Reproductive inefficiencies and opportunities in dairy and beef cattle in Australia

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Abstract. Reproductive performance is a key driver of the economics of dairy and beef breeding herds. In the absence of hormonal treatment to induce or stimulate lactation, regular parturition and initiation of lactation are key events directly affecting the average daily milk production of dairy herds, culling decisions and farm gross margins. Thus efficient reproductive management is a critical prerequisite for sustainable dairy production. Economic modelling of the performance of both southern and northern Australian beef cattle breeding enterprises has demonstrated that cows which recommence cycling and readily conceive in response to the annual seasonal improvement in pasture quality and quantity return the greatest gross margin per hectare. The major factors affecting the weaning rate in beef breeding herds are interval after calving to resumption of normal ovulations, embryo-foetal survival and perinatal survival.

Additional keywords: reproductive performance, beef, dairy cattle, factors affecting

Introduction

In Australia, dairy and beef cattle breeding herds are located in a wide range of environments from the tropics to temperate regions. In 2006 there were 2.79 M dairy cattle with about 77% of these in the temperate and subtropical regions of Victoria and New South Wales (ABS 2005), in areas of either moderate rainfall and or access to irrigation water for pasture production. Breeding of dairy cows in year-round calving herds is mainly by artificial insemination (AI), and in seasonal calving herds a combination of AI followed by bull mating is used. The majority of dairy cattle in Australia are Holstein-Friesians. In contrast to the dairy industry, in 2006 there were 26.1 M beef cattle in Australia with over half of the breeding herds in northern Australia, and all herds using natural mating with only very limited use of AI. Beef production systems range from intensive improved pasture to very extensive native pasture grazing systems. In northern Australia, 85% of beef cattle have some *Bos indicus* content (Farquharson and Banks 2002) whilst in southern Australia the majority of cattle are of *Bos taurus* origin.

Regardless of the production system, reproductive inefficiencies have a significant effect on herd and farm profitability. In dairy herds, economic modeling (Morton, 2001) has demonstrated that modest improvements in reproductive performance, e.g. improvements in 6-week in-calf rate in seasonal calving herds from 60% to 65%, and in 100-day in-calf rate in year-round calving herds from 41% to 53%, could increase annual gross farm income by \$6,000 and\$10,000 per 200 cows, respectively. Recent data by Best (2007) from central Queensland indicated that lifting weaning rates from 65% to 75% increased gross margins per adult equivalent (AE) from \$118 to \$140 in store steer systems and \$150 to \$170 in Brigalow breeding properties, assuming in both cases that breeder mortalities were 2%.

This paper will review the reported magnitude of reproductive inefficiency in dairy and beef breeding herds, the factors which significantly contribute to sub-optimal reproductive performance, and highlight strategies which may be used to reduce the risk of these factors adversely impacting on herd performance. The beef component of this review is biased towards the northern Australian beef industry as this reflects the experience of the authors.

Reproductive performance in dairy and beef herds

Dairy cattle

The Dairy Australia-funded InCalf Project conducted in the mid-‘1990’s used a population approach to define achievable levels of reproductive performance for seasonal (n=124) and year-round calving (n= 43) herds, and quantified the herd-, cow-, and insemination-level factors significantly affecting the reproductive performance of Australian dairy herds (Morton and McGowan, 2002). The measures developed by InCalf (www.incalf.com.au) which accurately define the efficiency of reproduction in seasonal calving dairy herds are 6-week-in-calf-rate (6wk ICR – proportion of cows which conceive within 6weeks of the planned start of mating), and in year-round calving herds 100-day-in-calf-rate (100-day ICR – proportion of cows which become pregnant by 100days after calving; these cows will have intercalving intervals of ≤12.5months). Taking the median performance of the 25% of herds with the highest overall measure of reproductive performance InCalf has defined achievable levels of performance for Australian seasonal calving (6wk ICR of 71%) and year-round calving herds (100-day ICR of 58%). The key drivers of 6wk ICR and 100-day ICR are submission rate (SR – the percentage of cows submitted for mating in the first 3 weeks of the mating period or within 80 days of calving in seasonal and year-round calving herds, respectively) and conception rate (CR – the percentage of inseminations/matings which results in confirmed pregnancy). The quartile of herds with the highest 6wk (seasonal herds) and 100-day ICR (year-round herds) had SR >86% and 73% respectively, confirming that high SR is essential for high reproductive performance. Also, based on the median performance of the 25% of herds with the highest 6-wk ICR, an achievable first service conception rate for Australian dairy herds is 53%.

Beef cattle

Commonly used indices to measure reproductive performance in beef herds include pregnancy rates, calving rates, branding rates and weaning rates, all expressed as a percentage of females joined to bulls. All of these indices have deficiencies with respect to accurate definition of inefficiencies in performance and unbiased comparisons between breeding herds. Pregnancy rates are useful with short mating periods but do not take into account subsequent prenatal, perinatal and postnatal losses. Calving, branding and weaning rates are, respectively, the number of calves born (both alive and dead), branded (at time of branding and castration) or weaned as a proportion of cows mated the previous years. Calving rates are often difficult to determine in extensive areas because of property size and often adverse seasonal conditions. Branding rate is the common index of fertility in extensively managed herds but it suffers from the inaccuracy that, although calf numbers are accurately recorded, cow numbers since mating are usually estimated because of mortalities, animals missed at musters and escaping into other paddocks. Weaning rate is the best index of fertility as it represents the breeding output from the herd but it suffers from the same problems as the calculation of calving and branding rates. Measures which take into account the efficiency with which females re-conceive after calving are required.

The biological goal touted for reproductive efficiency in beef herds is a calf born alive for every cow mated per year. In the extensively managed rangelands of northern Australia this is often impossible to repeatedly achieve due to marked variations in seasonal pasture growth, and may not necessarily be desirable as the sale of non-pregnant cows in good body condition represent a significant component of property income (Wicksteed 1980). There have been several reviews in the last 20 years of the scientific literature on reproductive performance in northern Australian beef herds. Holroyd and O'Rourke (1989) reported fertility data from 146 sites and mortality data from 29 sites since the 1960's to 1986 in northern Australia. Hasker (2000) identified 54 reports on fertility and 18 reports of mortalities in beef herds in northern Australia from 1987 to 1997. There is a wide range of reproductive rates reported and understandably, the highest rates tend to be in the more benign environments in years of more favourable seasons. These studies suggest that a realistic target for weaning rates for tropically adapted cattle in northern Australia in average or better rainfall years is 80 calves weaned for each 100 cows mated. This may be as high as 90% in extremely good seasons with excellent management. However a minimum weaning rate should be 70% across a range of years. Industry surveys would suggest that the majority of beef breeding herds in northern Australia would fall below this mark as O'Rourke et al (1992) reported an overall annual branding percentage of 63%, ranging from 48% in the Gulf of Carpentaria region to 73% in inland central and southern Queensland.

Whilst there have been a large number of studies and reports on various reproductive parameters such as pregnancy rates, calving rates, branding rates and weaning rates, unlike in the dairy industry or a recent epidemiological study of beef herds by McFadden *et al.* (2004) in New Zealand, there have been no organised concurrent studies in Australia where beef herds have been examined and reported under a common set of guidelines to make comparisons between herds more meaningful. The findings of McFadden *et al.* (2004) probably provide useful benchmarks for the more intensively managed herds in the temperate regions of Australia. These researchers reported the findings of a study of 1,005 beef breeding herds distributed throughout New Zealand. The median herd size was 136 (range 10-2,350) breeders, mostly Angus or Angus-Hereford cross cattle, and the majority of herds were mated for 2 to 3months. The median pregnancy rate was 91%, the upper quartile ≥94%, with 10% of herds having a pregnancy rate of ≤82%.

Factors affecting reproductive efficiency by stage of the reproductive cycle

***Onset of puberty* - dairy cattle**

The aim of heifer management on dairy farms is to have the majority of heifers calving for the first time at 24months of age, and thus heifers must reach puberty and be cycling normally by 13 to 14months of age. Failure to receive sufficient good quality colostrum continues to be a major factor predisposing dairy calves to infectious respiratory disease and enteritis, which in turns adversely affects calf growth rate and survival. Insufficient energy and protein intake both pre-and post weaning are the major causes of delayed onset of puberty.

***Onset of puberty* - beef cattle**

There is large variation in age at puberty of beef heifers. Weight is the most significant factor influencing puberty and this is mainly a function of breed, nutrition, season and genetic variation (Fordyce 2006). The reported mean liveweight at puberty of *Bos indicus* cross heifers using behavioural oestrus as the indicator is 285 kg at 20.5 months of age (Holroyd and Fordyce 2001). However, recent work by Johnston *et al*. (2006) using ultrasonography and the presence of the first corpus luteum as the indicator of puberty suggest that this was an underestimate. Johnston *et al.* (2006) found that the mean age and weight of puberty in Brahman heifers was 25.2 months and 337 kg and in Tropical Composites, 22.4 months and 332 kg.

The observed significant variation in age at puberty has management implications for maximizing fertility at first joining. Fordyce (2006) proposed the concept of managing heifers to reach a target weight rather than managing heifers to reach puberty. As pregnancy rates of heifers at their first ovulation are lower (Staigmiller *et al*. 1993), the target is to have heifers reach their third ovulation before the end of their first mating. Whilst mating of selected Brahman and Beefmaster heifers as yearlings has resulted in pregnancy rates of 80%, overall, yearling mating of tropically adapted heifers generally yields lower fertility rates. Further, Fordyce *et al.* (1994) showed that although heifers calving at 2 years of age have higher lifetime output, there is a need to provide preferential nutritional management to avoid reduced skeletal size and body weight in this class of animal.

***Resumption of ovulation post partum* - dairy cattle**

To achieve high 100-day ICR in year-round calving dairy herds the majority of cows must commence cycling and be submitted for at least one service by 80days after calving. Well managed, clinically normal dairy cows ovulate 14 to 21days after calving and ovulate for the second between Days 30 to 40 after calving (Jonsson *et al*. 1997). Cows with prolonged intervals to first postpartum ovulation have a significantly reduced chance of being mated by 80 days and conceiving by 100days after calving. In high producing multiparous Holstein cows the reported incidence of anovulation at approximately 50 to 70 days postpartum ranges from 15 to 32% (Gumen *et al.* 2003 and Chebel *et al.* 2006, respectively). Primiparous cows, cows in low body condition at calving and cows which have abnormal uterine involution are all at greater risk of prolonged interval to first postpartum ovulation. Sheldon *et al*. (2002) reported that the early postpartum immune response to uterine infection has a localized effect on ovarian function. Cows which had a follicle > 8mm in diameter on the ovary ipsilateral to the previously gravid uterine horn between 2 and 4weeks after calving had a shorter calving to conception interval, and the development of a dominant follicle in the ipsilateral ovary was correlated with a lower level of uterine bacterial growth in the early postpartum period.

***Resumption of ovulation post partum* – beef cattle**

Reviews by Entwistle (1983) and Montiel and Ahuja (2003) highlight the magnitude of the problem of delayed resumption of cyclicity post-partum in tropically adapted cattle in northern Australia. On average, lactating *Bos indicus* and *Bos indicus* derived females will cycle 6-7 months post-partum and pregnancy rates in lactating cows range from 20% through to 70% depending upon breed, liveweight, body condition, age and length of the mating period. (Entwistle, 1983). This leads to a pattern of cows calving in alternate years or failing to conceive in one or more years of their breeding life. The actual length of the postpartum interval in grazing animals has been difficult to determine because of the managerial problems of measuring cyclicity in large groups of lactating females with young calves, but recent estimates from the Beef CRC herds would suggest that in lactating first calf cows, the interval is on average 6.0 months in Brahmans and 4.7 months in Tropical Composites (RG Holroyd and G Fordyce unpublished data).

***Conception* - dairy cattle**

The median values for first service conception rate for the InCalf herds in the 1st, 2nd, 3rd and 4th quartile were 39.3%, 46.5%, 52.1% and 57.65, respectively (Morton, 2003). The average lactational incidence of repeat breeder cows (greater than two inseminations required per conception with cows returning to oestrus at a normal interval) has been reported to be 24% in primiparous cattle and 22% in multiparous animals in year-round calving herds in the Camden region of New South Wales (Moss *et al*. 2002). In both parity groups there was marked between herd variation in the incidence of repeat breeding (overall 7% to 46%). Santos et al (2004) and Diskin et al (2006) have recently reviewed the literature on conception failure in dairy cattle. The magnitude of losses observed are summarized as follows:

a) fertilization failure

Slaughter studies conducted during the 60's and 70's (reviewed by Sreenan and Diskin, 1986) reported rates of fertilization failure averaging 14% (expressed as a % of cows inseminated). However, more recent studies (primarily conducted in Holstein cattle) involving non-surgical collection of ova/embryos 5 to 6days after AI, have generally found much higher rates of failure, averaging 24%. Also in these later studies there were no significant differences between the rates of failure observed in lactating and non-lactating cows.

b) early embryonic mortality (embryonic death followed by/or luteolysis at the normal expected time) – again early slaughter studies reported losses (expressed as a % of fertilized ova recovered) averaging 12%, however more recent studies (reviewed by Santos *et al*. 2004) have generally found much higher rates of failure, averaging 34%. Although we must be cautious with historical comparisons, the days post insemination when the majority of the estimates of embryo loss were determined are similar for past and recent studies.

c) late embryonic mortality (embryonic death which occurs between the time of inhibition of normal luteolysis and the completion of foetal organogenesis – approximately Day 42 after insemination). In the early slaughter studies the apparent loss between Day 20 and Day 42 was 3% (loss expressed as % of cows pregnant on Day 20). In the more recent studies which utilized sequential ultrasonography, the losses between Day 28 and Day 45 were considerably greater (13%). McGowan (1991) using a combination of ultrasonography and milk progesterone found that the incidence of loss (expressed as a percentage of total inseminations examined; n = 453) in 2 commercial dairy herds (outer Sydney region of New South Wales) between day 24 and Day 42 after AI was around 16%.

The causes of embryonic mortality in dairy cattle have been extensively reviewed by Zavy (1994), Santos *et al.* (2004) and Diskin (2006).

Factors which were shown to significantly affect first service conception rate in the InCalf herds were:
1. Interval from calving to first insemination. The conception rate of cows calved 25days was approximately 20%, increasing to 40% for cows calved 50days and almost 50% for cows calved 75days. In seasonal calving herds the highest first service conception rate was achieved by those cows which had calved more than 12weeks before planned start of mating, with progressively lower values for those cows calving in 3weekly increments later.
2. AI practices. It was shown that 26% of farm technicians could achieve conception rate increases of more than 10% if optimal AI practices were used

3. Body condition at calving. Cows with a body condition score of <3 (using a 1 to 5 scale) at calving had a first service conception rate 14% lower than those calving in optimal condition (3.0 to 3.5)

4. Average milk protein percent for the first 120days of lactation. Cows with values less than or equal to 2.75% had a first service conception rate at least 9% lower than cows with values greater than 3.0%.

5. Periparturient disease problems. Cows which experienced dystocia, birth of twins, retained foetal membranes or abnormal postpartum vaginal discharge all had first service conception rates at least 5% lower than unaffected cows.

6. Conception rate of individual bulls – 10% of bulls had conception rates at least 2% lower than the majority of bulls used by farmers in this project.

7. Prolonged intercalving interval previous lactation. Cows which had a previous intercalving interval of more than 400 days had a lower first service conception rate.

8. Cow age. Cows greater than 7years of age had a lower first service conception rate than younger cows.

Further factors affecting the likelihood of conception in dairy cattle are:
a) body condition loss during early gestation. Silke *et al*. (2002) observed that cows losing 1 unit (5–point scoring system) of body condition from Day 28 to 56 of gestation had a 3.2 fold increase in risk of pregnancy loss in the same period.
b) sub-clinical endometritis. Gilbert *et al.* (2005) reported that cows with subclinical endometritis (defined by cytology) had significantly lower 100-day ICR than negative cows.
c) concurrent clinical and sub-clinical mastitis. Schrick *et al* (2001) reported that cows which had either clinical or subclinical mastitis in the period before first service had increased days to first service, services per conception and days open, and cows which had clinical mastitis in the period between first service and confirmation of pregnancy had increased services per conception and days open. Cytokines induced by the inflammatory reaction in the mammary gland may play a major role in this increased risk of conception failure.
d) repeat breeding. Researchers in Sweden (Bage *et al*. 2002) have shown that repeat breeder heifers had a prolonged duration of oestrus, delayed luteinising hormone peak, prolonged lifespan of the preovulatory follicle and a delayed postovulatory rise in plasma progesterone concentration .This hormonal asynchrony was considered the major cause for the poor fertilization rate in these heifers. Earlier studies summarized by Ayalon (1978) demonstrated a marked variation in the composition of the uterine fluids collected on days 5 to 11 after AI from normal and repeat breeder cows. Concentrations of potassium and calcium were consistently higher in the uterine fluids of repeat breeder cows, and total protein concentration were consistently higher in normal cows.
e) oocyte quality. Lonergan *et al.(*2003) concluded that 'the intrinsic quality of the oocyte determines its developmental capacity'. It has been shown that mRNA and protein synthesised during oocyte growth and maturation critically contribute to early development prior to embryonic genome activation.
f) corpus luteum function. Researchers in Ireland (Stronge *et al*. 2006) reported that low plasma concentrations of progesterone on day 5 after AI were associated with a low probability of embryo survival. Moore et al (8)

reported that mean serum progesterone concentrations on Day 21 or 22 and Day 23, 24 or 25 were lowest for cows that lost an embryo between Days 24 and Day 28.
g) heat stress. Exposure to high environmental temperatures significantly reduces oocyte quality and fertilization rate (Santos *et al*. 2004). Results of a series of recently published studies (reviewed by Santos et al, 2004) demonstrate that cows exposed to heat stress prior to AI were 31-33% less likely to conceive and also experienced very high rates of late embryonic mortality (42.7% loss between Days 27 and 50 of gestation). A recently completed study (Morton *et al*. 2006) on the impact of heat stress on the conception rate of pasture-based dairy herds in far northern Australia found that cows experiencing increased heat load in the period 5 weeks before and 1week after AI had reduced conception rates (Morton *et al*. 2006).
h) 'phantom cows' – Nation *et al* (2001) reported that although very late calving cows in seasonal calving herds (calved 6weeks or less before planned start of mating) had sufficient opportunity to conceive in a 21week breeding period a large proportion (13 to 23%) failed to do so. Part of the reason late calving cows failed to become pregnant by the end of the breeding season was due to failure to return to oestrus at the normal time after mating ('phantom cows'). Analysis of the progesterone profiles of these cows demonstrated that many had an apparent persistent corpus luteum. A large study of 1682 Friesian cows from 20 primarily year-round calving herds in the UK (Lamming and Darwash) has shown that up to 13.7% of cows had prolonged luteal activity (progesterone >3ng/ml for at least 19days) during their first or subsequent cycles after calving, and these animals also had a higher incidence of abnormal prolonged luteal activity after insemination.

***Conception* - beef cattle**

Fordyce *et al.* (2006) found that in 6 groups of regularly monitored *Bos indicus* females in northern Australia the pregnancy rates per cycle varied between 40% and 70%, with embryonic mortality likely to be the major cause of this variation. A recent study (Dunne *et al*. 2000) of embryo-foetal loss in cross-bred *Bos taurus* heifers found that 32% of embryos were lost before day 14 (early embryonic mortality) compared to 4.2% late embryonic-foetal losses between day 30 and birth. Cattle experiencing early embryonic mortality (losses before day 16 after mating) show no clinical signs other than return to oestrus at the normal expected time. However cattle experiencing late embryonic mortality (losses after day 16) have a prolonged interovulatory interval due to the extended duration of CL (corpus luteum) function. The interval between time of death of the embryo and reovulation is quite variable. Heifers which experienced embryonic death between days 27 and 38 of gestation reovulated between 39 and 77 days after the original insemination (Kastelic *et al*. 1991). The effects of an increased incidence of embryonic mortality on herd reproductive performance are:

1. decreased proportion of females calving during the first 6 to 9 weeks of the calving period
2. in herds with a restricted joining period some cows will not have an opportunity to reconceive. This is particularly the case for females experiencing late embryonic mortality.

The causes of conception failure in beef cattle have not been investigated as thoroughly as in dairy cattle. However, it is very likely that the factors associated with increased risk of failure are similar in dairy and beef cattle. Additional factors which are likely to be important in beef cattle are:
a) venereal infections. As the majority of beef cattle are naturally mated and many herds graze extensive rangelands where bull control is difficult, infection of susceptible females with *Campylobacter fetus venerealis* is not uncommon. This organism invades the uterus and sometimes the oviducts from the vagina after mating and induces a significantly increasing the chance of either early or late embryonic mortality. *Tritrichomonas foetus* infections cause similar losses although the incidence of trichomoniasis in beef herds tends to be lower than campylobacteriosis.
b) bull sub-fertility. A large study of tropically adapted bulls conducted in northern Australia (Holroyd *et al*, 2002) found that 7% of bulls sired no calves, 58% individually sired 10% or less calves in each of their breeding mobs, and 13% sired over 30% of the calves in each of their breeding mobs. The results of statistical modeling showed that the percent morphologically normal sperm in the ejaculate of bulls prior to mating was the single most important factor affecting individual bull calf output (Holroyd *et al*, 2002).
c) bovine viral diarrhea virus (BVDV) or bovine pestivirus infection around the time of mating and during the first trimester**.** McGowan and Kirkland (1995) have reviewed the impact of BVDV infection on all stages of conception and foetal development. An outbreak of BVDV infection in a naïve herd during the mating period can result in at least a 30% decrease in weaning rate (McGowan *unpubl.*). BVDV infection is common in beef herds both in southern and northern Australia with approximately 30% of herds showing evidence of recent infection and, overall 90% with evidence of previous infection.
d) body condition of cows at calving. A summary of eight trials with over 1000 mainly *Bos taurus* beef cows showed that cows in borderline or less condition (BCS $\leq$ 2.0) at calving achieved a pregnancy rate of 60% compared to 91% achieved by cows in moderate to good condition (3.0–3.5) at calving. The relative impacts of body condition at calving on interval to first ovulation and probability of conception have not been determined, however it is generally recognized that it is the impact on the latter which is most important.

Foetal and neonatal survival –
dairy cattle

Nation *et al* (2003) reported that the pregnancy loss between days 31 and 80 of gestation in 4 dairy herds in Victoria was 9%. Starbuck *et al* (2004) found that lactating cows with peripheral progesterone concentrations of < 3.77 ng/ml between days 30 and 36 after AI had significantly higher loss between weeks 5 and 9 of gestation than cows with values >3.77ng/ml (23% v's 8.5%, respectively). The concentration of progesterone at or below which only 50% of pregnancies were maintained was 2.8 ng/ml. Jousan *et al.* (2005) also reported that cows with a high somatic cell count (SCC – 400,000 cells/ml) near the time of insemination were 5.43 times more likely to experience mid-to-late foetal loss than cows with a SCC < 75,000 WBC/ml.

Although gestational losses in dairy cattle generally are of the order of 2 to 4%, losses around parturition and up to weaning can be much greater. The incidence of stillbirths in Holstein cattle increased from 9.5 to 13.2% in primiparous, and 5.0 to 6.6% in multiparous cows, between 1985 and 1996 (Bicalho *et al.* 2007). The level of perinatal and postnatal loss in an increasing number of herds is resulting in herds barely being able to meet their involuntary culling needs, with farmers resorting to purchasing in replacement heifers with the concomitant risk of introducing a range of economically important infectious diseases.

Foetal and neonatal survival –
beef cattle

The prevalence of losses from pregnancy diagnosis to weaning were reviewed by Burns *et al*. (2008)who reported prenatal , perinatal and post natal losses ranging from 1-17%, 2-12% and 1-15%, respectively. As a bench mark figure, "acceptable" levels of loss are 3% prenatal, 5% neonatal and a further 1% postnatal (Burns *et al*. 2008). Data from recently completed case studies conducted in northern Australian beef cattle herds indicate that losses between confirmed pregnancy and weaning in heifer herds of 15% to 20% and 5% to 10% in cow herds are not uncommon (unpublished).

The main infectious causes of foetal and neonatal loss are infections with BVDV, bovine ephemeral fever, Akabane virus, Leptospiral serovars *hardjo* and *pomona*, and *Neosporum caninum,* and infectious enteritis in new born calves. Non-infectious causes of losses include climatic and nutritional causes and maternal factors such as dystocia and abandonment of the calf. Rowan (1990) reported significantly higher perinatal loss in a Brahman (17.6%) herd compared to a Hereford (8.2%) herd and a Brahman-Hereford cross (8.7%) herd managed on the same property in south-east Queensland. The major cause of the increased incidence of loss in the Brahman herd was a significantly higher incidence of 'weak calf syndrome', defined as calves born alive and either too weak to stand or could stand but had difficulty in locating the teats and failed to suckle. A similar so called 'Dummy calf'syndrome has been reported in Brahman herds in the United States. Wythe (1970) reported that of 9,923 purebred Brahman calves born on one property, 27.3% had suckling problems shortly after birth. Recently, there have been reports of high levels of perinatal losses associated with hypovitaminosis A (Holroyd *et al.* 2005), dystocia and mismothering (Brown *et al* 2003). However even where comprehensive pathological investigations are conducted, there are still many losses (typically at least half) that are not diagnosed (Holroyd 1987; Brown *et al.* 2003), highlighting the need for development of alternative strategies to investigate the factors contributing to these losses.

Strategies to improve the reproductive efficiency of dairy and beef breeding herds.

The following framework for making optimal reproductive management decisions has recently been developed for the Australian dairy industry (www.incalf.au) and equally applies to the reproductive management of beef herds:

Step 1. Assess the current reproductive performance of the herd/breeding mob.
Step 2. Benchmark the herd's performance
Step 3. Estimate the contribution of factors which have been shown to have a major effect on herd performance
Step 4. Using standardised economic models estimate the financial outcome of controlling/modifying identified factors. Assess the practicality of implementing each option considered.
Step 5. Monitor the impact on reproductive performance of changes made, and where necessary modify, or add to the original options adopted.

The basic principles of improving the reproductive performance of beef cattle in northern Australia have been defined in reviews by Holroyd and Fordyce (2001) and Fordyce and Holroyd (2003). The findings of the InCalf project have provided the basis for development of a range of 'analytical tools' to both identify and control the factors affecting reproductive performance in dairy herds in Australia (www.incalf.com.au).

Conclusions

The causes of sub-optimal reproductive performance in dairy and beef cattle herds are multi-factorial. Certainly in northern Australian beef herds where management strategies have been implemented in a structured way, weaning rates have consistently exceeded 80% in a range of seasonal conditions (Holroyd and Fordyce 2001).

It is critically important that producers and their advisors have access to the findings of appropriately designed epidemiological studies which not only identify the most important factors contributing to variation in herd performance and but also quantify their impacts on performance. The latter information is critical in enabling producers to focus management changes and investment on those factors which have been shown to be contributing most to reproductive outcomes.

Measures of overall reproductive performance which can be readily derived and are correlated with economic return should be used to define the current performance of a herd. The development of universally recognized measures of performance enables producers to benchmark their herd's performance. This has recently been achieved by the InCalf project in the Australian dairy industry and is a key objective of the recently established MLA supported Northern Australian Beef Fertility (Cash Cow) project.

The application of new genetic technologies will become of increasing importance in improving reproductive performance providing attention is still rigorously applied to sound husbandry and management procedures. The recent development of a microarray panel of selected cDNA's of genes sensitive to changes in the early embryonic environment, which can be applied to single embryos (Brambrink *et al,* 2002), may greatly improve our ability to define the pathogenesis of embryonic mortality in cattle. Genetic selection to improve female reproductive performance in beef heifers is now feasible (Johnston *et al.* 2006) but the application of this in lactating cows and its relationship with lifetime fertility is yet to be tested. Work is currently underway within the CRC for Beef Genetic Technologies herds to identify gene markers for puberty and postpartum reconception. If successful, then a simple DNA test could be used to test for these two important reproductive traits in replacement beef females.

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