Improving Beef Cattle Production in Free Range Systems: Implications for Indonesia

Kieren McCosker

Beef Production Scientist, Department of Primary Industry and Fisheries, Katherine Research Station, Katherine NT 0851. P: +61 8 89739739
E-mail: kieren.mccosker@nt.gov.au

This review describes the relevant herd management practices and policies of northern Australian owners/managers of beef breeding businesses, focusing on those considered to be potentially applicable for free range beef cattle operations in Indonesia.

INTRODUCTION

The Northern Australian beef industry encompasses beef production within northern Western Australia, the Northern Territory and Queensland, and represents approximately 60% of the national beef herd and 9000 beef producing properties (Martin et al. 2013). The South East Asian live export trade is an important market for the northern Australian beef industry (Bortolussi et al. 2005) with the northern parts of the Northern Territory, Western Australia, and Queensland (Martin et al. 2013) supplying approximately 75-80% of the market (Riley et al. 2002).

The profitability of north Australian beef cattle enterprises has recently been reported as declining in terms of trade over time (McLean et al. 2013) due to lack of productivity gains, diminishing returns from reduced turnoff, lower beef prices and increased farm debt (Gleeson et al. 2012). Low reproductive performance in northern Australia is a result of multiple factors including pastures of poor quality and quantity during the dry season, extreme temperatures and humidity during dominant calving and mating periods, and large variability in seasonal rainfall (Entwistle 1983).

The northern rangelands vary greatly in terms of pasture production, fertility and soil types and therefore their ability to support animal production (Tothill and Gillies 1992) and are largely based on unimproved native or naturalized pasture species (Coates et al. 1997). Summer temperatures are high throughout northern Australia, ranging between 25-40°C with heat waves commonly experienced with maximum temperatures up to 50°C. Rainfall in the tropical parts of northern Australia is highly seasonal, with 90% of the annual rainfall falling between November and April during the ‘wet’ or ‘monsoon season’ (Nicholls et al. 1982).

In northern Australia, approximately 85% of beef cattle have some Bos indicus content to enable them to better cope with high environmental temperatures, low quality pastures and internal and external parasitism; in particular cattle tick (Boophilus microplus) and buffalo fly (Haematobia irritans sexigua) infestation. Cattle are typically mustered (brought together from the paddock into a cattle handling facility) twice a year for branding, weaning and other husbandry such as pregnancy diagnosis, usually in the late wet-early dry season (April-June) and then again in the mid-dry season. Helicopter mustering is now commonly used on most extensively managed properties. Approximately two-thirds of cow herds in the dry tropical rangelands of northern Australia are continuously mated, whereas in areas with higher soil fertility and more intensive management, herds are control mated typically for periods of 3 to 7 months.

ACHIEVABLE RATES OF PERFORMANCE

To evaluate the reproductive performance of a beef cattle herd requires consistent and accurate collection of appropriate data with standardized approaches of analysis. It is paramount
that the limitations of each measure are understood to minimize incorrect comparative analyses between herds and potential misinterpretation of results.

The interval from calving to the establishment of their next pregnancy is a significant determinant of the productivity and profitability due to its influence on both the annual percentage of calves weaned and the live weight of calves at weaning. The measure inter-calving interval, particularly within Indonesia, is often used to describe the efficiency with which herds or cows achieve this. However, there are known significant limitations with its derivation as it typically over-represents actual performance. For the derivation of inter-calving interval two calvings are required. Therefore, those cows that do not re-conceive or that are culled before re-conceiving are not represented in the measure, resulting in an optimistic representation of actual performance (Morton 2010). This is particularly true for first-lactation cows in northern Australia as generally only a small proportion re-conceive in less than 9 months from calving. A further major shortcoming of this measure in monitoring overall herd reproductive performance is that heifers are represented in this measure. The proportion of cows achieving pregnancy by various time periods since calving or mating start date, such as 4 months, has been used to describe reproductive performance and is a more robust measure of herd reproductive performance. Other measures commonly used within northern Australia beef enterprises are annual pregnancy rate, foetal/calf loss and weaning rate.

In assessing the performance of different beef production systems it is important to understand what the commercially achievable levels of performance are, as maximizing reproduction does not necessarily maximize profitability. Improved economic status of enterprises can only be realized if the expense of altering management to improve the reproductive performance of herds is less than the economic return from altering management. When desired levels of performance are higher than those routinely achievable on the available resources and conditions, the economic framework is typically not feasible as the expense of generating the required management changes are usually greater than the economic return. A recent study reported achievable and typical levels of reproductive performance for commercial beef herds within tropical tall grass pastured areas of northern Australia (Table 1)(McGowan et al. 2014).

Table 1. Typical and achievable levels of performance for beef herds of tropical areas of northern Australia (Northern forest)

<table>
<thead>
<tr>
<th>Cow age group</th>
<th>Pregnancy rate (%)</th>
<th>Pregnancy within 4 months* (%)</th>
<th>Foetal/Calf loss (%)</th>
<th>Weaning rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifers</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- Typical</td>
<td>67</td>
<td>16</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>- Achievable</td>
<td>81</td>
<td>11</td>
<td></td>
<td>69</td>
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<tr>
<td>1st lactation cows</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>- Typical</td>
<td>43</td>
<td>11</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>- Achievable</td>
<td>72</td>
<td>18</td>
<td>5</td>
<td>63</td>
</tr>
<tr>
<td>Mature cows</td>
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<tr>
<td>- Typical</td>
<td>66</td>
<td>17</td>
<td>14</td>
<td>54</td>
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<tr>
<td>- Achievable</td>
<td>74</td>
<td>31</td>
<td>9</td>
<td>61</td>
</tr>
</tbody>
</table>

*only derived for those cows that successfully reared their pregnancy.

MANAGEMENT OF THE BREEDER HERD

The major aspects of managing breeder cattle in free range systems of northern Australia and Indonesia, include management of the pasture resource, weaning management, addressing any mineral deficiencies and using an appropriate genotype (Holroyd and Fordyce 2001).

In tropical regions of northern Australia, and Indonesia, it is important that cattle are of an appropriate genotype. That is, a balance between productive ability, particular market aspects
(growth, size, type) and environmental tolerance. However, tropically unadapted cattle that cannot effectively dissipate heat suffer from heat stress which has negative effects on fertility and milk yield, potentially compromising calf survival. In tropical and subtropical regions, adapted genotypes are generally used as they exhibit higher survival and growth rates (Rudder et al. 1985). In areas of Queensland, substantial productivity gains by improvement of growth rates were documented by crossbreeding of Brahman bulls with Bos taurus cows (Rudder et al. 1976). However, the reproductive capacity of tropically adapted genotypes appears to decline with increasing Brahman content.

A recently completed study conducted within Indonesia reported comparable rates of pregnancy within 100 days of calving for Brahman/Brahman cross (12.4%) to Ongole (14.6%) cows (Mayberry et al. 2015). This project also found that Bali (Bos javanicus) cattle outperformed Bos indicus cattle for reproductive performance, which on average 49.2% of cows achieving pregnancy within 100 days of calving.

Frame size of cattle has also been shown to influence reproductive performance (McGowan et al. 2014). Generally, larger framed cattle reach puberty later and contribute fewer calves over their lifetime due to their increased maintenance energy requirement. Thus, an adjustment of stocking rates is required to reflect the size of the animals and consequently, fewer animals graze the available area reducing the potential number of weaners contributed by the herd on an annual basis.

Sustaining the pasture resource by using a suitable stocking rate is vital to ensure the long term viability of free-range beef production systems. Over utilizing pasture resources can lead to a spiral decline in the condition of the land and pasture over time. Land declining in condition generally cannot yield as much pasture as land in good condition meaning that less pasture is available to support animal production, decreasing the amount of kilograms of beef produced per unit area by both live weight gains and reproductive performance. Consequently this may lead to an increase in inputs (supplementary feeds) required to maintain animal performance or reduce the risk of mortality of cattle.

The incorporation of culling is essential in maintaining a profitable and productive breeding herd. As increased mortality is associated with aged cows, mortality risk can be managed by culled those cows greater than approximately 10 years of age or when their ability to forage declines due to deteriorating dentition. Additionally, removing those females with low fertility is a favourable long-term strategy as fertility traits are heritable and should always be based on performance records.

**MANAGEMENT OF BODY CONDITION**

A key requirement of efficient reproductive performance is the ability of cattle to cycle in early lactation with a number of detailed studies identifying nutritional influences, from before calving, being a significant determinant of early-lactation conception (Scaramuzzi et al. 2011). Body condition score reflects the nutritional status of cattle and indicates the body protein and fat reserves that can be mobilized during periods of under-nutrition and lactation when energy requirements are higher.

Body condition score is a key parameter that affects reproductive efficiency of all breeds. Simply, heavier/better conditioned heifers and cows have higher pregnancy rates. Mayberry et al. (2015) reported an across breed improvement of 21% for pregnancy within 100 days from calving and a decrease in calf loss by 14.6% for body condition score at calving≥4.0 cows relative to those ≤2.0 in a study completed in Indonesia. Each one unit change in body condition was estimated to be equivalent to a change in live weight of 9.6 kg, 58.5 kg and 31.3 kg for Bali, Brahman and Ongole breeds respectively (McCosker unpublished data).

Primarily, body condition of cattle can be manipulated by two ways: either by improving the quality of their diet such as supplementary feeding, reducing stocking rate, improved quality of pasture, or by reducing the duration of lactation by weaning management. Additionally, there are a number of different classes of cattle with different nutritional requirements such as heifers, non-
lactating and lactating cows, and aged cows. Whilst, segregation is not always a viable option, having management groups of free-ranging cattle based on their nutritional requirement may enable more appropriate management of those cattle with high nutritional requirements (e.g., lactating females) and reduce the risk of mortality or increase the probability of pregnancy.

**WEANING AND WEANER MANAGEMENT**

Lactation has a large energy requirement and extended lactation when nutrition is inadequate can lead to large losses in body condition and even mortality. Managing the duration a cow lactates is a critical breeder herd management strategy to support breeding performance. The key objective of weaning is to conserve body condition by minimizing loss across periods of low pasture quality, allowing an increased number of cows to be in better condition at the time of mating and consequently, improving the likelihood of lactating cows achieving pregnancy. The optimum timing of weaning is the best compromise between weaner growth and loss of body condition of cows.

There are minimal differences between the growth rates of weaned versus unweaned progeny if they're appropriately supplemented following weaning; particularly during dry season conditions as growth of unweaned progeny is restricted from diminished milk yield and quality during periods of diminished pasture quality. Furthermore, weaning results in a net reduction in maintenance requirements as the additional expenditure of energy and protein associated with lactation is less than that required to maintain a weaned calf. Additionally, by redirecting nutrients away from lactation to growth allows cows to improve body condition by the time of the next calving, increasing the likelihood of conception whilst lactating. Furthermore, lactation in itself reduces cycling in cattle as, particularly in *Bos indicus* cattle, the stimulation of suckling suppresses the release of hormones involved in ovulation.

First-lactation cows are generally still growing whilst lactating for their first time. The partitioning of nutrients towards growth as well as lactation often results in first-lactation cows being in poor body condition, which is considered responsible for prolonged periods of post-partum anoestrous often reported for first-lactation cows. Under research conditions in central and northern Queensland, Johnston *et al.* (2013) reported average lactation anoestrous intervals for tropical composite and Brahman first-lactation cows as approximately 84 and 134 days, respectively. Thus, progeny of first-lactation cows are generally weaned earlier than those from mature cows to reduce loss of body condition and increase their likelihood of pregnancy.

**MATING MANAGEMENT**

In contrast to much of Indonesia, beef production systems of northern Australia rely on very little use of artificial insemination. Bulls are generally exposed to cows for a minimum of 5-7 months and in many cases continuously. In a recently completed study conducted in Indonesia, Mayberry *et al.* (2015) reported a 22.3% higher pregnancy rate within 100 days of calving for those cows naturally mated, when compared to those mated via artificial insemination. The reduced pregnancy rate in those cows mated by AI was partly explained by problems associated with detection of oestrous, ability to contact AI technician or availability of AI technician. Additionally, the reduced likelihood of pregnancy via AI compared to natural mating is also well established.

The timing of mating is a criterial component of beef production systems with its objective to match the nutritional requirements of the breeding herd to the seasonal pattern of the pasture supply and quality. In monsoonal climates, controlled or seasonal mating aims to prevent cows calving at unfavourable times of the year rather than restrict the calving period. As such, the nutritional demands of breeders are greatest while lactating, peaking shortly after calving. Therefore the time of calving should match or be just before the peak nutritional quality of the pasture. Like northern Australia, Indonesia has extreme variations in rainfall, with the majority of the annual rainfall occurring during November-March suggesting that October to December is likely to be the
optimum period for calving. However, interestingly Mayberry et al. (2015) reported that cows calving during June to September had a greater likelihood of pregnancy within 100 days of calving compared to other times of the year.

Although maximum reproductive performance does not always equate to maximum profitability. If there are market incentives, such as increased valuations of cattle due to festive periods or religious ceremonies, these may dictate preferable times of mating. In such instances appropriate consideration of risk of mortality, loss of body condition and reduced future performance of cows is required as increased profits derived from the sale of the progeny can only be realized if it is not at the cost of future breeder performance or survivability.

In situations where the removal of bulls is not practical, herds are often continually mated all year round. Under such situations, conceptions are generally related to the rainfall in the preceding two months (Holroyd et al. 1979). Therefore, in monsoonal environments approximately 2/3 of conceptions naturally occur within the optimum period. Under such mating systems two annual musters are required to reduce body condition loss, mortality and increase the likelihood of cows becoming pregnant during the wet season (Sullivan and O’Rourke 1997).

**MANAGEMENT OF HEIFERS**

It is well established that the age of puberty and hence, age at which cattle contribute their first calf influences the profitability of a beef herd. However, a number of research studies conducted in northern Australia demonstrate that most heifers do not attain sufficient weight to be fertile until approximately two years of age. Therefore, the majority of properties within northern Australia calve heifers for the first time at three years of age. Heifers need to have reached their critical mating weight to achieve good pregnancy rates and increased likelihood of conceptions when lactating for the first time. The critical mating weight of Brahman cattle is thought to be approximately 340kg. However, there is large variation within and between breeds.

The fertility of beef cows is generally lowest during their first lactation due to the large nutritional requirements of lactation and maternal growth at the same time (Entwistle 1983). It is for this reason that the initial timing of mating of heifers is critical, with peak lactation planned to coincide with the best nutritional conditions. Segregation of heifers to provide preferential nutritional management is also a cost-effective way of improving fertility and increasing the likelihood of conceptions while lactating. Early weaning of their calves will also help to reduce loss of condition. Mating heifers one month earlier than cows provides increased opportunity to conceive during lactation, while timing of mating should also aim to avoid heifers calving in the mid-late wet season to reduce the risk of dystocia.

Heifers that achieve pregnancy early after being mated for the first time and first-lactation cows that achieve pregnancy are valuable breeding females as these traits are linked to increased lifetime reproductive performance. Male calves should be preferentially kept as potential sires from cows that demonstrate these traits.

**NUTRITIONAL MANAGEMENT**

Feeding supplementary feeds to breeding cattle to achieve target body conditions or mating weights is an additional cost. In free-range management systems, feeding costs can be reduced by appropriately stocking the pasture resource, segregating cattle into management groups on the basis of their nutritional requirements and matching lactation to the peak nutritional value of the pasture by managing the timing of mating and weaning.

These management factors are the most important things to get right in nutritional management. However, if mineral imbalances exist they also need to be addressed to ensure sound reproductive performance. Cattle grazing native pastures throughout much of northern Australia are generally limited by protein during the dry season and phosphorus during the wet season. Data from
Bali collected during the dry season suggests that the dietary crude protein content of pastures within low lying areas (eg. 5-6%) (Nitis 2006) is probably unable to meet the nitrogen requirements of breeding cattle. However, when cattle have diets that incorporate tree and shrub legumes or have access to grazing areas that are still actively growing during the dry season (eg. hilled areas), these diets will potentially satisfy a breeding cow's nitrogen requirement.

Cattle grazing P deficient situations can develop signs of aphosphorosis such as reduced appetite, growth rate, reproductive performance, milk yield, bone abnormalities, and stiffened gait (also known as 'peg leg') (Winks 1990). Calcium (Ca) and P are closely linked in animal metabolism with similar symptoms for both Ca and P deficiency. Pregnancy and lactation produce high demands for calcium and phosphorus which can lead to deficiency if the diet is inadequate in these nutrients. Calcium deficiency during lactation causes milk fever. Breeding cattle continuously grazing P deficient pastures have generally shown poorer than expected reproductive performance although, responses in reproductive performance from the supplementation of P have been inconsistent (Underwood and Suttle 1999) which has mostly arisen due to the animal’s ability to mobilize skeletal reserves when dietary P is inadequate. An indicator of wet season phosphorus availability was recently identified as an important factor affecting both pregnancy while lactating within 4months from calving and foetal/calf loss (McGowan et al. 2014); having both a direct effect as well as moderating the effects of other risk factors, such as body condition, on reproductive performance. The provision of supplemental P to aged cows has also been associated with reducing breeder mortality (Henderson et al. 2013).

During the wet season, the protein and energy content of the pasture increases promoting animal production and growth, which in some situations can lead to phosphorus (P) being the nutrient limiting production. Prabowo (2012) identified P as a limiting nutrient with areas of Indonesia and reported a response in wet season body weight of buffaloes supplemented with P. There are many reports of P supplementation increasing growth rates of growing cattle in northern Australia.

**IMPLICATIONS FOR INDONESIA**

Even though a number of dissimilarities exist between Australian to Indonesian beef production systems it is apparent that there are number of over-arching principles applied to beef production systems, in northern Australia that are potentially applicable for free range beef cattle operations in Indonesia. However, one disguising difference when comparing Indonesian free-range production systems to those in Australia is level of intensification. Reasonable levels of reproductive performance are achieved in northern Australia with relatively little inputs due to very low stocking densities allowing cattle to heavily selectively graze their available pasture resources. It is the opinion of the author that it is unrealistic to expect such low stocking densities to be achieved in free-range systems in Indonesia. Therefore, the incorporation of some inputs such as tree legumes and crop residues to provide additional energy and crude protein, particularly during the dry season, will be required to maintain appropriate levels of reproductive performance and potentially reduce the risk of breeder mortality. Under this nutritional plane, a moderate framed tropically adapted cow, in contrast with bigger later maturing genotypes (such as Limousin and Charolais), will have lower maintenance requirements and increased likelihood of reconceiving during lactation and contribute more calves during her lifetime. Deliberately avoiding cows lactating during the most unfavourable times of the year by not exposing cows to bulls during Oct-Dec and weaning progeny between 3-6 months of age, depending on the condition of the cow, will maximize the likelihood of cows being of suitable body condition (≥3.0) at the time of calving and increasing her likelihood of re-conceiving whilst lactating. Managing cows to readily achieve pregnancy whilst lactating will ultimately result in increased productivity of free-range and smallholder operations, increased number of breeding cows and increased domestic supply of beef in Indonesia.
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