conducts investment analysis. Having reliable inputs to enter into BREEDCOW can be an issue, obviously depending on the records available for a particular herd.

The CashCow project developed a tool call the BRICK that helps a business to understand biological and financial aspects of recent and current business practice. It depends on having accurate data. Outputs from the BRICK can be used as accurate Breedcow inputs, rather than guesses, improving the reliability and relevance of the testing of various herd scenarios.

Tools: Breedcow/Dynama software can be found at:
www.daff.qld.gov.au/business-trade/business-and-trade-services/breedcow-and-dynama-software

BRICK – development of this tool continues and a copy can be obtained from the Charters Towers office of the Queensland Department of Agriculture and Fisheries.

Appendix A – Other useful descriptive data of cow mobs

The CashCow project provided useful data on a number of aspects of the cow herd, in addition to the data covered in detail above.

Mature cow weights

The weight of the mature cow can provide a good indication of the quality of the country and the nutritional conditions that existed as the female progressed through to maturity. Data of this type has never been collected before from females in northern Australia. Slaughter data could provide similar estimates but is likely to be biased as most producers do not send unfinished lighter cows to slaughter unless they have no other market options.

Table A.1: Mean liveweight recorded at July–September muster, by cow age class and country type

Cow age class and country type	Mean liveweight (kg) recorded at the Jul–Sep muster									
	Pregnant					Not Pregnant				
	No.	Mean		95% Confidence interval		No	Mean		95% Confidence interval	
				Lower	Upper				Lower	Upper
Heifers										
Southern Forest	2,020	**409A**		375	442	490	**386A**		357	415
Central Forest	1,817	**453A**		401	505	558	**419A**		363	475
Northern Downs	2,432	**418A**		378	458	441	**371A**		329	414
Northern Forest	4,005	**353B**		329	376	1,267	**314B**		286	342
Overall	10,274	**408**		387	429	2,756	**373**		352	394
First-lactation cows										
Southern Forest	955	**468A**	7	453	484	300	**436A**	9	417	455
Central Forest	790	**497A**	22	453	540	196	**468A**	19	430	505
Northern Downs	867	**404B**	8	388	420	391	**372B**	6	359	385
Northern Forest	606	**353C**	13	328	379	434	**333C**	11	311	355
Overall	3,218	**431**	7	416	446	1,321	**402**	7	388	416
Mature and aged cows										
Southern Forest	8,185	**497A**	10	477	517	1,795	**466A**	12	442	490
Central Forest	6,641	**518A**	9	501	536	1,583	**486A**	11	464	509
Northern Downs	13,179	**458B**	5	447	469	2,807	**423B**	6	410	436
Northern Forest	12.678	**406C**	6	393	420	7,366	**351C**	7	336	366
Overall	40,683	**470**	4	462	478	13,551	**431**	4	422	441

Average mature weights of non-pregnant cows, by region

Southern Forest
466kg

Central Forest
486kg

Northern Downs
423kg

Northern Forest
351kg

Appendix A – Other useful descriptive data of cow mobs

Bos indicus content of cows

Over the past three to four decades, there has been a massive shift from *Bos taurus* breeds to *Bos indicus* in northern Australia, driven predominantly by tick resistance and performance in the harsher environments of the far north. The CashCow data provides a snapshot of the extent to which Bos indicus breeds are dominating the production systems of the north.

Table A.2: Level of Bos indicus content by country type

Country type	Level of *Bos indicus* content						Total no. of cattle
	<50%		≥50-<75%		≥75%		
	No.	%	No.	%	No.	%	
Heifers							
Southern Forest	1,525	55	667	24	561	20	2,753
Central Forest	565	22	1,622	63	405	16	2,592
Northern Downs	135	4	3,365	88	328	9	3,828
Northern Forest	0	0	725	9	7,534	91	8,259
Total	2,225	13	6,379	37	8,828	51	17,432
Mature and aged cows							
Southern Forest	3,991	67	1,129	19	796	13	5,916
Central Forest	788	17	3,016	65	837	18	4,641
Northern Downs	950	7	11,017	80	1,838	13	13,805
Northern Forest	0	0	1,679	11	13,521	89	15,200
Total	5,729	14	16,841	43	16,992	43	39,562

90% of the Northern Forest cows are ≥75% *Bos indicus* compared to only 13% of Southern Forest cows.

Hip height

Hip height was measured at the peak of the sacrum, which is adjacent to the hip joints.

Table A.3: Hip height, by cow age class and level of Bos indicus content

Cow age class and level of *Bos indicus* content	Hip height (cm)				
	No. of cattle	Mean	SE	95% Confidence interval	
				Lower	Upper
Heifers					
<50%	1,517	135.2A	1.2	132.8	137.6
≥50-<75%	5,675	137.3A	0.7	135.9	138.7
≥75%	4,241	137.2A	0.8	135.6	138.7
Mature and aged cows					
<50%	3,577	132.8A	1.3	130.3	135.3
≥50-<75%	5,888	134.9A	1.0	133.1	136.8
≥75%	9,142	134.8A	1.0	132.9	136.7

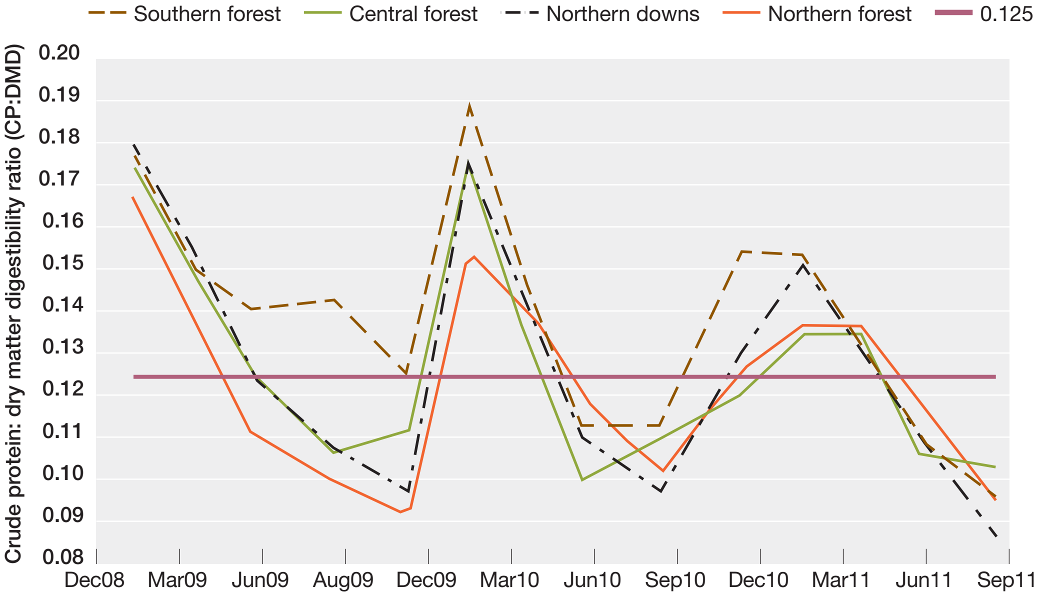
Note: Within cow age class, means that those not sharing a common superscript letter are significantly different at P<0.05.

Appendix A – Other useful descriptive data of cow mobs

Protein adequacy in Pasture – DMD:CP Ratio

The ratio of CP:DMD follows a similar pattern as other nutritional indicators, with lower nutritional value during the dry season (May–October) and higher values during wet season (November–April). Pasture protein was inadequate for a majority of properties between May and October each year. A ratio of 0.125 is the indicator used by most advisers to indicate responsiveness to NPN or protein supplementation.

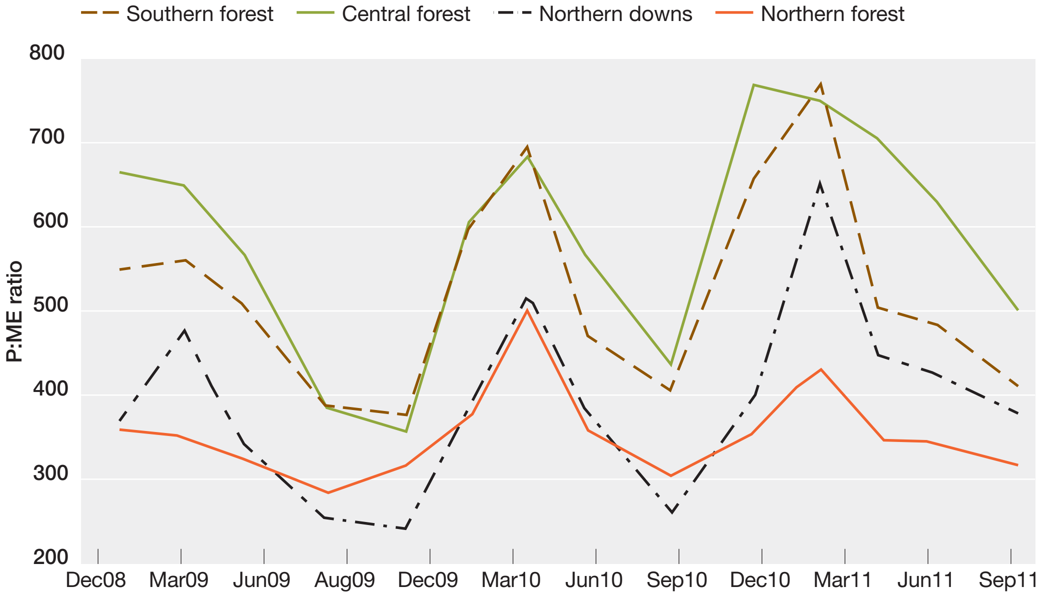
Figure A.1: Protein adequacy by country type



Phosphorus status

Faecal P:ME ratio has been used as an indicator of P intake relative to energy content of the diet, and suggested for use as a potential indicator of P status. Cattle grazing both Southern Forest and Central Forest had much higher P intakes, relative to diet ME (>500mg/kg), compared to cattle in the Northern Downs and Northern Forest regions.

Figure A.2: P status by country type

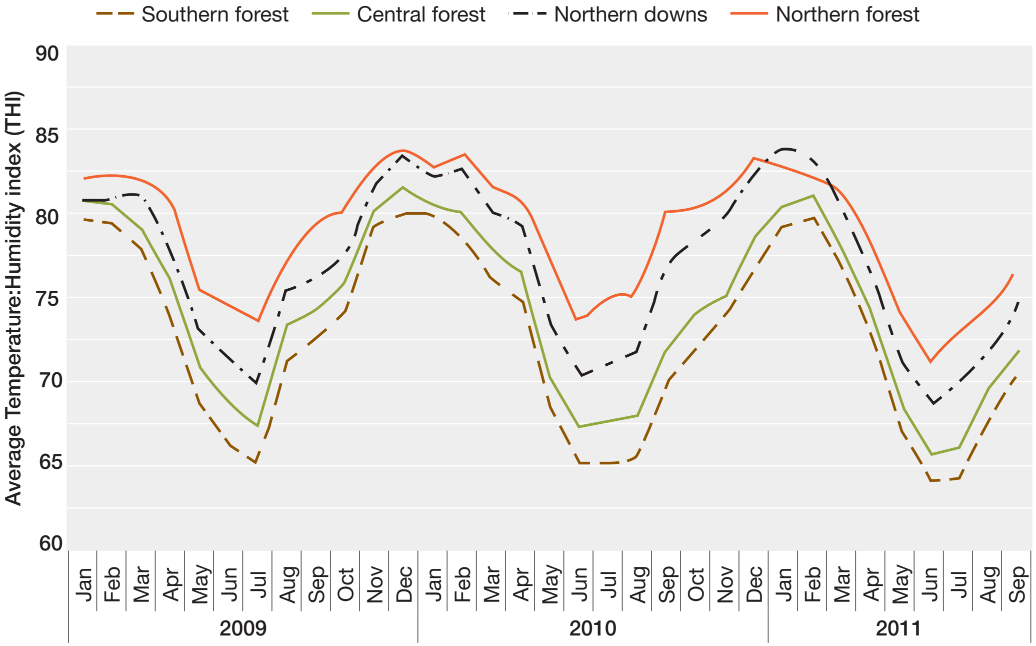


Appendix A – Other useful descriptive data of cow mobs

Thermal Humidity Index (THI)

Environmental comfort index calculated from ambient temperature (T) and relative humidity (H) as THI = 0.8T + H * (T – 14.4) + 46.4. An index of 79 was regarded as a critical value for analysis and, as expected, it exceeds this value most in Northern Forest.

Figure A.3: Thermal Humidity Index by country type



Diseases of reproduction

Bovine Pestivirus: Pestivirus (bovine viral diarrhoea virus type 1) was widespread through the whole of northern Australia.

Table A.4: Observed mob BVDV seroprevalence (%) by cow age class and year, within country type

Country type	Year	Cow/mixed			Heifer		
		No. of Mobs	Median	IQR*	No. of Mobs	Median	IQR*
Southern Forest	2009	18	73	13–100	14	21	0–80
	2011	17	80	45–92	6	74	55–80
Central Forest	2009	9	60	53–93	9	40	0–67
	2011	11	60	44–87	8	63	0–81
Northern Downs	2009	12	90	87–100	9	93	80–100
	2011	10	87	80–100	6	83	53–100
Northern Forest	2009	23	60	13–87	10	67	33–87
	2011	22	46	27–80	5	73	60–75

* IQR – interquartile range

Appendix A – Other useful descriptive data of cow mobs

Neospora caninum: The mean *N. caninum* seroprevalence was similar for heifers and cows, and was similar for each between years. This latter finding suggests that horizontal transmission (picked up in the environment from dogs and other similar vectors) is only occurring at a low level and the primary means of transmission is likely to be vertical (mother to offspring).

Table A.5: Observed mob Neospora caninum seroprevalence (%) by cow age class and year, within country type

Cow age class/cohort	Year	No of samples	Seroprevalence of *N. caninum*		
			Mean	95% Confidence interval	
				Lower	Upper
Main heifers	2009	46	10.9%	4.8	16.9
	2011	202	10.4%	6.5	14.3
Pilot heifers	2009	32	9.4%	0.2	18.6
	2011	78	12.8%	4.5	21.1
Cows/mixed	2009	601	11.8%	8.5	15.2
	2011	921	12.6%	9.6	15.3

Bovine ephemeral fever (three day sickness): Only females sampled in 2011 were tested for evidence of BEF virus infection. The mean seroprevalence (level of infection as detected by antibody levels in the mob) for heifers and cows was similar and very high.

Table A.6: Observed mob BEF seroprevalence (%) by cow age class and year, within country type

Cow age class/cohort	Year	No of samples	Seroprevalence of BEF*		
			Mean	95% Confidence interval	
				Lower	Upper
Main heifers	2011	150	90.0%	85.0	95.0
Pilot heifers	2011	53	90.6%	82.7	98.4
Cows/mixed	2011	764	86.1%	83.1	89.1

* BEF VNT ≥40 and includes unvaccinated and vaccinated mobs.

Leptospirosis: The overall *L. hardjo* seroprevalence by year and cow age class/cohort was low (about 10%).

Table A.7: Observed mob Lepto seroprevalence (%) by cow age class and year, within country type

Cow age class/cohort	Year	No of samples	Seroprevalence of *L. hardjo* (MAT titres ≥200)		Seroprevalence of *L. pomona* (MAT titres ≥200)	
			Mean	95% Confidence interval (Lower-Upper)	Mean	95% Confidence interval (Lower-Upper)
Main heifers	2009	4	0.0%	–	0.0%	–
	2011	120	5.9%	0.3–11.5%	3.0%	-1.4–7.4%
Pilot heifers	2009	7	0.0%	–	0.0%	–
	2011	34	15.3%	-6.5–37.1%	0.0%	–
Cows/mixed	2009	383	12.3%	6.8–17.7%	9.9%	3.6–16.3%
	2011	634	8.6%	4.1–13.1%	10.6%	-14.8%

Appendix A – Other useful descriptive data of cow mobs

Vibriosis – Campylobacter fetus subsp. *venerealis* infection: Vibriosis is still fairly common in northern Australia.

Table A.8: Observed mob Vibriosis seroprevalence (%) by cow age class and year, within country type

Country type	Year	No of Mobs	Mobs prevalence of *C.fetus* venerealis infection*		
			Nil	Moderate	High
Southern Forest	2009	19	36.8%	63.2%	0.0%
	2011	20	45.0%	35.0%	20.0%
Central Forest	2009	9	33.3%	66.7%	0.0%
	2011	11	54.5%	45.5%	0.0%
Northern Downs	2009	12	33.3%	58.3%	8.3%
	2011	10	30.0%	50.0%	20.0%
Northern Forest	2009	23	60.9%	39.1%	0.0%
	2011	21	66.7%	28.6%	4.8%
Total	2009	63	44.4%	53.9%	1.6%
	2011	62	51.6%	37.1%	11.3%

* Mob prevalence of C.fetus venerealis infection defined as Nil: 0%; Moderate: >0 to <30% and High: ≥30%

Q-fever (Coxiella burnetii): Samples were obtained from 58 mobs on 56 CashCow properties in Queensland only. Overall seroprevalence to either or both antigenic phases of *C. burnetii* was 16.8%. Seroprevalence was similar across country types. Positive samples were detected in 78.2% of properties surveyed.

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