final report

**Project code:** DAQ.062/UNQ.009

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# Developing cost effective strategies for improved fertility in *Bos indicus* cross cattle

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# Contents

# Part 1: Abstract

This collaborative project aimed to develop a range of practical, efficient, and profitable management strategies, with particular emphasis on young females, which would enable beef producers to consistently achieve minimum branding rates of 75% from mating of maiden 2-year-old heifers, and to increase lactating cow conception rates by 20% in north Australia. The research utilised 5/8 Brahman cross and high grade Brahman cattle under typical north Australian nutritional conditions. Major outcomes included:

.Puberty in Brahman cross heifers is delayed by poor seasons. Average weight at puberty increases by 4-5 kg for each month delay. Weaning age does not affect age and weight at puberty. Improving post-weaning dry season nutrition decreases both age and weight at puberty, thus increasing reproductive efficiency.

.Controlled yearling mating can economically improve lifetime reproductive performance.

.With appropriate nutrition and mating management, calf output to 4.5 years may be increased by up to 0.5 calves.

.No suitable, currently-available, practical product achieves contraception for controlled periods.

.Spike feeding for 50 days of heifers in their first pregnancy increases subsequent fertility by 15-20%, except in years with climatic extremes.

.Pre-weaning conception rates of lactating cows on tropical pastures may be increased by up to 25% using wet season nitrogen supplements.

.Neither pre-calving melatonin treatment, wet season creep feeding, nor oestradiol treatment increases lactating cow fertility.

.Improving post-weaning nutrition of cows in poor condition, induces ovarian cyclicity within 30 days.

# Part 2: Executive summary

### Background

The average branding rate in north Australian breeding herds is 55%-60%, and ranges from 35% up to 85%. Annual average female mortalities are estimated to be almost 10% and range between 1% and 15%. Fertility and survival rates are both higher in better environments and with better management. However, for most of the region, better heifer and cow management strategies are required to achieve consistently higher branding rates, with conceptions concentrated into the mid-late wet season so that mortalities can be reduced.

### Objective

This project aimed to develop a range of practical, efficient, and profitable management strategies, with particular emphasis on young females, which would enable beef producers to consistently achieve minimum branding rates of 75% from mating of maiden 2-year-old heifers, and to increase lactating cow conception rates by 20%.

### Method

In a five-year, collaborative project involving Queensland DPI, James Cook University, CSIRO, and NSW Agriculture, 17 research tasks were implemented. Thirteen of these tasks were incorporated in DAQ.062 and UNQ.009. These covered improving fertility and management efficiency of maiden heifers, reducing lactation anoestrus with particular emphasis on first-calf cows, and developing management systems to increase young female calf output.

### Research and conclusions

*Heifer fertility*

Heifers as young as 2 months of age weaned each year (1,380 in 8 groups) were supplemented or not in the dry season post-weaning, vaccinated or not against androstenedione, and then mated initially as either yearlings or 2-year-olds. First evidence of cycling was recorded, as were subsequent conceptions and calf output.

This project has provided for the first time, estimates of age and weight at puberty for *Bos indicus* cross heifers in the dry tropics, how this is affected by seasons and supplementation, and the implications in relation to mating management. Though the research used 5/8 Brahman crosses, it is expected that the same principles apply to higher grade Brahman cattle.

The variation in time of puberty was large. Over several year groups within management groups, the standard deviations were about 50 kg for weight and 5 months for age.

The average age at puberty was delayed in poorer seasons, with a range of 1.5 to 2.3 years recorded. A major finding was that average weight at puberty in these 5/8 Brahman cross heifers increased as age at puberty was delayed (+4-5 kg/month). For example, when the average age at puberty was 1.5 years, the average weight was about 270 kg; when the average age was delayed to 2.3 years, the average weight increased to approximately 310 kg.

Dry season supplementation of heifers appeared to simply simulate improved seasonal conditions; ie, advanced age at puberty, and reduced average weight at puberty - a double bonus. There was no long-term effect on fertility as lactating cows.

Another major finding was that heifers weaned at a younger age reached puberty at the same age and weight as their older counterparts. This means that puberty was later in early weaners simply because they were younger at weaning. Again, there were no effects on lactating cow fertility.

Androstenedione vaccination did not consistently affect pre-pubertal development and had no significant influences on conception rates at first mating or on subsequent fertility.

Detailed hormonal studies indicated that there were no specific periods of sensitivity to undernutrition during the pre-pubertal period. Techniques which can reduce the effects of $E_2$-negative feedback on pre-pubertal development have yet to be developed.

Maiden heifers which conceive in the first 3 months of continuous mating have higher long-term fertility (+0.1-0.2 calves under good management and continuous mating) and survival. High conception rates in this period were achieved in supplemented heifers in all years, but were as low as 55% in one unsupplemented year group in which 80% had not reached puberty till 2.6 years of age. Obviously, early weaning further exacerbated this problem, though supplementation advanced puberty sufficiently to achieve high conception rates as maiden 2-year-olds.

Conception rate in yearling-mated heifers was a function of the proportion reaching puberty; it averaged about 30% in the first few months of mating in those which were supplemented as weaners. The conception rate was 15% higher in heifers supplemented in the post-weaning dry season than in those not supplemented. Yearling mating increased long-term calf output on average by about 0.3 calves. It was found that 2-year-old heifers calving in the latter half of the growing season often experienced dystocia.

Intensive studies simulating weight loss and recovery of heifers in their second dry season showed that cyclicity in post-pubertal heifers will cease when 16-17% of weight is lost, with more profound anoestrus when 23% of weight is lost. Cycling does not resume till heifers grow beyond the weight at which loss commenced. This indicates that prevention of weight loss will achieve a rapid return to cyclicity which is necessary following breaks to prolonged dry seasons which occur around the time of mating.

In detailed physiological and endocrinological studies of heifers fed energy-deficient diets, profound anoestrus was achieved. Supplementation to prevent energy deficiency and sustain reproductive activity must include an appropriate protein balance.

A large number of possible strategies for contraception for controlled periods in heifers were reviewed and one tested. None was considered suitable, though implants incorporating trenbolone acetate may be worthy of further developmental research.

*Lactation anoestrus*

Spike feeding, the basics of which were developed in a previous project, was further evaluated in detail and at a practical level. Lifetime calf output was shown to increase by 0.3 calves on average; ie, herd branding rates increased by 5%. The approach necessary to consistently achieve a profitable response to spike feeding was defined and released in a producer-targeted publication.

Neither the use of melatonin implants in late-pregnant cows, nor the use of late-wet season creep feeding in lactating cows were found to produce any significant fertility responses. Despite reports prior to this project of potentially-good responses, these strategies are not recommended for north Australian cattle producers.

Protein levels in tropical pastures deteriorate rapidly in the wet season. Supplementation of lactating cows over the wet season with urea + sulphur was found to increase pre-weaning conception rates by up to 25%, even at very low intakes. Incorporation of N+S into wet season licks (generally based on phosphorus) throughout north Australia is recommended.

Short-term supplementation of lactating cows with 2 kg/day of a protein meal in the late wet season was found to increase pre-weaning conception rates by at least 10%. Astute timing may increase the response to 20%. However, it was clearly shown that this type of supplement in the early-mid wet season when cows are in peak lactation will not enhance fertility, despite having significant effects on both cow and calf growth.

Endocrinological studies confirmed the potency of oestrogen ($E_2$) negative feedback (in addition to the $E_2$-independent suckling effect) on recommencement of cycling in lactating cows. Short-term supraphysiological levels of $E_2$ were not able to counter the negative feedback. Vaccination against androstenedione (an $E_2$ precursor) may achieve this effect and warrants future study.

A profound negative effect of suckling on postpartum cycling was shown. The period to resumption of cycling after weaning was inversely related to body condition at weaning. Cows weaned in medium-good condition resumed ovarian cycles within about 50 days. However, ovarian cyclicity was only achieved about 30 days after an improvement in nutritional conditions in cows in poor condition when their calves were weaned. This indicates appropriate nutritional management to achieve target conception rates in lactating cows.

*Calf output*

A combination of high-level supplementation and yearling mating in the Burnett region was not able to achieve target growth and fertility because of prolonged severe seasonal conditions. The actual increase in calf output achieved of 0.3 calves was not profitable. The data indicated that this strategy would be profitable if calf output could be increased by 0.5 calves or that the supplement costs were reduced by 40% to achieve a 0.3 calf output increment. This is likely to be quite possible in average-good seasons.

*Recommendations for beef producers to increase reproductive efficiency of breeders*

A management system based on this project's findings has been developed for north Australian beef producers. The key features of this system are:

. Segregation of weaner heifers and provision of above-maintenance nutrition in the post-weaning dry season. Early-weaned heifers should be segregated from older heifers to increase efficiency of nutritional management.
. Segregation of heifers from 1.2 to 3.5 years of age in a heifer paddock.
. Mating the three age groups in the heifer paddock for about 3 months each year commencing at a time which ensures calving starts at about the time when first storms are expected in an average year.
. Spike feeding, when seasonal conditions are appropriate, in the heifer paddock.
. Provision of wet season licks which incorporate nitrogen and sulphur to heifers and mature breeders.
. Culling/selection at 1.2 and 1.5 years on physical traits and growth, with further selection on fertility at 2.5 and 3.5 years of age.
. At 3.5 years of age, transfer selected heifers to the mature breeding herd.

The benefits of this system over traditional management are:

. Mortality rate is lower because of supplementation and controlled time of calving.
. Calf output to 3.5 years of age is significantly higher.
. Segregating heifers enables targeted and more efficient husbandry.
. Tight calving patterns allow efficient nutritional and weaning management.
. The highest performing heifers, which are needed as replacement breeders, are efficiently identified.
. Cull animals are efficiently identified, thus enabling targeted management for profitable marketing.

Economic evaluation for a high proportion of north Australian herds shows that incorporation of this management system will increase Gross Margins by at least $5/AE. The overall estimated increase in profitability of the north Australian beef industry, given a 20% adoption, is a minimum of $10M annually.

**Developments from the project**

*Commercial exploitation of results*

No intellectual property which could be directed at patenting arose from this project. As well, there are no significant opportunities for any of the collaborators to commercially exploit the results.

It is recommended that all results and recommendations be freely available to the Australian beef industry and community as a public service.

*Technology transfer*

In recent years, there has been considerable transfer of this information to north Australian beef producers advisory publications, field days, producer visits to research groups, direct advice to producers, newsletter articles, and media releases.

The response by beef producers has been enthusiastic. However, changes in management practices are necessarily not rapid and the benefits of the recommendations from this project are not expected to be seen for several years.

*Recommendations on further R&D*

It is clear that several strategies which we examined in this project have the potential to further increase reproductive efficiency of commercially-managed breeding cattle with additional R&D:

. **N+S supplementation of breeders in the tropics**. The research in this project has only indicated the large responses possible from general adoption of wet season urea and sulphur supplementation. It appears that the economic efficiency of this supplementation could be significantly improved through better understanding of specific requirements and better delivery systems. This also applies to dry season supplementation.

. **$E_2$ feedback controls**. Any strategy which can diminish the potency of $E_2$ negative feedback may significantly reduce lactation anoestrus and advance pre-pubertal development. Though approaches attempted in this project were not successful, effective methods could have major benefit to the beef industry. Developments in this area require further detailed endocrinological and physiological studies.

. **Non-surgical contraception**. Surgical spaying is widely practised. There are large potential benefits from development of acceptable non-surgical methods to permanently achieve infertility, or to achieve contraception for defined periods.

. **Mating management**. The studies on yearling mating in this project have only provided initial indicators that it can significantly improve reproductive efficiency if implemented correctly. Further R&D could define more efficient use of yearling mating combined with strategic nutritional boosts across a range of seasonal conditions.

. **Photoperiod effects on fertility**. Though specific tasks within this project failed to improve reproductive efficiency through manipulation of photoperiod effects, it appeared in several detailed studies and concurrent overseas studies, that opportunities for melatonin treatment to enhance heifer fertility may exist. As well, revealing the level of influence of photoperiod on reproductive activity may improve practical reproductive management procedures.

Other opportunities to increase reproductive efficiency of commercial beef herds became more clear from this project:

. **Stocking rate effects on reproductive efficiency**. The sensitivity of pre-pubertal heifers and post-calving cows to undernutrition that this project has demonstrated suggests that reproductive efficiency may be greatly affected by stocking rates which exceed acceptable levels of pasture utilisation. Diminishing the prevalence of overgrazing relies on accurate relationships between stocking rate and fertility; this information does not currently exist for north Australia.

. **Early prediction of fertility**. Increasing fertility achieved through this project will further increase surplus female numbers from a constant-size breeding herd. Targeting surplus females for marketing generally requires removal from the breeding herd at a young age. It is important that superior breeding stock are retained. Opportunities to develop technology for assessing potential fertility in juvenile heifers have developed in recent years through this project and concurrent research.

The mid-term review of this project highlighted the major impact of this project on:

. **Increased turnoff of surplus females**. Turnoff of females and juveniles will significantly increase and become more consistent. This provides an opportunity to improve marketing and develop better markets for surplus females, thus further increasing the value of this project to the north Australian beef industry. Without this, incentives to diminish the current widespread problems of overgrazing may not emerge.

# Part 3: Detailed report

## Introduction

This is the final report for the QDPI and JCU components of a 5-year, MRC-supported project which was carried out by four collaborating research organisations in Queensland and northern NSW. Separate final reports have been submitted for CS.120 (CSIRO component) and DAN.044 (NSW Agriculture component) which were 3- and 4-year projects, respectively. This project was part of the MRC's North Australian Program (NAP2).

North Australian breeder herds are, and will increasingly be, a major source of cattle for growth and fattening by both northern and southern Australian and overseas operators. The challenge for this project was to develop technologies that will enable north Australian beef producers to sustain profitable and efficient Brahman and Brahman cross breeding herds.

This report outlines the research and presents the resulting practical and economic benefits for the north Australian beef industry.

## Acknowledgments

We wish to acknowledge the cooperation and contributions of the following people to the project:

*Beef producers in the development of the project and experiments

*Swan's Lagoon Beef Cattle Research Station Manager (Keith Jeppesen) and staff and the staff on other research stations where experiments were conducted

*The administration staff of the organisations involved

*Our colleagues for their comments and criticisms of the project and experiments

# Project team

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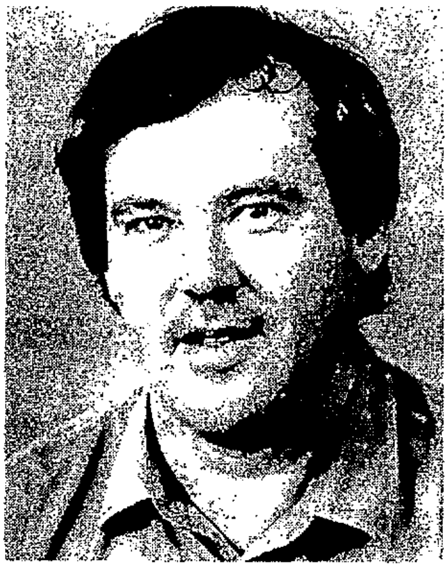

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# Project background

This project followed a previous collaborative project by JCU, QDPI, and CSIRO (NAP.AP1) based in the Townsville region and funded by the AMLRDC. In that project a series of coordinated studies were undertaken to improve production efficiency in *Bos indicus* cattle through nutritional control of postpartum anoestrus (AMLRDC Final Report in December 1989). This project addressed some of the significant issues identified in AP1.

There are significant opportunities to improve breeder herd production efficiency in north Australia. This is particularly so in harsh and intermediate environments, and less so in very good environments. A large proportion of environments in north Australia are either harsh or intermediate - the arid and dry tropics. This project has provided strategies which are applicable in all areas.

Estimates of weaning rates and cow loss rates are very difficult to obtain in the dry tropics. The NAP2 producer survey indicated that weaning rates in the harsh and intermediate `zones' average 38% and 55%, respectively, and that cow loss rates in the harsh `zone' average 7%. This is inconsistent with Australian Bureau of Statistics figures which show that male turnoff from north Queensland is consistently double that of females (the only reliable data we have). Using the method (simulation herd modelling) of Wicksteed (1986), we estimate that this indicates an average branding rate in the vicinity of 60%, and that an average of 10% of all cows die annually.

It is likely that the branding rate over both harsh and intermediate zones averages 55-60%. Some producers within both zones have branding rates as low as 35%, and some as high as 85%.

NAP2 target weaning rates for the harsh and intermediate zones are 58% and 72%. We consider feasible targets for minimum average weaning rates to be 70% and 75% in the harsh and intermediate zones, respectively. These levels must be attained with minimum cost and low associated risk. One key to achieving this is a good understanding of the biology of breeding cattle under a wide range of management and nutritional conditions.

As indicated above, we believe that the NAP2 survey significantly underestimated losses. Our estimate is that losses range from 1% to 15% in both zones. Observations by QDPI extension staff in the region also suggest that weaner loss rates are no lower than that of cows.

Applying available information can overcome many barriers to improving breeder herd production efficiency. However, there remain significant problems in achieving high conception rates with these occurring at the right time in both maiden heifers and lactating cows, especially those rearing their first calf. As well, optimum mating management for cattle in this region has still not been defined. Overcoming these obstacles will not only improve conception rates, and reduce losses, but also increase ease of management.

For stand-alone north Australian properties, the profitability of bullock turnoff remains much higher than for turnoff of cattle for fattening (stores); this is because of a good current market for heavy bullocks, low and inconsistent weaning rates, low store prices, and the higher risks associated with a higher proportion of the herd as breeders (Sullivan *et al*. 1992). Market changes may attract/force some of these producers to store production. The markets have already resulted in increased vertical integration with store production in the dry tropics and transfer of steers to fattening environments. The developing live export trade of feeder cattle to Asia is increasingly a profitable alternative. Store producers will need to achieve consistently high weaning rates to maintain profitability.

Even for bullock producers, the efficiency of breeder herd production must be improved to maintain viability and overcome ever-increasing costs.

In many breeding situations, consistently high branding rates allow significant management and marketing flexibility, thus permitting producers to take greater advantage of the opportunities which increase efficiency.

This project aimed to provide practical cost-effective strategies for improving breeder herd efficiency; strategies developed will enable producers to more consistently achieve high weaning rates and low losses. The estimate made for the potential contribution of this project to the north Australian beef industry was $15M annually.

North Australian Beef producer Survey (1990). Queensland Department of Primary Industries and Meat Research Corporation, Brisbane. March 1992.

Sullivan, M.T., Rudder, T.H., and Holmes, W.E. (1992). Impact of younger turnoff on the profitability and structure of cattle herds. *In*: Sullivan, M.T. `Changing beef markets - Should north Queensland producers change management to meet them?' *Proceedings of the Australian Society of Animal Production* **19**, 53-60.

Wicksteed, L.T. (1986). *In*: Field Day Proceedings, North Queensland Branch of the Australian Society of Animal Production, 'Bryne Valley', Home Hill, December 1986.

# Project objectives

The objectives agreed with the Meat Research Corporation at the commencement of the project were:

(i) By June 1994, to have evaluated a range of cost-effective management, nutritional, and hormonal strategies which will enable north Australian cattle producers to achieve 75% conception rates from matings of maiden heifers and lactating cows.

(ii) Quantify the consequences of early weaning and creep feeding on female fertility in continuously-mated herds in the dry tropics and develop strategies to optimise animal and economic responses to these management practices.

(iii) Develop and evaluate strategic supplementation and hormonal feedback controls which may economically improve conception rates of maiden heifers and lactating cows prior to the end of the wet season in northern Australia by an average of 20% units and reduce out-of-season conceptions.

# Tasks

The overall collaborative project incorporated 17 research tasks which were addressed at 7 sites by 4 organisations as presented in Table 1. The assigned task numbers are specific to each organisation's contract. DAQ.062 and UNQ.009 were the QDPI and JCU components, respectively, of the overall project.

As shown, the tasks were grouped under 3 major themes: heifer fertility, lactation anoestrus, and calf output. These areas and tasks were defined in the development of the project.

In each area of research there are many known and unknown variables. A basic aim of our studies was to provide some of the `missing links' so that practical cost-effective strategies could be developed to improve breeding efficiency of specific classes of cattle.

*Heifer fertility*

The tasks aimed to establish strategies to increase overall maiden heifer conception rates, and to increase the proportion of conceptions which occur during the optimum time of the year (mid wet season), thus improving ease of progeny management, reducing mortalities, and increasing subsequent fertility. The challenge was great due to a major deficiency of basic data.

*Lactation anoestrus*

Tasks under the lactation anoestrus theme had similar aims to those in the heifer fertility research. The target period for increased conceptions was prior to the first weaning round.

*Calf output*

In the area of calf output, the overall impact on production efficiency of strategies which may increase fertility were examined in well-managed seasonally-mated herds.

**Table 1**. Research themes, project tasks, organisation task numbers, and experimental sites for MRC NAP2: DAQ.062/UNQ.009/CS.120/DAN.044

| Themes/Tasks | Organisation | | | | | | |
|---|---|---|---|---|---|---|---|
| | QDPI | | JCU | | CSIRO | | NSWA |
| | Swan's | Gayndah | T'ville F'View | Comm Prop | T'ville | R'ton | Grafton |
| **Heifer fertility** | | | | | | | |
| The influence of dry season growth and supplementation of prepubertal Brahman cross heifers on their subsequent fertility | 1 | | | | | | |
| Long-term effects of early weaning of heifers on growth and fertility | 4 | | | | | | |
| Nutritional interactions on fertility responses to prepubertal steroid immunisation in heifers | (3) | | 4 | | | 4 | |
| The biology and timing of critical prepubertal development of the reproductive system in Brahman cross heifers | 3 | | (4,6) | | | (4) | |
| Define relative importance of different nutrients in influencing ovarian activity, and subsequently fertility, in maiden Brahman cross heifers | | | 6 | | | | |
| Define critical premating growth pathways in Brahman cross heifers in the dry tropics to achieve optimal fertility levels | | | 7 | | | | |
| Suppression of oestrus during the second half of the year in continuously-mated Brahman cross heifers and cows | 8 | | 8 | | | | |
| **Lactation anoestrus** | | | | | | | |
| Appropriate dose levels for melatonin to ensure continued elevation of circulating melatonin levels for a period of at least four months | | | 2 | | | | |
| The use of melatonin to improve wet season conception rates of lactating Brahman cross cows | 5 | | 3 | 3 | | | |
| Creep feeding effects on postpartum anoestrus and cattle behaviour | 7 | | | | | | |
| Strategic supplementation (spike feeding, wet season N) and hormonal feedback controls to reduce the postpartum anoestrus interval in Brahman cross cows | 6 | | 5 | | | | |
| Suckling effects on ovarian/pituitary function in postpartum Brahman cross cows | | | 9 | | (1) | | |
| To evaluate the efficacy of pre- and post-weaning nutrition on the fertility of early weaned Brahman cross cows | | | (9) | | 1 | | |
| **Calf output** | | | | | | | |
| Increasing productivity through strategic production supplementary feeding of heifers and young cows | | 2 | | | | | |
| The influence of breed and postpartum nutrition on weaner output of cows calving early in the sub-tropics dry season | | | | | | | 1 |
| The life-time effect of early weaning on cow productivity in a Brahman-cross herd | | | | | 3 | | |
| Supplementary feeding strategies for early weaned calves at pasture | | | | | 2 | | |

# Experimental sites

### Queensland Department of Primary Industries

*Swan's Lagoon Beef Cattle Research Station, Millaroo*

Swan's Lagoon is 36,000 ha in area and is located approximately 120 km SSW of Townsville in the northern spear grass area. The climate is dry tropical; 75% of the 882 mm average rainfall occurs on average between December and March. The soils are generally of low fertility; P levels in unfertilised areas are generally not above 5 ppm. Native pastures predominate in this open eucalypt forest country, with only a small area developed with stylo legumes.

The cattle used were from a stabilised 5/8 Brahman x 3/8 Shorthorn cross in two herds: one with 450 breeders mated for 3 months annually; the other with approximately 900 breeders and mated continuously.

*Brian Pastures Research Station, Gayndah*

Brian Pastures (owned by the MRC) is located in the southern spear grass zone of Queensland.

The cattle used in this project were 5/8 *Bos indicus* and were located on a satellite block called `The Ridges'. It is predominately native pasture (black spear grass and wire grass) on steep hills with shallow skeletal soils; there are small areas of alluvial clay on creek flats.

### James Cook University of North Queensland

*Douglas Campus, Townsville*

Good laboratory facilities for reproductive studies are available, with holding facilities for cattle for both intensive and semi-intensive studies. The laboratory facilities are utilised by several organisations in north Queensland.

*Fletcherview Tropical Veterinary Research Station, Charters Towers*

Fletcherview, an area of 2,000 ha, located 30 km NW of Charters Towers in the `Basalt' region of the upper Burdekin River, is a JCU facility used for teaching in a number of disciplines (Veterinary Science, Zoology, Geology) and for beef cattle research. The rainfall of 625 mm occurs predominately in the period December to March. The mixture of soil types from lateritic earths (basalt-derived soils) to alluvial soils, are characteristic of the region.

Cattle are $\geq$ 7/8 Brahman with approximately 250 breeders in a total herd of 700.

**CSIRO**

*Tropical Beef Centre (formerly Rendel Laboratory), Rockhampton*

This laboratory is well equipped for detailed reproductive and nutritional research.

*Lansdown Research Station, Woodstock*

Lansdown is a 4300 ha property 45 km south of Townsville. The soils and climate are similar to Swan's Lagoon, though pasture development is much greater. The property carries approximately 450 Droughtmaster breeders (about 5/8 Brahman x 3/8 Shorthorn) which are seasonally mated.

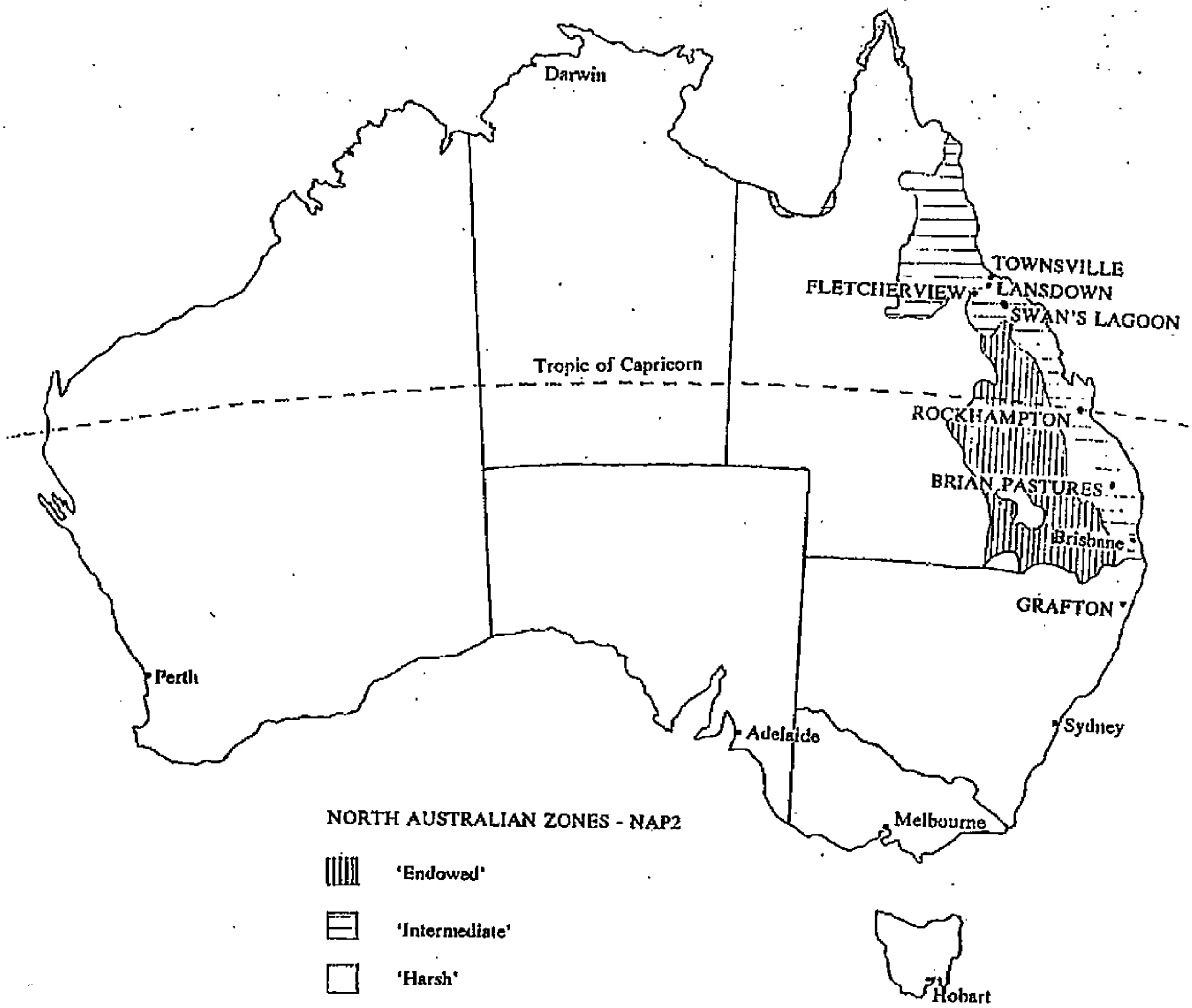
**Commercial properties**

*"Blue Range"*

"Blue Range" is a large, family-owned and managed commercial property located on the Burdekin River south of Greenvale with approximately 6000 Santa Gertrudis/Brahman cattle. Year-round mating is practised with principal turnoff being heavy bullocks. "Blue Range" is one of the better managed properties in the district.

# NORTH AUSTRALIA PROGRAM

Sites: UNQ.009 DAQ.062 CS.120 DAN.044



# Achievement of objectives

The objectives, as previously outlined, were met by this project. The strategies evaluated in DAQ.062 and UNQ.009 to enable beef producers in north Australia to consistently achieve 75% conception rates in maiden heifers and lactating first-calf cows and which could increase wet season conception rates by 20% included:

. Post-weaning dry season supplementation of weaner heifers to advance pre-pubertal development
. Nutritional management of early-weaned heifers to counter delayed pre-pubertal development
. Yearling mating
. Pre-mating management of 2-year-old heifers to ensure cyclicity during mating
. Spike feeding
. Supplementation of lactating cows with urea + sulphur over the wet season
. Short-term supplementation of lactating cows with a protein meal in the late wet season
. Nutritional management to achieve trigger responses to early weaning

Strategies which may increase breeder herd efficiency under less severe conditions than the evaluation was conducted were:

. Yearling mating with high-level dry season supplementation of weaners and pregnant yearlings
. Early mating in maiden 2-year-olds combined with early weaning

Strategies which were evaluated and not considered to be able to either biologically or economically enhance breeding efficiency included:

. Use of an androstenedione vaccine in pre-pubertal heifers
. Non-surgical contraception for controlled periods - no suitable product is available
. Creep feeding
. Melatonin implants
. Early wet season supplementation of peak-lactation cows with a protein meal

Supporting detailed research aided in development of the practical strategies. Further outcomes from these studies included:

. Control of $E_2$-negative feedback on reproductive activity in pre-pubertal heifers and postpartum cows may be possible
. Techniques to investigate specific nutrient effects on ovarian function are available

The outcomes of the research have been developed into practical recommendations for management of heifers and lactating cows with particular emphasis on females up to 3.5 years of age. Transfer of this technology to north Australian beef producers is well advanced and continuing through many avenues.

All milestones (Tables 2 and 3) were achieved to our satisfaction.

**Table 2.** DAQ.062 non-budget milestones

| No. | Milestone | Completion date |
|---|---|---|
| 2 | Creep feeding systems for calves successful under extensive conditions | 30.06.90 |
| 4 | Effects of weaner heifer nutrition on pregnancy rates in their initial lactation established | 30.09.90 |
| 5 | Decision on whether to undertake developmental biology studies on heifer fertility | 31.12.90 |
| 8 | First results of early weaning effects on female progeny growth and fertility | 30.09.91 |
| 10 | The effects on lactating cow conception rates of short-term pre-partum dry season supplementation quantified | 30.06.92 |
| 12 | Effects of weaner heifer nutrition on subsequent fertility quantified | 30.09.92 |
| 13 | The effects of creep feeding quantified | 31.12.92 |
| 14 | Optional independent review on project tasks to date and recommendations for continuance | 31.12.92 |
| 16 | Estimation of calf output from heifers in two nutritional management treatments in the southern spear grass zone | 30.06.93 |
| 17 | Critical period for reproductive system development in prepubertal Brahman cross heifers described | 30.06.93 |
| 19 | Evaluation of hormone feedback controls to boost fertility completed | 30.09.93 |
| 20 | Evaluation of melatonin effects on cow fertility complete | 31.12.93 |
| 21 | Practical product evaluated for controlled temporary anoestrus in cows | 31.12.93 |
| New | The benefit of nitrogen supplements for lactating cows in the growing season assessed | 31.12.93 |
| 23 | Quantification of the long-term effects of early weaning on fertility in biological and economic terms | 30.06.94 |
| 25 | Complete trial on estimation of economic benefit of production feeding to boost cow fertility in the southern spear grass zone | 30.09.94 |

**Table 3.** UNQ.009 non-budget milestones

| No. | Milestone | Completion date |
|---|---|---|
| 1 | Optimal melatonin doses determined | 31.03.90 |
| 3 | Optimal growth patterns consistent with optimal fertility in maiden heifers defined | 30.06.90 |
| 4 | Decision on whether to undertake developmental biology studies on heifer fertility | 31.12.90 |
| 6 | Incorporation of Milestone 3 into Producer Demonstration Site (PDS) | 30.06.91 |
| 7 | Protein/energy effects on maiden heifers ovarian function defined | 30.06.91 |
| 9 | Evaluation of immunisation x nutrition interaction effects on ovarian activity | 31.12.91 |
| 11 | The effects on lactating cow conception rates of short-term pre-partum dry season supplementation quantified | 30.06.92 |
| 13 | Optional independent review on project tasks to date and recommendations for continuance | 31.12.92 |
| 15 | Fertility responses to steroid immunisation described in 2-year-old and 3-year-old heifers | 30.06.93 |
| 16 | Critical period for reproductive system development in prepubertal Brahman cross heifers described | 30.06.93 |
| 17 | Complete studies of unsuccessful early weaning programs in commercial herds | 30.06.93 |
| 19 | Evaluation of hormone feedback controls to boost fertility completed | 30.09.93 |
| 20 | Evaluation of melatonin effects on cow fertility complete | 31.12.93 |
| 21 | Practical product evaluated for controlled temporary anoestrus in cows | 31.12.93 |
| 23 | Series of experiments on suckling/weaning effects on postpartum reproductive function successfully completed | 30.06.94 |
| 24 | Techniques for enhancement of early weaning responses developed and tested | 30.09.94 |
| 25 | Protein/energy effect on maiden Brahman heifers fertility quantified in large scale field trials | 30.09.94 |

## Mid-term review

After the first 3 years of the project, an external review team assessed the project and made recommendations on continuance (DAQ.062 Milestone 14; UNQ.009 Milestone 13). The review team appointed by the MRC was:

. Dr Leo CumminsDepartment of Agriculture, Victoria
. Mr Geoff NeitheUniversity of Queensland
. Dr Grahame CavayeCattlemen's Union

Appendix 3 is the reviewers' report. The key outcomes were:

*General*

**Overview**: The review team was impressed by the nature of the research and the interim results presented. They considered the project ambitious with a good combination of basic and applied research. The program was well resourced. Collaboration and cooperation between organisations was very good. They considered the project well structured with appropriate milestones.

**Successful strategies**: Outcomes considered successful were postpartum supplementation in NE NSW, spike feeding, and early weaning studies to reduce lactation anoestrus.

**Possibly useful strategies**: Wet season nitrogen supplementation of breeders was considered a potentially-useful strategy.

**Failed strategies**: Melatonin therapy and creep feeding were both identified as non-viable strategies for improving fertility.

**Strategies not yet well tested**: Strategies assessed as not having been well tested were anoestrus control and genetic effects on fertility.

**Mechanisms**: The reviewers identified the detailed endocrinology studies which have supported the reproduction x nutrition studies as valuable for both the northern and southern cattle industries.

**Application**: To achieve adoption by cattle producers of outcomes, there was an identified need for sound economic analyses which take account of climatic variability.

**Consequences**: The reviewers agreed that the project would contribute significantly to increased female turnoff from north Australian beef herds. They noted that this will present new marketing challenges, especially in view of potential overstocking and land degradation if turnoff is not increased.

**Report on studies reviewed**: An appendix detailing the reviewers' assessment of specific research they were briefed on is included in their report.

*Response to the terms of reference*

1. **Project structure, conduct, and progress**: The reviewers considered the project satisfactory on all aspects. They highlighted the need for close linkage between basic and applied research with good planning and research methods.

2. **Contribution to NAP2 goals**: It was indicated that the project's outcomes will increase production efficiency, with impact greatest through reduced mortalities.

3. **Economic evaluation and adoption**: Economic evaluation was necessarily incomplete but impressed the reviewers. It was recognised that uptake of the project outcomes would be as parts of systems, and that all strategies required specific levels of management and infrastructure before adoption would be economically successful.

4. **Results presentation to industry**: It was suggested that, for all the consequences of recommendations to become apparent, practical field information from adoption sites is required; spike feeding was cited as a working example where this had been achieved.

5. **New potential opportunities and constraints**: Opportunities for RD&E to increase breeder herd efficiency identified by the review team were:

. Mustering logistics
. Stocking rate effects on breeder efficiency and the environment
. Culling effects on herd dynamics
. Identifying poor performers
. Pastures for early weaners
. Physiology of reproduction
. Breeder mortality
. Efficient utilisation of wet season pasture growth
. Contraception to achieve controlled breeding periods
. Heifer management to advance pre-pubertal development
. Prediction of reproductive potential
. Balancing fertility with other traits in genetic improvement

Major constraints to breeder herd RD&E identified were:

. Climatic variation which increases research costs
. Continual erosion of financial support

6. **Flow-on effects of extra turnoff**: The major benefit seen from increased fertility was greater flexibility in north Australian production systems with the ability to respond more efficiently to markets and seasonal variations. Adoption of the project's outcomes may be limited if heavy bullock production continues as the most profitable option in most areas; this may be countered by increasing competition for stores.

7. **Strengthening potential project outputs**: It was recommended that MRC maintain support for practical research groups and current resources. The reviewers recommended that a balance between basic and applied research be maintained.

Extra funding was recommended for UNQ.009 (for a full-time research position) and NSW.009 (for extra leasing costs and for extension).

8. **Future project management**: Geoff Fordyce was recommended as new project coordinator. Dr Lee Fitzpatrick was recommended to a full-time appointment till 31 July 1994.

# Task reports and conclusions

# Heifer fertility

**THE INFLUENCE OF DRY SEASON GROWTH AND SUPPLEMENTATION OF PREPUBERTAL BRAHMAN CROSS HEIFERS ON THEIR SUBSEQUENT FERTILITY**
**(DAQ.062 Task 1)**

**Task leader**: Geoff Fordyce

**Background**: Previous research suggested that two factors for achieving satisfactory fertility are important in maiden 2-year-old *Bos indicus* cross heifers in the dry tropics: a mating weight of at least 275 kg and gaining weight; a positive growth rate during the post-weaning period (Doogan *et al.* 1991). Heifers weaned into dry seasons with above-average nutrition had higher early conception rates when mated as maiden 2-year-olds than heifers which experienced poor post-weaning seasonal conditions. However, this result was confounded by year and the specific contribution of nutrition to the `year' effect was not established. As well, effects on later fertility were unknown because of confounding due to culling of females which failed to rear calves when non-lactating at mating.

**Hypothesis**:*Enhancing growth during the dry season following weaning will increase conception rates of 2-year-old heifers by up to 20%, and may also enhance inherent fertility. The effect is independent of weight.*

**Task objectives**

To determine the effects on subsequent fertility (maidens and lactating cows) of supplementing weaner heifers over the dry season.

**Research**

Seven experiments were conducted at Swan's Lagoon during the project (Table 2). Each incorporated treatments which addressed the hypothesis. Late-generation 5/8 Brahman x 3/8 Beef Shorthorn cross heifers from two breeding herds (H1 and H2) were used in all experiments; unless otherwise stated, H2 heifers were used. All, except the radical weaners in 1989 (weaned in January/February), were weaned at the end of the growing season (April-July) in each year, which corresponds to the usual first weaning round of the northern beef industry. All except the H1 heifers were mated continuously from first mating (usual northern beef industry practice). The H1 heifers were mated for 3 months each year, commencing in late January; this corresponds to the average peak conception period in continuously-mated cattle in north Australia.

**Table 2**. Treatments and number of heifers allocated at weaning in each year group

| Trmt | Weaning age | | | | Supplementation | | | $A_4$ Vacc | Initial mating | | Year group | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 87 | | 89 | 90 | 90 | 91 | 92 | 93 |
| | RW | EW | AW | BW | NS | WS | DS | A4 | M1 | M2 | H1 | H2 | H2 | H2 | H1 | H2 | H2 | H2 |
| 1 | _ | | | | _ | | | | | _ | | | 14 | | | | | |
| 2 | _ | | | | | _ | | | | _ | | | 33 | | | | | |
| 3 | | _ | | | _ | | | | _ | | | | | | | | | 9 |
| 4 | | _ | | | _ | | | | | _ | 2 | 8 | 33 | 11 | | 21 | 19 | 9 |
| 5 | | _ | | | _ | | | _ | _ | | | | | | | | | 9 |
| 6 | | _ | | | _ | | | _ | | _ | | | | 11 | | | | 8 |
| 7 | | _ | | | | _ | | | _ | | | | | | | 17 | 19 | 8 |
| 8 | | _ | | | | _ | | | | _ | 2 | 9 | 30 | 10 | | 20 | 19 | 9 |
| 9 | | _ | | | | _ | | _ | _ | | | | | | | | | 9 |
| 10 | | _ | | | | _ | | _ | | _ | | | | 12 | | 20 | 19 | 9 |
| 11 | | _ | | | | | _ | | | _ | 9 | 7 | | | | | | |
| 12 | | | _ | | _ | | | | _ | | | | | | 61 | | | 8 |
| 13 | | | _ | | _ | | | | | _ | 38 | 40 | 119 | 40 | | 39 | 36 | 8 |
| 14 | | | _ | | _ | | | _ | _ | | | | | | | | | 8 |
| 15 | | | _ | | _ | | | _ | | _ | | | | 38 | | | | 9 |
| 16 | | | _ | | | _ | | | _ | | | | | | | 33 | 36 | 9 |
| 17 | | | _ | | | _ | | | | _ | 38 | 39 | | 40 | | 40 | 36 | 8 |
| 18 | | | _ | | | _ | | _ | _ | | | | | | | | | 8 |
| 19 | | | _ | | | _ | | _ | | _ | | | | 38 | | 40 | 35 | 8 |
| 20 | | | _ | | | | _ | | | _ | 19 | 27 | | | | | | |
| 21 | | | | _ | _ | | | | _ | | | | | | | | | 17 |
| 22 | | | | _ | _ | | | | | _ | | | | | | | | 17 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | | | | _ | | _ | | | _ | | | | | | | | | 17 |
| 24 | | | | _ | | _ | | | | _ | | | | | | | | 17 |
| Total | | | | | | | | | | | 108 | 130 | 229 | 200 | 60 | 230 | 219 | 204 |

Treatments were:

NS No supplements Supplementation only for survival, with extra supplement for young weaners if required.
WS Weaner supplements Supplemented with ~300 g/day cotton seed meal (CSM) for their first dry season, except for No.90 H1 which received 1 kg CSM daily.
DS Dry season supps As for WS, plus supplementation with CSM and M8U in their subsequent two dry seasons, respectively.

RW Radical weaner Less than 100 kg at weaning and an estimated average of 135 days younger than AW. These were fed pellets (16% CP) for 2 or 3 months and thereafter only until they reached 100 kg when they received the same supplementation as EW heifers.
EW Early weaner 100-149 kg at weaning and an estimated average of 61 days younger than AW. If not receiving CSM as part of their treatment, fed molasses with 10% CSM and 5% urea if required for growth till they reach 150 kg, after which they receive the same nutrition as AW heifers.
AW Average weaner 150-200 kg at weaning
BW Big weaner More than 200 kg at weaning and an estimated average of 61 days older than AW.

A4 $A_4$ vaccination Vaccinated against androstenedione for 6 months following weaning

M1 Mating at 1 year Initial mating to calve as 2-year-olds
M2 Mating at 2 years Initial mating to calve as 3-year-olds

*Growth*

Supplementation with ~0.3 kg CSM daily in the post-weaning dry season (Dry 1) increased heifer growth rates from about maintenance by an average of 0.1 kg/day (Table 3). There was generally some compensation in the subsequent wet season (Wet 1). The weight advantage of 0-30 kg early in Wet 1, was generally halved annually and little difference remained after 3.5 years of age (Table 4).

Seasonal conditions, as reflected in growth rates, varied greatly between year groups. The 1987 and 1991 heifers both experienced severe seasons in Dry 1, but then had good seasons; the 1993 heifers also suffered a poor initial dry season. The 1989 and 1990 heifers had good Dry 1 conditions, but then suffered very poor seasons through to first mating; the 1992 heifers experienced a similar, though less severe, seasonal pattern.

As a result the 1987 and 1991 heifers were very heavy (average: >300 kg) at 2-year-old mating. The 1989 and 1990 heifers were light. The 1992 heifers were intermediate.

**Table 3**.Growth rates (kg/day) of Swan's Lagoon heifers
(Numbers of heifers shown in Table 2)

| Yr Grp | Treatment | | | Period | | | |
|---|---|---|---|---|---|---|---|
| | Mate age | Supp | Wean age | Dry 1 | Wet 1 | Dry 2 | Wean-2yr mating |
| 87 | M2 | NS | EW | -0.01 | 0.63 | 0.03 | 0.27 |
| | | | AW | -0.05 | 0.68 | -0.01 | 0.26 |
| | | WS | EW | 0.12 | 0.62 | -0.04 | 0.30 |
| | | | AW | 0.08 | 0.63 | -0.03 | 0.28 |
| 89 | M2 | | RW | 0.24 | 0.48 | -0.15 | 0.23 |
| | | | EW | 0.12 | 0.46 | -0.14 | 0.20 |
| | | | AW | 0.01 | 0.47 | -0.17 | 0.17 |
| 90 H1 | M2 | WS | AW | 0.39 | 0.22 | -0.17 | 0.20 |
| 90 | M2 | NS | EW | 0.06 | 0.28 | -0.06 | 0.17 |
| | | | AW | 0.04 | 0.25 | -0.11 | 0.15 |
| | | WS | EW | 0.18 | 0.25 | -0.09 | 0.20 |
| | | | AW | 0.16 | 0.23 | -0.12 | 0.18 |
| 91 | M2 | NS | EW | 0.07 | 0.64 | 0.05 | 0.26 |
| | | | AW | -0.05 | 0.68 | 0.04 | 0.26 |
| | | WS | EW | 0.08 | 0.66 | 0.05 | 0.26 |
| | | | AW | 0.02 | 0.68 | 0.02 | 0.26 |
| | M1 | WS | EW | 0.09 | 0.68 | 0.05 | 0.25 |
| | | | AW | 0.01 | 0.71 | 0.03 | 0.24 |
| 92 | M2 | NS | EW | 0.11 | 0.47 | 0.09 | 0.25 |
| | | | AW | 0.02 | 0.50 | 0.07 | 0.22 |
| | | WS | EW | 0.18 | 0.49 | 0.04 | 0.26 |
| | | | AW | 0.13 | 0.55 | -0.02 | 0.25 |
| | M1 | WS | EW | 0.17 | 0.45 | -0.09 | 0.23 |
| | | | AW | 0.12 | 0.48 | -0.14 | 0.21 |
| 93 | M1+M2 | NS | EW | 0.05 | | | |
| | | | AW | -0.01 | | | |
| | | | BW | -0.09 | | | |
| | | WS | EW | 0.16 | | | |
| | | | AW | 0.07 | | | |
| | | | BW | 0.00 | | | |

Yearling mating had only a small long-term effect on growth. In the No.91 heifers at 3.5 years of age, yearling-mated WS heifers were only 11 kg lighter than WS heifers which had been mated initially at 2 years of age. In the No.90 H1 group, those which conceived as yearlings were 3% smaller and 15 kg lighter at 4.5 years of age than those which conceived initially at 2 years of age.

**Table 4**.Weights (kg) - corrected for the products of conception
(Numbers of heifers shown in Table 2)

| Year Group | Treatment | | | Average age (years) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mate age | Supp | Wean age | Wean | 1.2 | 2.2 | 3.5 | 4.5 | 5.5 | 6.5 | 7.5 |
| 87 | M2 | NS | EW | 142 | 249 | 336 | 403 | 433 | 465 | 456 | 494 |
| | | | AW | 176 | 259 | 343 | 396 | 421 | 433 | 460 | 484 |
| | | WS | EW | 146 | 252 | 336 | 437 | 447 | 453 | 440 | 479 |
| | | | AW | 172 | 261 | 350 | 425 | 405 | 452 | 482 | 499 |
| 89 | M2 | | RW | 85 | 203 | 249 | 365 | 411 | 452 | | |
| | | | EW | 133 | 204 | 248 | 375 | 404 | 452 | | |
| | | | AW | 176 | 236 | 270 | 383 | 428 | 463 | | |
| 90 H1 | M2 | WS | AW | 193 | 239 | 288 | 379 | 451 | | | |
| 90 | M2 | NS | EW | 130 | 160 | 236 | 386 | 429 | | | |
| | | | AW | 176 | 195 | 270 | 381 | 431 | | | |
| | | WS | EW | 129 | 177 | 252 | 360 | 407 | | | |
| | | | AW | 176 | 217 | 287 | 375 | 430 | | | |
| 91 | M2 | NS | EW | 134 | 194 | 314 | 392 | | | | |
| | | | AW | 173 | 210 | 332 | 403 | | | | |
| | | WS | EW | 133 | 203 | 317 | 391 | | | | |
| | | | AW | 172 | 231 | 346 | 413 | | | | |
| | M1 | WS | EW | 134 | 199 | 319 | 399 | | | | |
| | | | AW | 173 | 222 | 328 | 406 | | | | |
| 92 | M2 | NS | EW | 128 | 184 | 284 | | | | | |
| | | | AW | 167 | 206 | 307 | | | | | |
| | | WS | EW | 127 | 200 | 295 | | | | | |
| | | | AW | 167 | 237 | 327 | | | | | |
| | M1 | WS | EW | 128 | 200 | 273 | | | | | |
| | | | AW | 167 | 237 | 298 | | | | | |
| 93 | M1+M2 | NS | EW | 128 | 165 | | | | | | |
| | | | AW | 162 | 190 | | | | | | |
| | | | BW | 217 | 229 | | | | | | |
| | | WS | EW | 127 | 193 | | | | | | |
| | | | AW | 165 | 206 | | | | | | |
| | | | BW | 217 | 240 | | | | | | |

*Puberty*

Achieving puberty early greatly increases heifer management options and increases the ease with which maidens can synchronise breeding with the remainder of the herd. Early puberty increases early calf output, thus lifetime calf output, under good management.

**Table 5.** Post-weaning supplementation effects on puberty
(Numbers of heifers shown in Table 2)

| Yr Grp | Supp | Percentage cycling | | | | | | | | | Time of puberty | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 12m | 14m | 15m | 16m | 18m | 20m | 21m | 22m | 24m | Weight | | Age (m) | |
| | | | | | | | | | | | Av | 80% | Av | 80% |
| 87 H1 | NS | 0 | | 33 | | 49 | | 79 | | 92 | 280 | 316 | 20.3 | 22.0 |
| | WS | 0 | | 33 | | 73 | | 93 | | 95 | 279 | 317 | 18.9 | 22.1 |
| 87 H2 | NS | 16 | | 43 | | 81 | | 89 | | 98 | 256 | 301 | 17.5 | 23.2 |
| | WS | 4 | | 35 | | 79 | | 85 | | 89 | 267 | 305 | 18.1 | 20.4 |
| 90 | NS | 3 | 5 | | 6 | 8 | 14 | | 16 | 11 | 307 | 370 | 27.7 | 31.9 |
| | WS | 9 | 11 | | 13 | 24 | 30 | | 30 | 27 | 287 | 337 | 24.1 | 28.7 |
| 91 | NS | 0 | 25 | | 33 | 47 | 57 | | 67 | 58 | 267 | 342 | 20.1 | 27.0 |
| | WS | 8 | 22 | | 40 | 55 | 58 | | 68 | 68 | 258 | 324 | 18.6 | 23.3 |
| 92 | NS | 4 | 13 | | 11 | 24 | 46 | | 70 | 78 | (250) | | (19.9) | |
| | WS | 2 | 18 | | 33 | 42 | 64 | | 76 | 89 | (264) | | (18.7) | |

Very few heifers were cycling at the end of their initial dry season post-weaning. In the following 12 months, there was a general trend for cumulative percent of WS heifers having reached puberty to be higher than in NS heifers (Table 5). The average advantage was about 8%, and ranged up to 24%; peak differences occurred at about 18 months of age.

The variation in estimated age and weights at puberty was large:

| Year group | sd weight (kg) | sd age (months) |
|---|---|---|
| 87 | 44 | 3.9 |
| 90 | 65 | 6.9 |
| 9165 | 5.6 | |
| 92 | 38 | 4.3 |

Average age at puberty varied across year x supplementation groups from 256 to 307 kg; average age varied between 17 and 28 months (Table 5). Average age and weight at puberty were both lower in year groups which experienced better seasonal conditions. This is an important finding; the level of effect was quite large. Across all year groups, a reduction in growth from weaning to start of mating as a 2-year-old of 100 g/day delayed age of puberty by 7 months. For each month of delay in reaching puberty, the average weight at puberty increased by 4-5 kg. The relationship from preliminary analyses was:

Average weight at puberty (kg) = 184 + 4.4 x Average age at puberty (months)

It appeared that the effect of supplementation in the post-weaning dry season was simply to simulate improved seasonal conditions, thus decreasing age at puberty and reducing the average weight needed to commence cycling. In the No.90 heifers, supplementation reduced age at puberty by 3.5 months and weight at puberty by 20 kg (Table 5).

Post-weaning dry season supplementation of heifers which experience successive good seasons is unable to reduce age and weight at puberty, eg, in No.87's.

*Maiden heifer fertility*

At 2 years of age in the No.87, No.91, and No.92 heifers, weights at the start of mating were above average. Puberty had been reached by 80% of heifers whether supplemented or not (Table 5). In these age groups, post-weaning dry season supplementation had no influence on early conception rates (Table 6).

The No.90 heifers had reached an average of only 270 kg at the start of 2-year-old mating. As a result of delayed puberty and increased weight at puberty, conception rate of previously-unsupplemented heifers within the first 3 months of mating was 55%. Post-weaning dry season supplementation increased this by almost 30% to 83%.

Because supplementation as weaners decreased the weight needed to reach puberty, previously-unsupplemented heifers needed to be heavier at the start of initial mating to achieve the same conception rates within 3 months (Figure 1).

The difference between NS and WS groups was still 10% after 6 months mating. Eighty percent of NS heifers did not conceive till more than 5 months after the same proportion of WS heifers (Table 6).

In all yearling mating, 30-40% of WS heifers conceived within the first 3 months of mating, with few more conceptions in the following 3 months (Table 6). In both the No.91 and No.92 heifers, these conceptions matched the proportion of unmated WS contemporaries that had reached puberty (Table 5).

In the only yearling comparison, conception rate in the first 3 months of mating in WS No.93 heifers was 15% higher than in NS heifers (Table 6). This advantage was not significantly different from the difference in proportion cycling in unmated contemporaries (Table 5), but was higher than the average advantage of WS over NS heifers in proportion cycling over all year groups.

*Lactating cow fertility*

There was no apparent effect of post-weaning dry season supplementation on calving to conception intervals (CTCI), except in the 1987 H1 heifers where the first CTCI was longer in NS treatment (Table 6). The CTCI (excluding the 9% of cows which do not have a CTCI, because they have either died, have not reared a calf, or have not conceived after rearing a calf) following later calvings did not differ between treatments, and the NS heifers compensated for most of the early differences.

In all years in all year groups there was no effect, after correction for time of calving, of and treatment on reconception patterns of lactating cows.

The CTCI in lactating 2-year-old No.91 heifers (conceived as yearlings) was approximately one month longer than in the No.90 (3-year-old) WS heifers which were concurrently in their initial lactation (Table 6).

*Calf output*

The long-term advantage in calf output due to weaner supplementation is 0.1-0.2 calves (Table 6); this equates to an increase in herd branding rates of about 3%. This was achieved in both the No.87 and No.90 heifers which represent heifers which experienced opposite extremes in seasonal conditions.

In the No.87 years group, calf output was reduced by 20% by mating for only 3 months annually (H1 heifers) compared to continuous mating (H2 heifers).

**Figure 1**.Effect of weaner supplementation on weight-fertility relationships of maiden 2-year-old heifers

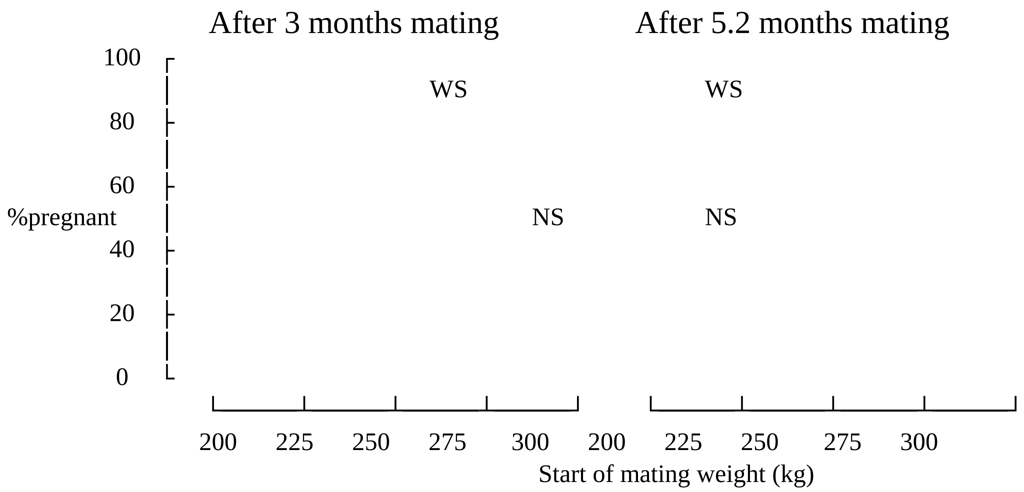



**Table 6.**Post-weaning supplementation effects on subsequent conceptions and calf output
(Numbers of heifers shown in Table 2)

| Year Group | Treatment | | First conception | | | | Calving to conception intervals (m) | | Lifetime calf output (Matings) |
|---|---|---|---|---|---|---|---|---|---|
| | | | % Pregnant | | Month | | | | |
| | Mate age | Supp | 3m | 6m | Av | 80% | First | Av | |
| 87 H1 | M2 | NS | 95 | 95 | 0.7 | 1.1 | 7.8 | 8.3 | 3.1 (5) |
| | | WS | 90 | 90 | 1.9 | 1.5 | 4.5 | 7.0 | 3.3 (5) |
| 87 H2 | M2 | NS | 87 | 96 | 1.7 | 1.6 | 4.4 | 4.9 | 4.0 (5) |
| | | WS | 83 | 90 | 1.7 | 1.3 | 5.3 | 4.9 | 4.1 (5) |
| 90 H1 | M1 | WS | 46 | 54 | 6.8 | 12.5 | 20.1 | | 1.6 (3) |
| 90 | M2 | NS | 55 | 79 | 3.9 | 8.3 | 4.8 | | 1.4 (2) |
| | | WS | 83 | 89 | 2.1 | 2.7 | 4.7 | | 1.6 (2) |
| 91 | M2 | NS | 95 | 98 | 1.2 | 1.3 | 2.6 | | 0.9 (1) |
| | | WS | 85 | 92 | 1.1 | 1.7 | 2.4 | | 0.9 (1) |
| | M1 | WS | 30 | 36 | 8.0 | 12.1 | 5.7 | | 1.1 (2) |
| 92 | M2 | NS | 78 | | | | | | |
| | | WS | 76 | | | | | | |
| | M1 | WS | 40 | 40 | | | | | |
| 93 | M1 | NS | 24 | | | | | | |
| | | WS | 39 | | | | | | |

When compared to contemporary, seasonally-mated, 5/8 Brahman cross heifers which were not supplemented in the post-weaning dry season and were initially mated at 2 years of age, calf output to 4.5 years of the yearling-mated No.90 H1 heifers was about 0.4 calves higher (1.6 v 1.1). Within the No.90 H1 group, calf output to 4.5 years of age was much higher in those conceiving initially as yearlings than in those which conceived initially as 2-year-olds (2.1 v 1.2 calves). From this and the No.91 heifers (Table 6), we estimate that the life-time advantage of yearling mating WS heifers is about 0.2-0.5 calves. This is equivalent to a 5% increase in herd branding rate.

One disadvantage of yearling mating occurs when yearlings conceive late in their initial mating. This leads to calving in the middle of the following wet season when heifers are immature and fat. We have seen several dystocias as a consequence, resulting in death of both cow and calf.

*Conclusions*

The major finding of this research has been that improving nutrition in prepubertal Brahman cross heifers in the dry tropics, not only advances puberty, but also significantly reduces average weight at puberty by 4-5 kg per month that puberty is advanced. Supplementation simply appears to simulate the effect of better seasonal conditions.

The major impact of this is that in average-poor conditions, conception rates early in initial mating as both 1- and 2-year-olds are significantly increased through post-weaning dry season supplementation. In the No.90 heifers, a 30% advantage was established. In the No.93 yearling-mated heifers, conception rate was 15% higher in WS than in NS heifers.

Early conception in initial mating reduces the proportion of out-of-season calves, thus mortalities, and increases the chance of reconceiving as a lactating cow prior to the first weaning round in the following year.

There appear to be no consistent significant effects of post-weaning dry season supplementation on the ability to reconceive during lactation.

Combining post-weaning dry season supplementation with yearling mating under good management is expected to increase lifetime calf output from Brahman cross females by 0.5 calves which is nearly a 10% increase in herd branding rate (assuming females are kept for 7 breeding seasons and base branding rate is 75%).

**Economic evaluation**

From the studies conducted to date, realistic and conservative estimates of the average biological effects of this supplementation in a Brahman cross herd are shown.

| | Estimated changes in herds with management | |
| --- | --- | --- |
| | Below average | Above average |
| Reduced weaner losses | -7% | 0% |
| Increased net value of disposed heifers | $10 | $10 |
| Increased heifer weaning rates | +7% | +5% |
| Reduced weaning rates in first-calf cows | -1% | -1% |
| Reduced death rates in first-calf cows | -5% | -2% |
| Reduced death rates in second-calf cows | -1% | -1% |

The cost of dry season supplementation of weaner heifers to maintain low growth over the dry season averages approximately $15-20/head.  Computer simulation modelling (using BREEDCOW - Bill Holmes, QDPI, Townsville) using the above data shows that in herds with either above- or below-average management, gross margins after interest are increased by approximately 4-5% as a result of improving weaner heifer management and nutrition.

**Practical implications for north Australian beef producers**

This research shows clearly that there are substantial economic benefits from improving nutrition of heifers to sustain growth and body condition in the post-weaning dry season, especially if this is combined with short (~3-month) mating in yearlings.

Dry season nutrition of heifers can be adequately improved using either improved pastures or supplements which incorporate true protein and energy, eg, protein meals or mixtures of energy concentrates (eg, molasses) and true protein.

The increased fertility of heifers, combined with seasonal mating, increases the ease of management of heifers through to 3.5 years of age as a result of reduced out-of-season calving and increased weaning efficiency.

# LONG-TERM EFFECTS OF EARLY WEANING OF HEIFERS ON GROWTH AND FERTILITY
# (DAQ.062 Task 4)

**Task leader**: Geoff Fordyce

## Background

Previous research had suggested two factors are important in maiden 2-year-old *Bos indicus* cross heifers in the dry tropics achieving satisfactory fertility:

. a mating weight of at least 270 kg and gaining weight.

. a positive growth rate during the post-weaning dry season.

Many heifers are now weaned when weighing 100-150 kg, and even lighter in some instances. The effects of under-nutrition on fertility may be exacerbated in these heifers through either failure to reach the target weight or through experiencing more profound slowing of pre-pubertal development.

**Hypothesis**:*Detrimental effects of early weaning on fertility can be countered by improving post-weaning dry season nutrition*.

## Task objectives

To measure the differences in pre-pubertal development, maiden conceptions, reconception following calving, and calf output of heifers weaned when greater than or less than 150 kg.

To assess whether post-weaning dry season supplementation of early weaners effectively eliminated any fertility differences due to weaning age.

## Research

Six of the experiments outlined in Table 2 (excluding H1 No.90 heifers) and DAQ.062 Task 1 contributed to this task; heifers were early weaners (EW) and average-sized weaners (AW) which were unsupplemented (NS) or supplemented (WS) as weaners. Late-generation 5/8 Brahman x 3/8 Beef Shorthorn cross heifers were used in all experiments. Most were weaned at the end of the growing season (April-July) in each year; this corresponds to the usual first weaning round of the northern beef industry. Almost all were mated continuously from first mating (usual northern beef industry practice).

**Table 7.** Weaning age effects on puberty
(Numbers of heifers shown in Table 2)

| Year Group | Wean age | Percentage cycling | | | | | | | | | Time of puberty | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 12m | 14m | 15m | 16m | 18m | 20m | 21m | 22m | 24m | Weight | | Age (m) | |
| | | | | | | | | | | | Av | 80% | Av | 80% |
| 87 H1 | EW | 0 | | 0 | | 38 | | 77 | | 92 | 270 | 295 | 20.3 | 20.6 |
| | AW | 0 | | 30 | | 67 | | 89 | | 96 | 282 | 319 | 19.5 | 22.0 |
| 87 H2 | EW | 0 | | 21 | | 63 | | 75 | | 88 | 272 | 305 | 19.0 | 23.0 |
| | AW | 12 | | 40 | | 76 | | 83 | | 93 | 265 | 312 | 18.2 | 21.7 |
| 90 | EW | 5 | 5 | | 2 | 7 | 18 | | 18 | 14 | 287 | 352 | 26.5 | 29.8 |
| | AW | 6 | 9 | | 12 | 19 | 23 | | 24 | 20 | 299 | 358 | 25.7 | 31.9 |
| 91 | EW | 13 | 20 | | 26 | 39 | 49 | | 61 | 57 | 264 | 347 | 19.8 | 26.3 |
| | AW | 3 | 25 | | 39 | 55 | 62 | | 70 | 66 | 271 | 329 | 19.6 | 26.8 |
| 92 | EW | 4 | 7 | | 11 | 21 | 46 | | 77 | 82 | (248) | | (19.1) | |
| | AW | 6 | 21 | | 33 | 44 | 61 | | 74 | 83 | (264) | | (19.1) | |

*Growth*

Growth rates of early weaners averaged 0.06 kg/day higher than in AW heifers over the post-weaning dry season (Dry 1; Table 3). This reduced the 38 kg average difference at weaning by a third to 24 kg early in the following wet season (Table 4). There was a small interaction with supplementation, with the weight difference being reduced by 5 kg less in WS than NS heifers.

Growth subsequent to Dry 1 was not affected by weaning age, resulting in an overall advantage of only 0.01 kg/day to AW over EW heifers in growth to the start of mating as maiden 2-year-olds; the weight advantage of AW heifers was maintained at 24 kg.

The data available suggested that weight differences between EW and AW heifers were not erased until 5 years of age.

*Puberty*

As discussed under Task 1, few heifers achieved puberty by the end of their first dry season. In the following year, about 12% more AW heifers were cycling at any time than EW heifers (Table 7). This difference peaked at 18 months of age when an average of 19% more AW heifers were cycling.

Average estimated age at puberty was about 2 weeks older in AW heifers than EW heifers (Table 7). However, puberty was reached at an average of 8 kg lighter in EW heifers. These differences did not appear to be related to seasonal conditions with differences consistent between years.

There appeared to be no consistent interaction of post-weaning dry season supplementation with percentage cycling between 12 and 24 months, or with weaning age on age and weight at puberty. Therefore, differences between NS and WS heifers within both EW and AW heifers were as discussed in DAQ.062 Task 1.

*Maiden heifer conceptions*

In the No.89 and No.90 year groups which experienced poor seasonal conditions, conceptions in the first 3 months of mating as maiden 2-year-olds were 18% and 27% higher in average weaners than in early weaners (Table 8). The differences were reduced to 9% and 18%, respectively, after 6 months mating. This appeared simply due to seasonal conditions delaying puberty overall. With EW heifers being an average of 2 months younger than AW heifers, similar rates of conception could not be achieved till later in EW heifers. 80% conception rates were achieved 4 and 7 months later in No.90 and No.89 EW heifers, respectively, than in AW heifers (Table 8).

**Table 8.** Weaning age effects on subsequent conceptions and calf output
(Numbers of heifers shown in Table 2)

| Year Group | Treatment | | First conception | | | | Calving to conception intervals (m) | | Lifetime calf output (Matings) |
|---|---|---|---|---|---|---|---|---|---|
| | | | % Pregnant | | Months | | | | |
| | Mate age | Supp | 3m | 6m | Av | 80% | First | Av | |
| 87 H1 | M2 | EW | 100 | 100 | 0.6 | 0.8 | 5.3 | 6.9 | 3.7 (5) |
| | | AW | 92 | 92 | 1.4 | 1.5 | 5.7 | 7.4 | 3.2 (5) |
| 87 H2 | M2 | EW | 88 | 96 | 1.4 | 1.3 | 5.0 | 4.8 | 4.0 (5) |
| | | AW | 87 | 94 | 1.5 | 2.6 | 4.7 | 4.7 | 4.1 (5) |
| 89 | M2 | RW | 74 | 79 | 3.6 | 8.0 | 5.8 | | 2.4 (3) |
| | | EW | 60 | 67 | 4.5 | 10.5 | 5.7 | | 2.4 (3) |
| | | AW | 78 | 86 | 2.6 | 3.3 | 5.4 | | 2.5 (3) |
| 90 | M2 | EW | 48 | 70 | 4.4 | 8.3 | 5.0 | | 1.4 (2) |
| | | AW | 75 | 88 | 2.6 | 4.2 | 4.7 | | 1.5 (2) |
| 91 | M2 | EW | 87 | 93 | 1.5 | 2.2 | 2.6 | | 0.9 (1) |
| | | AW | 89 | 94 | 1.2 | 1.5 | 2.4 | | 0.9 (1) |
| | M1 | EW | 18 | 18 | 9.8 | 12.3 | 6.2 | | 0.8 (1) |
| | | AW | 36 | 45 | 7.0 | 12.1 | 5.6 | | 1.2 (2) |
| 92 | M2 | EW | 81 | | | | | | |
| | | AW | 67 | | | | | | |
| | M1 | EW | 16 | 16 | | | | | |
| | | AW | 53 | 53 | | | | | |
| 93 | M1 | EW | 12 | | | | | | |
| | | AW | 18 | | | | | | |
| | | BW | 56 | | | | | | |

The No.89 RW heifers achieved similar conception rates to AW heifers, which were higher than in EW heifers, in the first 6 months of mating. This may have been because all RW heifers were supplemented throughout the post-weaning dry season, while EW heifers had supplementation discontinued once they reached 150 kg.

In the No.87, No.91, and No.92 year groups, few heifers were lighter than 280 kg at the start of mating as 2-year-olds. Conception rates were high. With high proportions of both EW and AW heifers having reached puberty prior to initial mating, conception rates were unaffected by weaning age (Table 8).

At yearling mating in No.91, No.92, and No.93 heifers, AW heifers had much higher pregnancy rates than EW heifers, with most conceptions occurring within the first 3 months of mating (Table 8). Differences were directly related to percentage cycling which have been discussed. Pregnancy rates in yearling-mated No.93 BW heifers were substantially higher than in AW heifers.

As for puberty, there was no consistent significant difference between EW and AW heifers in the effects of post-weaning dry season supplementation on maiden conceptions at both 1 and 2 years.

*Lactating cow conceptions*

Age at weaning had no influence on calving to conception intervals (CTCI) later in life (Table 8). This was confirmed by a lack of weaning age effect in all year groups on pregnancy rates of lactating cows within time of calving.

*Calf output*

In continuously-mated cows, calf output of EW cows was consistently about 0.1 calves less than from AW cows (Table 8). As for other fertility traits, there was no interaction with post-weaning dry season supplementation; ie, lifetime calf output is increased in EW and AW cows by 0.1-0.2 calves through post-weaning dry season supplementation.

*Conclusions*

The original hypothesis establishing this research assumed a detrimental effect of early weaning on fertility. Our research clearly showed that there is little practical effect on age and weight at puberty as a result of weaning younger.

This project only compared heifers weaned at the first round. Our supplementation studies (DAQ.062 Task 1) indicate that if weaning of young heifers was delayed to the second round, and if their growth is maintained, it could be expected that they would reach puberty at a younger age than if weaned at the first round.

When juvenile heifers have low growth up to first mating at 2 years, puberty is delayed. The outcome is that at least 20% fewer early-weaned heifers conceive early in the initial mating compared to heifers weaned older. This depresses long-term calf output marginally, particularly as a result of calving late in the wet season with first weaning delayed to the second round.

The most dramatic effect of late conceptions in unsupplemented heifers which were early weaners is the resultant out-of-season calvings. This leads to higher mortalities under low-level management, or to higher management costs under good management where mortalities are generally low.

The problems of early weaning prior to a run of poor seasons appear to be readily countered by post-weaning dry season supplementation which advances puberty sufficiently to enable most heifers to conceive early in their initial mating as 2-year-olds.

A majority of heifers in north Australia have access to bulls as yearlings onwards. We have found that around 30% of Brahman cross heifers, which have been supplemented as weaners, will conceive early when mated as yearlings. As well, early weaners may have between 6% and 37% lower fertility as yearlings when compared to older weaners. Post-weaning supplementation can increase yearling conceptions by 15% in both early and older weaners.

The original working hypothesis could therefore be considered to be substantiated.

## Economic evaluation

Where weaning down to 100 kg at each muster is practised, the proportion of weaners which weigh less than 150 kg at weaning averages around 60% where management level is low and 40% where management level is high (because more conceptions are concentrated into the second half of the growing season in the latter situation).

**Table 9**.Productivity responses to supplementation to maintain growth above maintenance in early-weaned heifers

| Parameters affected by supplementation of early-weaned heifers | Level of herd management | |
|---|---|---|
| | Low | High |
| *Mortalities* | | |
| Weaner | -4% | -1% |
| First-calf cows | -4% | -2% |
| Second-calf cows | -1% | -1% |
| *Branding rates* | | |
| Maiden heifers | +4% | +3% |
| First-calf cows | -1% | -1% |
| *Costs and returns* | | |
| Net value of disposed heifers | +$6 | +$6 |
| Supplementation costs | +$20 | +$20 |
| *Increase in GM for 3,000 AE herd* | | |
| Yearling turnoff | $7,000 | $3,000 |
| Bullock turnoff | $5,000 | $1,000 |

From the studies conducted to date, realistic and conservative estimates of the average biological effects on female productivity of supplementation of early-weaned heifers are as shown in Table 9.

The cost of dry season supplementation of weaner heifers to maintain low positive growth over the dry season averages approximately $20/head. Computer simulation modelling (using

BREEDCOW - Bill Holmes, QDPI, Townsville) shows that in herds with either above- or below-average management, gross margins either before or after interest are increased by approximately $1-2/AE as a result of post-weaning dry season supplementation to maintain at least low positive growth of early-weaned heifers. Only where weaners are already being supplemented (High Management in Table 9) and bullock turnoff is the objective, does extra attention to early weaners return low yields.

## Practical implications for north Australian beef producers

The biological effects and major increases in productivity as a result of adoption of early weaning in north Australian cattle herds are well documented. Many northern beef producers have been concerned that early weaned calves may have sub-optimal performance.

Our research shows that early-weaned heifers reach puberty later, simply because they are born late, as early and older weaners reach puberty at a similar weight and age. This potentially-lower fertility of early weaners is readily rectified by improving their nutrition sufficient to maintain at least low positive growth in the post-weaning dry season, eg, with 0.3-0.5 kg CSM daily. A major response is earlier conceptions as maiden heifers and this increases weaning rates and reduces out-of-season calvings.

Weaning down to 100 kg as a routine practice at musters from the end of the growing season onwards in the dry tropics is highly profitable. Supplementing early-weaned heifers to enhance subsequent productivity through increased calf output and reduced mortalities further improves profitability by an estimated $1-2/AE.

# NUTRITIONAL INTERACTIONS ON FERTILITY RESPONSES TO PREPUBERTAL STEROID IMMUNISATION IN HEIFERS
# (UNQ.009 Task 4)

**Task leader:**Prof Keith Entwistle (To Dec 1992)
Geoff Fordyce (From Jan 1993)

**Background:** Work at Rockhampton by Dr Michael D'Occhio and others had suggested that pre-pubertal steroid immunisation of heifers could advance age at puberty and that this might be related to lifetime reproductive performance. These studies were undertaken in a relatively benign and stable nutritional environment. In contrast, much of north Australia is characterised by extreme nutritional variability, the effect of which could well modulate physiological responses to pre-pubertal steroid immunisation.

**Hypothesis**:*Advances in age at puberty through prepubertal steroid immunisation are influenced by interactive effects of nutrition.*

## Task objectives

Assess both short-term (ovarian activity) and longer-term (pregnancy rates) responses of heifers immunised or not against androstenedione ($A_4$) and on differing nutritional planes.

## Research

Four year groups of heifers (No.90 to No.93) were used as detailed in Table 2. Heifers were either not vaccinated (NV) or vaccinated (A4) against androstenedione at weaning with boosters 1, 3, and 5 months later. In all years, WS heifers (supplemented with 300 g CSM/day in the post-weaning dry season) were used, with NS heifers (unsupplemented) included in the No.90 and No.93 heifers. The No.90 to No.92 heifers were mated initially at 2 years (M2), with the No.93 heifers mated as yearlings (M1). Growth and weights of these heifers are shown in Tables 3 and 4.

Post-weaning dry season plasma progesterone levels were approximately doubled by vaccination (See following task report - DAQ.062 Task 3 - for further explanation). Though this indicated an effect on steroidogenesis, the ovaries were not the source of this progesterone; the effect on ovarian steroidogenesis was not clear. Ultrasound studies of the ovaries of the No.92 WS heifers in the post-weaning dry season showed that, both supplementation and androstenedione vaccination appeared to slightly increase ovarian activity (Table 10).

$A_4$ vaccination did not consistently influence the proportion cycling up to 2 years of age or weight and age at puberty, though a small advantage to A4 heifers did occur in the No.90 year group (Table 12).

**Table 10.** Supplementation and $A_4$ vaccination effects on mean ovarian size and follicle populations in weaner heifers (Average of four 2-monthly examinations)
(Numbers of heifers shown in Table 2)

| Treatment | | Total follicle numbers | | | Ovary length (cm) |
|---|---|---|---|---|---|
| Supplement | Vaccination | Small (2-4 mm) | Medium (5-7 mm) | Large (≥8 mm) | |
| NS | NV | 7.7 | 1.0 | 0.3 | 1.6 |
| WS | NV | 8.1 | 1.0 | 0.4 | 1.7 |
| WS | A4 | 8.5 | 1.2 | 0.4 | 1.7 |

At 2 years of age, the only group in which $A_4$ vaccination increased pregnancy rates in the first 3 months of mating was the NS No.90 heifers (+14%; Table 11). This advantage was lost after 6 months mating. An advantage due to $A_4$ vaccination in percentage pregnant after 3 months mating also occurred in the yearling-mated No.93 heifers. Following initial conception, no subsequent effects on fertility were observed (Table 11).

**Table 11.** The effects of androstenedione vaccination in weaner heifers on subsequent conceptions and calf output (Numbers of heifers shown in Table 2)

| Year Group | Treatment | | | First conception | | | | Calving to conception interval (m) | Lifetime calf output (Matings) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | % Pregnant | | Months | | | |
| | Mate age | Supp | Vacc | 3m | 6m | Av | 80% | First | |
| 90 | M2 | NS | NV | 48 | 78 | 4.2 | 9.3 | 4.6 | 1.4 (2) |
| | | | A4 | 62 | 81 | 3.5 | 7.3 | 4.9 | 1.4 (2) |
| | | WS | NV | 82 | 92 | 2.1 | 2.7 | 4.6 | 1.6 (2) |
| | | | A4 | 83 | 85 | 2.2 | 2.7 | 4.9 | 1.5 (2) |
| 91 | M2 | WS | NV | 85 | 92 | 1.1 | 1.7 | 2.4 | 0.9 (1) |
| | | | A4 | 85 | 92 | 1.6 | 2.2 | 2.4 | 0.8 (1) |
| 92 | M2 | WS | NV | 76 | | | | | |
| | | | A4 | 61 | | | | | |
| 93 | M1 | NS | NV | 6 | | | | | |
| | | | A4 | 12 | | | | | |
| | | WS | NV | 24 | | | | | |
| | | | A4 | 35 | | | | | |

**Table 12.** The effects of androstenedione vaccination of weaner heifers on puberty
(Numbers of heifers shown in Table 2)

| Year Group | Treatment | | Percentage cycling | | | | | | | Time of puberty | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Supp | Vacc | 12m | 14m | 16m | 18m | 20m | 22m | 24m | Weight | | Age (m) | |
| | | | | | | | | | | Av | 80% | Av | 80% |
| 90 | NS | NV | 0 | 2 | 4 | 8 | 16 | 18 | 12 | 310 | 359 | 27.9 | 33.6 |
| | | A4 | 6 | 8 | 8 | 8 | 13 | 15 | 10 | 303 | 370 | 27.5 | 31.3 |
| | WS | NV | 4 | 6 | 10 | 22 | 28 | 30 | 28 | 291 | 337 | 24.6 | 27.7 |
| | | A4 | 14 | 16 | 17 | 27 | 31 | 29 | 25 | 283 | 335 | 23.6 | 29.0 |
| 91 | WS | NV | 8 | 22 | 40 | 55 | 58 | 68 | 68 | 258 | 324 | 18.6 | 23.2 |
| | | A4 | 10 | 23 | 30 | 48 | 58 | 65 | 63 | 280 | 343 | 20.4 | 26.9 |
| 92 | WS | NV | 2 | 18 | 33 | 42 | 64 | 76 | 89 | (264) | | (18.7) | |
| | | A4 | 9 | 17 | 31 | 43 | 57 | 78 | 81 | (260) | | (18.6) | |

## Economic evaluation

Though $A_4$ vaccination of weaner heifers achieved small positive effects on prepubertal development, these were not consistent and were not of sufficient magnitude for the present vaccine to be of economic value in practical fertility management.

## Practical implications for north Australian beef producers

The androstenedione vaccine evaluated in this study could not consistently advance prepubertal development of *Bos indicus* cross heifers under typical north Australian conditions, whether heifers are supplemented or not following weaning.

# THE BIOLOGY AND TIMING OF CRITICAL PREPUBERTAL DEVELOPMENT OF THE REPRODUCTIVE SYSTEM IN BRAHMAN CROSS HEIFERS (DAQ.062 Task 3)

**Task leaders**:Geoff Fordyce
Dr Lee Fitzpatrick

## Background

There had been indications from previous studies that there may be critical physiological phases of prepubertal development which poor nutrition may either alter or delay. This is of great importance in the north Australian beef industry where a majority of calves are weaned at the end of the growing season and then have nutrition which varies from well below to just above maintenance till the start of the next wet season.

**Hypothesis**:*Critical physiological phases of development towards puberty occur in Bos indicus heifers between 3 and 12 months of age which can be affected by management and nutrition.*

Preliminary studies by Dr Michael D'Occhio in Rockhampton showed progesterone levels unexpectedly above 1 ng/ml in pre-pubertal weaner heifers. It was hypothesised that this is a reflection of events in reproductive development.

## Task objectives

To assess the effects of nutrition on post-weaning dry season progesterone profiles and relationships with prepubertal development

To determine whether post-weaning dry season supplementation effects on prepubertal development are influenced by weaning age

To determine whether maiden heifer and lactating cow conception rates are influenced by post-weaning dry season supplementation, independently of effects on puberty

To assess the potential of supraphysiological levels of oestradiol ($E_2$) in advancing pre-pubertal development

## Research

Six experiments were conducted (excluding No.90 H1) as outlined in Table 2 and DAQ.062 Task 1 report. Late-generation 5/8 Brahman cross heifers were used in all experiments. Most were weaned at the end of the growing season (April-July) in each year; this corresponds to the usual first weaning round of the northern beef industry. Almost all were mated continuously from first mating (usual northern beef industry practice). A further study was conducted at Douglas using Brahman heifers.

*Nutrition x post-weaning dry season progesterone and puberty*

Plasma progesterone ($P_4$) was assayed regularly in the No.90, No.92, and No.93 age groups between weaning and the end of the first dry season when heifers averaged 12 months of age.

Significant levels of plasma $P_4$ are not expected in pre-pubertal heifers. However, in the No.90, No.91, and No.92 heifers in the post-weaning dry season, over 20%, 10%, and 30%, respectively, of samples assayed were over 1 ng/ml which is the level usually indicative of cyclicity (Table 13). $P_4$ levels were close to zero at weaning; levels did not return to zero in non-cyclic heifers till the arrival of the wet season. This phenomenon did not recur in the second dry season.

Ovarian production coupled with low liver clearance rate of $P_4$ was excluded as a source of the $P_4$. `Shock' feeding with high quality lucerne hay and CSM failed to influence plasma levels in both weaner and mature heifers; in the mature cyclic heifers, levels remained at 4.1 ng/ml.

$P_4$ levels were just as high in spayed as in entire heifers. The steady reduction of plasma $P_4$ from 2.5 ng/ml to 0.5 ng/ml over 3 hours during the `shock' feeding of the weaner heifers, indicated a stress-related response; this is some evidence that the adrenals may be the source.

There were no effects of either supplementation or weaning age on $P_4$ levels (Table 13). $A_4$ vaccination did elevate plasma $P_4$, though the mechanism remains unclear.

There were consistent, but very low, correlations (~0.1) between progesterone levels and both age and weight at puberty.

We were not able to establish any significant fertility indicator role of post-weaning dry season $P_4$ levels. Analyses to date have not shown variations in $P_4$ levels which might indicate the existence of periods of pre-pubertal development sensitivity.

*Supplementation x weaning age effects on puberty*

In the reports on DAQ.062 Tasks 1 and 4 where weaning age and post-weaning dry season supplementation effects on puberty were examined, we found no evidence for the existence of periods of variable sensitivity to these influences on pre-pubertal development. Rather, the results indicate that at all periods prior to puberty, heifers are sensitive to undernutrition; puberty is delayed and weight at puberty is increased.

**Table 13**.Supplementation, weaning age, and androstenedione vaccine effects on post-weaning dry season plasma progesterone in heifers
(Numbers of heifers shown in Table 2)

| Yr Grp | Treatment | | Average Dry 1 plasma $P_4$ (ng/ml) | Range in plasma progesterone | | | |
|---|---|---|---|---|---|---|---|
| | | | | 0.00-0.49 | 0.50-0.99 | 1.00-1.99 | >1.99 |
| No.90 | Entire | NS | 0.77 | 51% | 24% | 18% | 7% |
| | | WS | 0.70 | 60% | 20% | 13% | 7% |
| | | EW | 0.74 | 55% | 22% | 16% | 7% |
| | | AW | 0.73 | 56% | 22% | 15% | 7% |
| | | NV | 0.53 | 65% | 22% | 11% | 2% |
| | | A4 | 0.93 | 47% | 22% | 20% | 12% |
| | Spayed | NS | 0.75 | 57% | 23% | 16% | 6% |
| | | WS | 0.48 | 72% | 15% | 10% | 3% |
| No.92 | Entire | NS | 0.48 | 74% | 16% | 7% | 3% |
| | | WS | 0.48 | 73% | 16% | 9% | 2% |
| | | EW | 0.42 | 77% | 15% | 6% | 1% |
| | | AW | 0.51 | 71% | 17% | 9% | 3% |
| | | NV | 0.48 | 73% | 16% | 9% | 2% |
| | | A4 | 0.68 | 58% | 23% | 13% | 5% |
| No.93 | Entire | NS | 1.08 | 44% | 25% | 18% | 13% |
| | | WS | 0.97 | 46% | 23% | 18% | 13% |
| | | EW | 1.00 | 48% | 23% | 17% | 12% |
| | | AW | 1.06 | 42% | 25% | 19% | 13% |
| | | NV | 0.81 | 51% | 25% | 16% | 8% |
| | | A4 | 1.25 | 39% | 23% | 20% | 18% |
| | Spayed | NS | 1.32 | 37% | 21% | 21% | 21% |
| | | WS | 1.40 | 43% | 20% | 13% | 24% |
| | | NV | 1.02 | 47% | 21% | 19% | 13% |
| | | A4 | 1.69 | 33% | 20% | 15% | 23% |

A previous study (Doogan *et al*. 1990) showed that start of mating weight x fertility relationships are affected by growth rates between 18 and 24 months of age, as well as in the dry season after weaning, though the latter is more pronounced. Many heifers reach puberty between 12 and 18 months of age; obviously, the overall effects of nutrition on prepubertal development and the consequent effects on weight x fertility relationships is diluted greatly because of this. This highlights the fact that pre-pubertal development is sensitive to nutrition at any age.

*Weaner supplementation and conceptions*

Effects on maiden heifer conceptions appear related closely to puberty which was discussed in the previous section.

In the same studies, there was no influence of either weaning age or post-weaning dry season supplementation on the fertility of lactating cows.

*Diminishing oestradiol negative feedback effects*

Brahman heifers aged 13 months (n=32) were ovariectomised and implanted with 1/4 of a Compudose® implant to simulate ovarian $E_2$ secretion. Half were fed a native pasture hay and gained 0.38 kg/day, while the other half grazed a wet season pasture and gained 0.88 kg/day over a 6-week period. In the latter 3 weeks of this period, half of each nutritional group received a full Compudose® implant to achieve supraphysiological levels of circulating $E_2$. At the end of the 6 weeks, all full implants were removed. The heifers then grazed a common pasture for 15 weeks during which average growth rate was 0.2 kg/day.

LH release in response to exogenous GnRH gradually declined in all heifers over the study period. The response was lower in high-$E_2$ heifers during the short-term exposure period, but only in the high-growth heifers. Lower LH release following exogenous GnRH challenge was considered indicative of higher endogenous release, thus a diminished releasable pool, as a result of reduced potency of $E_2$ negative feedback.

*Conclusions*

The results discussed above indicate that pre-pubertal development is certainly slowed by under-nutrition, as generally occurs in the post-weaning dry season in the dry tropics. However, pre-pubertal heifers appear sensitive to these effects at any age or time and respond to improved nutrition; as well, the slowing of pre-pubertal development has no apparent specific effect on fertility beyond puberty.

$E_2$ negative feedback is a major control mechanism in pre-pubertal development. Our studies indicated that short-term exposure of rapidly-growing, pre-pubertal heifers to supraphysiological levels of $E_2$ may partially inhibit $E_2$-negative feedback effects on LH secretion.

Elevated progesterone levels in weaner heifers may be a reflection of important pre-pubertal processes and possibly related to indicators of subsequent fertility. This phenomenon certainly warrants further investigation.

**Economic evaluation**

Economic evaluations relevant to this task have been presented in reports on DAQ.062 Tasks 1 and 4.

## Practical implications for north Australian beef producers

Pre-pubertal development is probably sensitive to environmental influences (particularly nutrition) at all ages.

The major implication is that heifers in almost all years will have puberty advanced by improved post-weaning dry season nutrition, thus enabling higher conception rates, at least as yearlings, and a higher proportion of conceptions at an optimum time; the latter has a major effect on survival of those heifers in subsequent years, and their ultimate calf output.

Additional techniques that can temporarily desensitise the hypothalamus to $E_2$-negative feedback, thus potentially advancing pre-pubertal development, remain to be developed.

**DEFINE RELATIVE IMPORTANCE OF DIFFERENT NUTRIENTS IN INFLUENCING OVARIAN ACTIVITY AND SUBSEQUENT FERTILITY IN MAIDEN BRAHMAN CROSS HEIFERS**
**(UNQ.009 Task 6)**

**Task leader:**Prof Keith Entwistle (To Dec 1992)
Dr Lee Fitzpatrick (From Jan 1993)

## Background

Growth manipulation of maiden heifers in the pre-mating dry season (19-24 months of age) is a widely -used practice which has not given consistent responses on PDS sites in central Queensland under NAP. Earlier studies in NAP.AP1 suggested that ovarian activity in heifers is more responsive to energy than to protein components of the diet.

**Hypothesis**:*In the field situation, while both protein and energy are limiting, the primary deficiency of energy can be diminished by providing either energy or nitrogen based supplements, thus improving fertility.*

## Task objective

To define the relative importance of energy and protein in nutritional influences on ovarian activity and fertility in maiden Brahman cross heifers.

## Research

Preliminary studies concentrated on a detailed evaluation of energy effects on ovarian function, with emphasis on development of new techniques for investigating relationships between nutrition and ovarian function. Prevailing drought conditions delayed further research which is expected to be recommenced soon with separate funding.

*Experiment 1*

Eight Brahman cross heifers displaying regular cyclic ovarian activity were transferred from a sorghum hay diet fed *ad lib*. (Period I) to the same diet fed at a level calculated to supply half of the maintenance energy requirements of the animals (Period II). The animals were weighed, and bled weekly for hormonal determination to assess ovarian activity.

Heifers lost an average of 17% of their original weight before ovarian cycles ceased (Table 14). Although plasma glucose concentrations are known to be closely controlled by homeostatic mechanisms, the restricted feeding regime significantly reduced glucose concentrations in Period II (-11%; P=0.03). The dramatic fall in urea concentration in Period II (-40%) indicated that significant net mobilisation of protein reserves to meet the energy deficit had not occurred and that there was probably a significant increase in the body protein:fat ratio.

**Table 14.**Effects on cyclic heifers of feeding half maintenance energy requirements

| Parameter | Period I | Period II | Approx se |
|---|---|---|---|
| Weight (kg) | 338 | 282 | 10 |
| Plasma concentrations | | | |
| Progesterone (ng/ml) | 6.4 | <0.5 | 0.7 |
| Glucose (mM) | 3.9 | 3.4 | 0.14 |
| Urea (mM) | 6.4 | 2.6 | 0.4 |

*Experiment 2*

Post-pubertal maiden Brahman heifers (n=17) were used in a long-term linear study to determine the sequential ovarian and endocrine changes which occur in the period preceding the onset of nutritional anoestrus due to dietary restriction and during the period leading to subsequent resumption of oestrous cycles following refeeding. Ovarian follicular growth and turnover, and endocrine patterns during the oestrous cycles of Brahman heifers were also characterised during the course of these studies.

The ovaries of 17 postpubertal were examined daily by ultrasonography (Aloka 210DX ultrasound scanner with a 7.5 MHz linear transducer). The growth and regression of ovarian follicles >5 mm and the diameter of the corpus luteum (CL) were recorded. Twelve heifers were randomly allocated to a restricted diet (TRT) in order to produce a decrease in liveweight until the onset of anoestrus. The other five heifers remained on an unrestricted diet (CTL).

Mean (±sem) liveweight (LW) at the start of the treatment period were 319±4 and 316±4 kg for CTL and TRT heifers, respectively. A mean reduction in LW of 62±6 kg, equivalent to 20% of initial LW, occurred during the treatment period in the TRT heifers; during the same period, LW of the CTL group increased by 67±7 kg (21%)

Onset of nutritional anoestrus was preceded by linear decreases in size of ovarian follicles and corpora lutea, and in persistence of the first dominant follicle in each oestrous cycle, which were proportional to the decrease in liveweight (P<0.001). Unrestricted feeding following anovulation resulted in a linear increase in dominant follicle size which was correlated with liveweight change (P<0.001), ovulation resuming when dominant follicles were 105±4% of pre-restriction ovulatory follicle size.

The duration of the first interovulatory interval following refeeding was 9±1.0 days, these initial short interovulatory intervals being followed by oestrous cycles of normal length. Duration of the refeeding period ranged from 8 to 97 days and the restricted period from 48 to 132 days, with condition score at resumption of ovulation varying from 2.5 to 6.0. There was considerable between-animal variation in time to resumption of ovulation.

There was no relationship between liveweight at the beginning of the restriction period and time to anovulation, but the duration of the interval to resumption of ovulation was inversely related to the period of dietary restriction required to induce anovulation (P=0.04). Changes in day length over the ten month period were related to changes in duration of the interovulatory interval, size and persistence of the CL and size of the ovulatory follicles.

During the course of these studies, a novel technique that allows catheters to be accurately placed in the posterior aorta and(or) vena cava under ultrasonographic guidance (via the lateral saphenous artery/vein) has been developed. When combined with the nutritionally restricted heifer model described above, this technique will allow controlled studies of critical nutrient effects on ovarian function to be undertaken for the first time in a way that should allow effects of energy and(or) protein to be separated.

**Economic evaluation**

This research augments recommendations for nutritional management developed under all tasks in this project. The economic benefit is partially expressed in the evaluation of a management system recommended as a result of this project (See Benefit to north Australian beef producers).

**Practical implications for north Australian beef producers**

Supplementation to prevent energy deficiency and sustain reproductive activity must include an appropriate protein balance.

## DEFINE CRITICAL PREMATING GROWTH PATHWAYS IN BRAHMAN CROSS HEIFERS IN THE DRY TROPICS TO ACHIEVE OPTIMAL FERTILITY LEVELS (UNQ.009 Task 7)

**Task leader:** Prof Keith Entwistle (To Dec 1992)
Dr Lee Fitzpatrick (From Jan 1993)

### Background

Heifer infertility has been identified as an important source of reproductive wastage in north Australian beef herds. Pre-mating dry season growth pathways may have a significant influence on maiden fertility. This research complements studies of post-weaning dry season pathways on fertility (DAQ.062 Task 1).

**Hypothesis**: *Marked annual variations in heifer fertility in tropical herds partially reflect variations in pre-mating growth pathways due to varying nutrition.*

### Task objective

To establish minimal premating nutritional requirements for Brahman cross heifers in north Australia.

### Research

Cycling 2-year-old Brahman heifers were fed either verano hay to maintain weight (n=12), or native pasture hay to lose weight at 0.5 kg/day for 15 weeks (n=11) or 19 weeks (n=11). Half of the weight-loss heifers were ovariectomised after nutritional depletion, while the balance were fed to regain weight and were ovariectomised 26 weeks after the start of the trial. Heifers on verano hay were ovariectomised after either 17 or 26 weeks. Following ovariectomy, 2-3 heifers from each group were implanted with Compudose® to achieve plasma oestradiol ($E_2$) concentrations of 24 pg/ml.

Heifers lost 16% and 23% of initial weight when nutritionally-restricted for 15 and 19 weeks. All heifers approached initial weight by 26 weeks following nutritional repletion.

Steroid-dependent mechanisms, which inhibit hypothalamo-pituitary function, were amplified following 15 weeks of weight loss. This was reflected in depressed ovarian activity with few healthy ovarian follicles and decreased follicular steroidogenesis. Extending weight loss for a further 5 weeks, escalated steroid-independent hypothalamo-pituitary inhibition as reflected in the absence of a post-ovariectomy rise in plasma LH. This indicates profound inhibition of ovarian activity in these post-pubertal heifers. Increased plasma free-fatty-acid concentrations in nutritionally-restricted heifers may have acted as inhibitory signals on the hypothalamus, and at least in part, decreased GnRH secretion. In contrast to other similar studies, no reduction in plasma glucose occurred.

Repletion of heifers to pre-treatment weight did not improve ovarian activity, except to increase ovarian steroidogenesis, nor did it decrease sensitivity of the hypothalamo-pituitary axis to the negative feedback effects of $E^2$. Photoperiod effects may have compounded nutritionally-related, steroid-dependent inhibition of hypothalamo-pituitary activity which resulted in the cessation of ovarian activity in some heifers fed the maintenance diet.

*Conclusions*

If post-pubertal heifers experience significant weight loss in the premating dry season, recovery of cyclicity will not be achieved until weight is much higher than when weight loss commenced. Following an extended dry season, this may delay conception.

An unexpected outcome from these studies was a suspected strong photoperiod effect on ovarian activity.

## Economic evaluation

Improving dry season nutrition of yearling heifers will advance development in pre-pubertal heifers in most years (See DAQ.062 Task 1 report) and will increase the chance of early conceptions in mating in poor seasons. This effect has been included in economic analyses in DAQ.062 Task 1 and of a recommended management system for heifers (See Benefit to north Australian beef producers).

## Practical implications for north Australian beef producers

This research indicates that prevention of weight loss in heifers in the dry season prior to mating as maiden 2-year-olds, will ensure rapid recommencement of cycling following a break in the season. Following a prolonged dry season which extends to close to the normal start of mating, time of conception may be advanced. This will result in heavier weaners and an increased chance of reconceiving as a lactating 3-year-old.

## SUPPRESSION OF OESTRUS DURING THE SECOND HALF OF THE YEAR IN CONTINUOUSLY-MATED BRAHMAN CROSS HEIFERS AND COWS (DAQ.062 Task 8/UNQ.009 Task 8)

**Task leaders**: Geoff Fordyce and Prof Keith Entwistle

### Background

Out-of-season calving is a major contributor to the high losses of breeding cattle in north Australia. Bull control is very difficult and expensive to achieve in many situations. The optimum time for conceptions is the second half of the growing season. Exogenous compounds to prevent conceptions during the second half of the year may efficiently achieve this.

**Hypothesis**:*Exogenous compounds will be able to be administered as an implant to prevent pregnancy in post-pubertal female cattle for accurate pre-determined periods*

It was also hoped, that these same strategies could replace surgical spaying and webbing when administered to achieve long-term effect.

### Task objectives

To evaluate the potential practical value of all available methods of pregnancy prevention for extended periods in cattle using the following criteria:

. Well-defined and controllable duration of effect
. No chemical residues and no withholding periods
. Easily handled and administered
. Effect for at least 4 months
. Relatively inexpensive
. No significant adverse side-effects, including carry-over effects

To evaluate the efficacy of potentially-useful products in extensively-managed breeding cattle.

## Research

*Evaluation of possible strategies*

Many possible strategies for prevention of pregnancy were considered, though none were considered suitable. Those considered were:

| | |
|---|---|
| Low-dose progesterone | Untested |
| High-activity progestagens | Residues, abortions, variable time effect |
| CIDR (progesterone) | Not sufficiently developed for this purpose |
| Antigestagens | Restricted drug |
| LHRH agonists | Not sufficiently developed. Significant time effect variation |
| LHRH antagonists | Not sufficiently developed |
| LHRH immunisation | Variable time control, multiple treatments required |
| Anti-zona antibodies | Untested possibility. Almost certainly high time effect variation with little control over period |
| Trenbolone acetate | Masculinising effect |
| Compudose | Untested possibility for pre-pubertal animals. Probably low effect |
| IUD | Not developed to remain *in situ* in cattle |

Limits to technology development obviously denied many possibilities, especially in the area of LHRH agonists and antagonists.

*Evaluation of low-dose progesterone*

Only one untested possibility appeared that it had some chance of satisfying the stated criteria: low-dose progesterone. The possibility was that, even though cycling was most likely to continue, behavioural oestrus and/or conception and implantation might be affected.

In an experiment at Swan's Lagoon, 2.5-year-old cycling heifers were given either nothing, an implant which released 30 μg/day of progesterone for 6 months, or an implant which released 8 μg/day of hydroxyprogesterone (a progesterone ester) for 12 months.

Neither cyclicity nor oestrus behaviour was affected by either implant. Ovarian function was unaltered. Real-time ultrasound studies revealed that the average number of small (2-4 mm), medium (4-7 mm), and large (8+ mm) follicles per heifer (both ovaries) was constant at about 17, 1.7, and 0.6, respectively. Average estimated follicular fluid volume per heifer remained at about 1 ml.

When subsequently mated for 7 weeks with fertile bulls, all but one of the cycling heifers conceived across all treatments.

Low dose progesterone or hydroxyprogesterone were ineffective as contraceptives.

*Conclusions*

No product has yet been developed for beef producers to enable cost-effective practical contraception without side-effects in cows or heifers.

## Economic evaluation

When products become available, the return on investment by producers is expected to be very high under extensive management where bull control is very difficult. In this situation in north Australia, herd simulation modelling indicates an increase in Gross Margins of about $12,000 for a typical 3,000-AE herd.

## Practical implications for north Australian beef producers

At this time, further basic scientific research is required to develop products and suitable delivery mechanisms for cost-effective contraception in cattle.

# Lactation anoestrus

## APPROPRIATE DOSE LEVELS FOR MELATONIN TO ENSURE CONTINUED ELEVATION OF CIRCULATING MELATONIN LEVELS FOR A PERIOD OF AT LEAST FOUR MONTHS
(UNQ.009 Task 2)

Task leader: Prof Keith Entwistle

### Background

*Bos indicus* cross cattle show evidence of photo-periodic effects on fertility being long-day breeders. In a pilot trial, conception rates of small groups of lactating Brahman cross cows rose from 54% to 74% when mated subsequent to 4 months continuous treatment with melatonin implants.

Hypothesis: *Slow-release implants can elevate circulating day-time melatonin concentrations to normal night-time levels for 4 months.*

### Task objective

To determine appropriate melatonin dose levels to ensure continued elevation of circulating melatonin levels for a period of at least 4 months, thus enabling study of melatonin therapy on fertility.

### Research

One dose-response experiment using 24 lactating Brahman cows was conducted at Fletcherview. Melatonin doses of 0, 36, 54, and 72 mg (0, 2, 3, and 4 Regulin® implants) were administered. Day (10am) and night (10pm) blood samples were taken weekly for 16 weeks and assayed for melatonin. Cows were joined with bulls for the duration of this study.

Circulating day-time melatonin levels were increased from $66 \pm 3$ pmol/l to $770 \pm 88$ pmol/l which was similar to normal night-time levels ($450 \pm 33$ pmol/l) with administration of 54 and 72 mg, but not 36 mg of melatonin. This elevation was maintained for at least 16 weeks after treatment. Both prolactin and LH levels were unaffected by melatonin administration.

During this study, neither weight changes nor pregnancy rates (overall mean: 90%) were affected by melatonin dosage.

## Economic evaluation

This task was required to achieve DAQ.062 Task 5/UNQ.009 Task 3.

## Practical implications for north Australian beef producers

See the following report on DAQ.062 Task 5/UNQ.009 Task 3.

# THE USE OF MELATONIN TO IMPROVE WET SEASON CONCEPTION RATES OF LACTATING BRAHMAN CROSS COWS
(DAQ.062 Task 5/UNQ.009 Task 3)

Task leaders: Prof Keith Entwistle and Geoff Fordyce

## Background

*Bos indicus* cross cattle show evidence of photoperiodic effects on fertility, being long-day breeders. These effects appear mediated by melatonin which is produced in the brain by the pineal gland.

Hypothesis: *Cessation of payout of melatonin implants, which have elevated day-time circulating levels of melatonin for at least 16 weeks, mimics long day-length effects thus enhancing postpartum fertility.*

In a pilot trial, conception rates of small groups of lactating Brahman cross cows rose from 54% to 74% when mated after 4 months continuous treatment with Melatonin implants (SR Sutherland and KW Entwistle, Unpublished).

## Task objectives

To assess the effects on conception patterns of lactating cows in the mid-wet season, following payout of melatonin implants which were administered in the mid-dry season when cows were 5-8 months pregnant.

## Research

In a follow-on from dosage studies conducted at Fletcherview (UNQ.009 MSR 1), 608 pregnant *Bos indicus* cross cows at three sites in subcoastal North Queensland (Swan's Lagoon, Fletcherview, Blue Range) were included in an experiment to examine effects of a single implant (72 mg) of Melatonin on subsequent postpartum fertility.

In August-September 1990, cows were allocated to either treatment or control groups on the basis of age, foetal age (range 4-7 months) and body condition score. At each site between 166 and 206 animals were involved giving appropriate numbers for detection of significant treatment effects.

There were no significant differences in either pregnancy rate (Table 15) or time of conception between groups at any of the three sites, although the unusually prolonged wet season increased postpartum anoestrous intervals so that most conceptions took place well after the implants would have stopped releasing melatonin.

Table 15.Melatonin effects on pregnancy rates of lactating cows

| Site | Treatment | |
|---|---|---|
| | No implant | 4 x Regulin® implants |
| Fletcherview | 58% | 62% |
| Swan's Lagoon | 66% | 68% |
| Blue Range | 52% | 47% |
| **Overall** | 59% | 59% |

*Conclusions*

Despite the adverse seasonal conditions experienced in this trial, there did not appear to be sufficient evidence that this strategy could significantly enhance postpartum fertility. As a result, no further studies were conducted.

## Economic evaluation

No practical response to melatonin treatment was achieved.

## Practical implications for north Australian beef producers

Melatonin, when administered as an implant with a 4-month pay-out period to pregnant *Bos indicus* cross cows in the mid-dry season, does not appear to increase conception rates.

## CREEP FEEDING EFFECTS ON POSTPARTUM ANOESTRUS AND CATTLE BEHAVIOUR
## (DAQ.062 Task 7)

Task leader: Geoff Fordyce

### Background

Lactation in *Bos indicus* cows has a potent suppressant effect on resumption of cycling after calving. Many cows are able to cycle in response to relief from this stimulus and associated energy drain.

Hypothesis: *Creep feeding of calves for a short period in the latter half of the growing season will trigger cycling in up to 20% of cows.*

In a preliminary observation at CSIRO Lansdown, it was suggested that creep feeding calves would achieve substitution for milk (Schlink *et al.* 1988 *Proc. ASAP* 17, 326). The reduced lactation yield (2.7 v 4.7 kg/day) resulted in a 20% increase in conception rates. There are no other previous literature reports of the effects of creep feeding of cow fertility under conditions even remotely similar to this environment or similar base levels of fertility. Some confounding which occurred in the CSIRO study, and the fact that it was done in small paddocks, required that the efficacy of this strategy in improving fertility be evaluated under controlled conditions in larger paddocks.

### Task objectives

To quantify the costs of and biological and economic responses to short-term creep feeding in the wet season.

To compare the efficacy of creep feeding to spike feeding in increasing conception rates in lactating cows.

### Research

Two experiments were conducted in the 1989/90 and 1990/91 growing seasons using 1/2 to 3/4 Brahman cross cows. Calving occurred from late October to late January. Cows were mated from mid-late January to mid-April. Using the cow/calf separator and creep feeding panels adjacent to a trapping enclosure around the water trough, calves were given *ad lib.* access to calf pellets (16% CP) for 40 days from late February to early April, with the objective of achieving pellet intake of almost 2 kg/day.

*Experiment 1*

Three replicates each of unfed (CONTROL) and creep-fed (CREEP) cows (30-34 per replicate) were allocated to 100 ha native pasture paddocks. Cows were 3 to 5 years of age. Seasonal conditions were very good. Pastures and cows were in good condition.

Within a week of commencement of creep feeding, calves actively sought the supplement and readily accessed it via the cow/calf separator. However intakes were low and variable and averaged only 100 g/day.

The pregnancy rate in CONTROL cows increased from 70% to 88% over the period of creep feeding. In CREEP cows it increased from 63% to 90%. Though CREEP cows had a much higher response (27% v 18%), the lower starting point of CREEP cows suggested that this effect was not due to creep feeding. There was no response to creep feeding in either calf growth (1.0 kg/day), cow growth (0.1 kg/day), or cow condition (+0.6 units). Milk yield could not be estimated due to very wet conditions.

*Experiment 2*

Two replicates of each treatment (34-36 cows per replicate) in the same trial area were used. Cows were all 3 years of age (first calf).

Seasonal conditions were poor. Following a very poor dry season with a late seasonal break (late December), there was 2 months of equally stressful extreme wet conditions. This was followed by virtually no significant rain. Cows remained on average in store condition.

Creep feed appeared equally attractive to calves as in the previous experiment. However, average intake of only 400 g/day was achieved.

Conditions were considered excellent for testing the strategy, as CONTROL cows achieved a pregnancy rate of 52% (even increase over the mating period), and their lactation yield was only an estimated 3.6 kg/day. However, again there was no response in either fertility (either pattern of conceptions or total conceptions), cow growth (0.12 kg/day), cow condition (+0.1 units), or calf growth (0.8 kg/day).

*General*

Video taping was used to show that calves actively sought creep feed. As well, in both experiments, cattle were herded when necessary to the creep feeding point in an attempt to increase intakes of creep feed.

The low intakes were considered primarily a function of grazing behaviour. Calves move out with their dams and graze pasture as well as suckle. Before returning to water each morning, calves suckle. They also generally drink water when they first reach the trough. This presumably results in insufficient `gut space' for calves to achieve intakes which might achieve the desired effects on fertility.

*Conclusion*

The failure of the creep feeding strategy to have any effect on calf growth was assumed to have been due to simple substitution of pellets for good quality pasture that these calves would have been grazing.

## Economic evaluation

The cost of creep feeding was estimated to be approximately $25/head. If it was targeted at only cows in their initial lactation and no response is achieved, computer simulation modelling (using BREEDCOW - Bill Holmes, QDPI, Townsville) for a 3,000 AE herd shows that overall losses would be $7,000-$9,000 (higher with younger steer turnoff age).

## Practical implications for north Australian beef producers

Creep feeding during the optimum period of conceptions (latter half of the growing season) had no benefits. Though the preliminary CSIRO trial suggested that this strategy might be worth pursuing, these further studies show that it cannot be recommended in the dry tropics during the growing season as a strategy to improve fertility.

# STRATEGIC SUPPLEMENTATION AND HORMONAL FEEDBACK CONTROLS TO REDUCE THE POSTPARTUM ANOESTRUS INTERVAL IN BRAHMAN CROSS COWS
(DAQ.062 Task 6/UNQ.009 Task 5)

Task leaders:Prof Keith Entwistle (to Dec 1992)
Dr Lee Fitzpatrick (from Jan 93)
and Geoff Fordyce

## Background

Cost-effective pre- and postpartum strategic supplementation or other methods of improving nutrition or manipulating hormonal fertility regulators are key elements in reducing the postpartum anoestrus interval.

> Hypothesis:*Strategically-fed supplements or hormonal feedback controls for breeding cows will increase the probability of cycling before weaning by up to 20%; cow and calf growth may also be enhanced, thus increasing ease of management.*

Collaborative research with JCU (Prof Keith Entwistle's group) which commenced in 1986/87, developed a strategic supplementation system to increase conception rates in lactating *Bos indicus* cross cows. The strategy is feeding an energy-rich supplement for a short period late in the dry season to mid-late pregnant cows and is called spike feeding. However, further studies were required for development of reliable guidelines for its use.

A previous study in the NT where calf output was increased by 50% in response to wet season nitrogen, and observations by NQ graziers of low efficacy of wet season P supplements, indicate that cows may suffer wet season N deficiency which may also limit utilisation of P supplements. Given the potential effect of wet season supplemental N on fertility, cow growth, cow survival, and calf growth, and following requests from graziers, research of this began in 1991.

In a review on postpartum anoestrus in cattle, Fitzpatrick (Proc AVA Conf, 1990 pp.81-99) outlined that resumption of cycling is dependent on increasing LH secretion. Oestrogen ($E_2$) exerts negative feedback on the hypothalamus and pituitary in acyclic lactating cows. Suckling has negative effects on both GnRH secretion and pituitary function and this appears to involve $E_2$ negative feedback. Undernutrition has similar effects, particularly on the pituitary; in this state, sensitivity to $E_2$ negative feedback is heightened. Therefore, the resumption of cycling in lactating cows may be accelerated by overriding $E_2$ negative feedback on gonadotrophin release.

# SPIKE FEEDING

## Task objective

To establish guidelines for a repeatable, useful economic response to spike feeding.

## Research

Table 16 outlines the Swan's Lagoon trials and responses achieved. Table 17 does likewise for the Fletcherview studies. Spike feeding has been demonstrated at Producer Demonstration sites as shown in Table 18. This research has been complemented by parallel JCU studies (by Vivienne Doogan and Prof Keith Entwistle) which have shown that pre-partum access to green feed (related to early storms and to a high SOI) significantly increases herd fertility in the following year in tropical Australia.

### *Conclusions*

The spike feeding research and demonstration experiences are:

. The energy equivalent of 1.5 kg of cotton seed meal or 2.0 kg of M8U is required daily as a supplement.

. Feeding must continue for at least 50 days. Feeding for less may achieve ovarian changes, but which may not be reflected in increased pregnancy rates.

. Spike feeding can increase pregnancy rates in cows of all ages; however, mature cows are more likely to have high pregnancy rates without feeding, and when this occurs, no response can obviously be achieved.

. Responses to spike feeding can be achieved in first-calf heifers in the best seasons.

. If a break in the season is very late, and particularly where this is followed by extremely wet conditions, any potential advantages gained by spike feeding are eroded by the extended nutritional stress. It is clearly evident though, that lack of green feed for a month after the cessation of spike feeding is not sufficient nutritional stress to counter the effects of spike feeding.

. Breeders should be settled into paddocks from before spike feeding till the end of mating. Changing paddocks may create stresses (possibly behavioural and nutritional) which can suppress fertility and responses to strategies which can improve fertility.

. Responses to spike feeding heifers in their first pregnancy can increase lifetime calf output by 0.3 calves, ie, increase overall herd fertility by 5%.

Table 16. Swan's Lagoon spike feeding trials

| Year | Cattle used | Calving period | Supplement | Period of feeding | Seasonal conditions | Response |
|---|---|---|---|---|---|---|
| 86-87 | 3-8 year old, 1/2-3/4 *Bos indicus* cross<br>(n=150) | Nov-Jan | CSM: 1.0 kg/d<br><br>M8U: 1.9 kg/d | Start: Early Sep<br><br>Time: 38 days | Season: Good<br><br>Break: Late Oct | 49% of fed and unfed lactating cows cycled by 80 days postpartum, despite distinct ovarian differences, especially in the M8U-fed group |
| 87-88 | 9-11 year old, 1/2-3/4 Brahman cross<br>(n=50) | Nov-Jan | CSM: 1.0 kg/d | Start: Early Sep<br><br>Time: 42 days | Season: Poor<br><br>Break: Late Nov | 26% more fed cows were cycling between 80 and 180 days postpartum |
| 88-89 | 3-6 years old, 1/2-3/4 Brahman cross<br>(n=452) | Nov-Jan | M8U: 2.0 kg/d | Start: Early Sep<br><br>Time: 26, 39, or 54 days | Season: Good<br><br>Break: Late Nov | Mature cows: No effect - 91% of controls pregnant by late April<br><br>3 year olds: Pregnancy rate by late April from 76% to 91% after 54 days of feed - 14-25% higher between 2 and 9 months after calving; no effect from 39 days of feed |
| 89-90 | 3 year old 1/2-3/4 Brahman cross<br>(Herd 1: n=28)<br>(Herd 2: n=34) | Nov-Jan | M8U: 2.1 kg/d | Start: Early Sep<br><br>Time: 56 days | Season: Good<br><br>Break: Late Nov | Herd 1: Pregnancy rate by late April increased by feeding from 75% to 92%<br><br>Herd 2: Pregnancy rate increased by late April from 59 to 66% - low rate and low response may be due to paddock changes after feeding<br><br>Herds 1+2: Advantage in calf output over 5 years of 0.3 calves (+8%) |
| 90-91 | 3 year old 1/2-3/4 Brahman cross<br>(n=211) | Nov-Jan | CSM: 1.5 kg/d<br><br>M8U: 2.3 kg/d | Start: Early Sep<br><br>Time: 49 days | Season: V. poor<br><br>Break: Late Dec<br><br>Jan-Feb: extreme wet | 44% pregnant; no response to feeding |

Table 17. A summary of spike feeding trials conducted at Fletcherview and Lansdown during 1989-92

| Year | Site | Cattle used | Calving period | Supplement | Period of feeding | Seasonal conditions | Response |
|---|---|---|---|---|---|---|---|
| 88-89 | Fletcherview | 3-11 year old, 3/4-7/8 *Bos indicus* cross | Dec-Feb | M8U: 1.3 kg/d | Start: Early Sep<br>Time: 43 days | Season: Good<br>Break: Oct | 81% pregnant; no response to feeding |
| 88-89 | Lansdown | 3-9 year old, Droughtmaster | Oct-Dec | M8U: 2.3 kg/d | Start: Early Sep<br>Time: 43 days | Season:<br>Break: Oct | 3-fold increase in fed, lactating cows ovulated by 60 days postpartum |
| 89-90 | Fletcherview | 3-11 year old, 3/4-7/8 Brahman cross | Dec-Feb | M8U: 1.9 kg/d | Start: Early Sep<br>Time: 50 days | Season: Good<br>Break: Oct | 88% pregnant; no pregnancy rate response to feeding. Fed cows conceived 10.5 days (se: 3.8) earlier. |
| 91-92 | Fletcherview | 3-10 year old 3/4-7/8 Brahman cross | Dec-Feb | M8U: 2.0 kg/d | Start: Early Sep<br>Time: 47 days | Season: Good<br>Break: Nov | 12% more fed, lactating cows pregnant in the first 6 weeks of mating |

Table 18. Spike feeding at Producer Demonstration Sites

| Site | Year | Cattle used | Calving period | Supplement | Period of feeding | Seasonal conditions | Response |
|---|---|---|---|---|---|---|---|
| `Rowanlea', Calliope | 88-89 | 3-year-old, 1/2 *B. indicus* cross | Sep-Jan | CSM: 0.8 kg/d | Start: Early Aug<br><br>Time: 95 days | Season: Good | Weaning rate increased from 85% to 91% |
| `Rowanlea', Calliope | 89-90 | 3-year-old, 1/2 *B. indicus* cross (n=68) | Sep-Jan | CSM: 1.0-1.5 kg/d | Start: Late July<br><br>Time: 74 days | Season: Average | Pregnancy rate increased from 49% to 67% by the end of May |
| `Wambiana', Charters Towers | 91-92 | 3-year-old, high grade Brahman cross (n=114) | Nov-Feb | M8U: *ad lib.* (~2.0 kg/d) | Start: Early Sep<br><br>Time: 56 days | Season: V. Poor<br><br>Break: April | No response - heifers in very poor condition due to season; 2% of wet cows pregnant by early April |

## Economic evaluation

It is reasonable to expect that spike feeding heifers in their first pregnancy will increase pregnancy rates by an average of approximately 15%, though the response may be nil in very poor seasons (maybe one year in five) and may be up to 25% in average and better seasons. Astute judgement of likely seasonal conditions using such parameters as the SOI may better indicate the few years in which spike feeding is unlikely to have worthwhile effect. An economic evaluation of this response (Table 19) shows that it is certainly worth the investment. Herd simulation modelling shows that the overall return is approximately $1/AE; ie, for a typical 3,000 AE herd, use of spike feeding will increase profitability by $3,000.

## Practical implications for north Australian beef producers

Spike feeding, when implemented as recommended in the Farm Note for northern beef producers, significantly improves production efficiency. It should be targeted at specific groups of cattle to ensure economic return. To achieve this requires a good level of management; therefore, spike feeding is not for all properties in every season. As management levels improve, the use of spike feeding in the north Australia should also increase.

PDS evaluation of spike feeding has been conducted on two properties as shown in Table 18. At one site, spike feeding achieved the expected response when sufficient supplement was provided, but a low response when less than adequate supplementation was carried out. At the other site, spike feeding had no effect due to an extremely poor season. The producers involved at both PDS projects were satisfied that:

. spike feeding works as suggested.
. spike feeding does not have an effect in years with extreme nutritional stress.

Some of these producers use spike feeding. Those who are not spike feeding cite two major reasons:

. difficulty in obtaining finance which is repayable after several years, especially in poor seasons.
. level of management is not sufficient to enable suitable segregation of target cattle for spike feeding.

The concept of spike feeding has been incorporated into a management system in a Producer Demonstration Site in central western Queensland (`Swanlea', Aramac). Cows are transferred from spinifex country onto spelled high quality buffel pastures on pulled gidyea country when the first storms arrive. The management system used has achieved conception rates of 98%, 89% and 84% in 1989, 1990, and 1991, respectively; the specific contribution of spike feeding cannot be estimated though it is recognised by this group that the spike feeding effect of the high-quality pasture is important.

Table 19. Spike feeding 100 pregnant heifers

| | |
|---|---|
| *Responses* | |
| Extra calves | 15 |
| Reduced mortalities of cow-calf units | 2 |
| *Costs* | |
| Feeding: M8U at 2 kg/day x 12.5 c/kg x 50 days | $1,250 |
| Labour : One man week | $400 |
| Therefore, at 8% interest, costs of extra progeny due to feeding: | |
| . females when marketed at 2.5 years | $150 |
| . males when marketed at 4.5 years | $175 |
| Variable costs of rearing progeny | |
| . females | $40 |
| . males | $50 |
| Losses of progeny | |
| . females (3%) | $61 |
| . males (6%) | $279 |
| Total cost | $3449 |
| *Returns* | |
| Net return on female progeny | $270 |
| Net return on male progeny | $620 |
| Reduced losses in breeders and progeny | $600 |
| Total return | $6935 |
| Return on investment | 201% |

It is likely that the adoption of spike feeding will gather momentum as:

. more producers understand the concept and the levels of management improve; this is all dependent on a economically-healthy beef industry.

. production from northern properties shifts towards young store turnoff and away than bullock turnoff. Strategies such as spike feeding then become critical in maintaining high branding rates.

## WET SEASON NITROGEN

### Task objectives

To determine the effects on the fertility, and growth of lactating cows and their progeny of:

. up to 20 g/day of urea with balanced sulphur over the wet season.

. short-term, high-level supplementation with a true-protein in the mid-late wet season.

### Research

*Experiments*

In 91/92 3-year-old lactating Brahman cross breeders (n=113) were fed dry licks based on DCP, molasses, and salt from the break in the season to weaning in early June. Half received an additional 5 g/day of urea nitrogen from March to May.

Pasture protein levels dropped off very rapidly after growth spurts following rain.

Plasma urea nitrogen (PUN) and rumen fluid ammonia nitrogen (RFAN) levels were low throughout the study. PUN was elevated slightly by N feeding. RFAN followed the same pattern, though the treatment differences were not significant. Estimated feed intakes were unaffected by treatment.

No effects on fertility, growth, and milk yields of cows and on growth of their progeny were achieved as a result of feeding 5/day of urea nitrogen to lactating cows from March to May.

In 1992/93, 162 5/8 Brahman cross cows (51 No.89, 111 No.90) were allocated to be either unsupplemented or supplemented with nitrogen over the wet season. The No.89 cows (3.5 years) were in their second pregnancy and had been in the 1991/92 experiment. Supplemented cows consumed about 1 g of N/day from a dry lick in the first 3 months (Dec-Feb), and then were fed 2 kg cotton seed meal (CSM) per day for 35 days (March).

Cows were losing weight when nitrogen levels (plucked pasture samples) fell below 1.0% and faecal nitrogen fell below 1.5%. Nitrogen supplementation increased faecal nitrogen levels when both pasture and faecal nitrogen levels fell below 1.6% and plasma urea nitrogen fell below 4 mM.

Dry lick supplementation did not affect growth. CSM increased cow growth by 0.65 kg/day. It increased calf growth by 0.08 kg/day in the No.90's and had no effect on the No.89's calves.

Plasma urea nitrogen (PUN) and rumen fluid ammonia nitrogen (RFAN) levels were moderate in December-January, and low at all other times. RFAN and PUN were highly correlated across the experiment. Both were elevated slightly by nitrogen in the dry lick in the No.89's, but not in the No.90's. Both were elevated significantly by CSM feeding.

Pregnancy rates increased from 23% to 54% in lactating No.89's from inclusion of nitrogen into the wet season dry lick. The response appeared to occur with less than 5 g urea per day. There was no similar response in No.90's, though their dry lick intake was probably very low.

The fertility response to CSM was immediate in all non-pregnant cows. CSM increased pregnancy rates in No.89's and No.90's by 10% and 18%, respectively, after 35 days of supplementation.

In 1993/94 we examined the effect of a short-term postpartum increase in nutrient supply provided as a supplement high in undegraded dietary protein and rumen-inert fat for the first-calf cow. For 7 weeks during January-March, half of 159 first-calf 5/8 Brahman cross cows in 3 replicates on native pasture were fed 3 kg/head/day of a supplement based on CSM, grain sorghum and rumen inert fat (Megalac®) (66:27:7). The cows calved in November-December.

The cows were in prime condition early in the dry season, but lost approximately 50 kg and had declined to backward store by mid-December when most were in early lactation. The seasonal break was later than normal in January and coincided with the start of the supplementation period. All cows gained weight from January to May, but cows fed supplements gained an additional 25 kg. Feeding supplements also increased calf weights by 9 kg at the end of the supplement phase, and this advantage persisted until weaning.

In mid-January when mating commenced, only 6% of the cows were cycling. After 7 weeks of supplementation, 36% of the cows were pregnant, and an additional 37% were cycling. By mid-May, 70% of the cows were pregnant. There was no effect of supplementation on the postpartum anoestrus interval.

*Overall responses*

In cattle which have been trained to eat dry licks, urea + sulphur over the wet season may significantly increase pregnancy rates during lactation.

In the 1992/93 experiment, it is likely that the No.89's were responding to about 5 g of urea daily. We may have achieved a response this year because the cows were eating some urea right through the wet season, whereas in 1991/92, cows only consumed urea from March onwards. McCosker and his co-workers also found that the cows need access to urea right through the wet season to get a response. Recent South African research also failed to achieve a response when feeding only in the latter half of the wet season.

Wet season urea did not affect growth of either cows or calves, though it slightly increased nitrogen status of the cows. This contrasts with the Mt Bundey research (tropical tallgrass area v spear grass area for our study) which showed large increases in calf growth. However, intakes at Mt Bundey were near 20 g urea daily, which is much higher than in our cows.

This research shows that responses of at least 10% in pregnancy rate may be achieved with feeding CSM at 2 kg/day for about a month in mid-lactation. Perhaps, if feeding had started earlier (eg, mid-March) or if mating had been extended (eg, to mid-May), the responses would have been much greater; a reasonable guesstimate based on the trends in cumulative pregnancy rates is about 20% more pregnant by the end of mating.

Starting supplementation much earlier in the wet season (mid-January), during the vegetative stage of pasture growth and the peak lactation period of cows, increased milk output and weight gain, but fertility was not affected. This agrees with previous studies on immediate postpartum supplementation of cows with a protein meal.

### *Conclusions*

In this dry tropical spear grass area, there are low intakes of nitrogen in lactating cows during the growing season, as evidenced by low PUN and RFAN. Inclusion of urea and sulphur into dry licks to achieve intakes of up to 5 g/day does not appear to significantly affect growth, but can increase conception rates in lactating cows by up to 25% through elevation of nitrogen status. This area of research should be continued to better define recommendations, and particularly to develop efficient methods of presenting nitrogen over the wet season, eg, urea with low levels of CSM.

Lactating cows will respond rapidly to supplementation with cotton seed meal at 2 kg/day, with advantages of 0.5 kg/day in growth, and through increased conceptions. Feeding should not be delayed to late in the mating season if maximum responses are to be achieved; equally, feeding should not commence early in the wet season during the maximum vegetative stages of pasture growth.

## Economic modelling

Herd modelling, based on best guesstimates and some data from the NT, indicate that wet season supplementation of lactating breeders with N-based dry licks may increase Gross Margins for a typical 3,000-AE north Australian herd by about $9,000. This is despite it being costly to implement where wet season feeding has not previously been used. Further research will provide better information on responses and expected returns on investment.

## Practical implications for north Australian beef producers

Inclusion of N+S into licks (generally based on phosphorus in north Australia) throughout the wet season will enhance production efficiency, primarily through increased conceptions, fewer out-of-season calves and lower mortalities.

Supplementation of lactating cows in the mid-late wet season with high levels of protein meal cannot be recommended until better estimates of responses are made. However, producers may opt for this strategy based on a 10-20% increase in calvings if alternative sources of young cattle are very expensive. As well, if the supplementation is targeted, similar biological and economic responses to that achieved with spike feeding may be realised.

# OESTROGEN FEEDBACK

## Task objectives

To assess the potential of controlling $E_2$ negative feedback through:

. definition of the relative importance of ovarian dependent ($E_2$ feedback) and independent effects on postpartum LH secretion and the resumption of postpartum cyclicity.

. determining the level to which spike feeding effects on postpartum cyclicity are mediated by $E_2$ feedback.

. assessing whether supraphysiological $E_2$ levels in postpartum cows can enhance postpartum LH secretion and advance cyclicity.

## Research

In all experiments (Table 20) there were no effects of any treatment, either pre- or postpartum, on weight or body condition.

In Experiment 1, which was conducted in a good season with cows in forward condition, 60% of cows had cycled prior to ovariectomy at 60 days postpartum (PP). In anoestrus cows, $E_2$ totally suppressed the post-ovariectomy LH and FSH rises (Table 21). This suppression was diminished in cows which were spike fed. In these relatively nutritionally-replete cows, weaning had no effect on plasma LH levels.

In Experiment 2, during which seasonal conditions were average, there were no effects of spike feeding on LH 30 days postpartum when cows were Ovx; as well, there was no post-castration rise in LH nor any effect of $E_2$ on LH in the 3 weeks following castration. Low responsiveness to GnRH challenge suggested inadequate endogenous GnRH secretion to achieve sufficient pituitary LH reserves, thus inhibiting potential increases in LH release.

In Experiment 3, both Spike feeding and weaning reduced the intervals from calving to first ovulation postpartum ($P<0.01$), but the effects were not additive (Table 22). Postpartum plasma LH levels were unaffected by Spike feeding but were increased independently and additively by weaning and ovariectomy (Figure 2).

In Experiment 4, the proportion of cows that had ovulated by 150 days postpartum was not influenced by postpartum treatment with $E_2$ (Figure 3). However, $E_2$ treatment tended to decrease the proportion of cows pregnant at that time.

Table 20. Summary of experiments conducted to evaluate $E_2$ feedback on fertility control

| No. | Year | Site[A] | Total no. cows | Objectives addressed | Treatments/Management | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Spike feeding (2 kg/d M8U) | | Weaning | | $E_2$ (Compudose 200®) | | Ovariectomy | |
| | | | | | Prop | Days | Prop | Days PP | Prop | Implants @ days PP | Prop | Days PP |
| 1 | 88/89 | SL | 25 | 1,2 | Half | 39 | Half | 60 | Half | 1 @ 60 | All | 60 |
| 2 | 89/90 | FV | 20 | 1,2 | Half | 42 | None | | Half | 1 @ 30 | All | 30 |
| 3 | 92/93 | FV | 40 | 1,2 | Half | 56 | Half | 7-10 | None | | Half | 7-10 |
| 4 | 89/90 | LD | 24 | 3 | None | | None | | Half | 2 @7 | None | |

A: SL = Swan's Lagoon FV = Fletcherview LD = Lansdown

All experiments used *Bos indicus* cross cows and a factorial design

**Table 21.** Effects on mean plasma LH and FSH (ng/ml) of $E_2$ in anoestrus cows ovariectomised (Ovx) 60 days postpartum

Means within block with the same post-script are not significantly different

| | | Treatment | |
|---|---|---|---|
| | | No implant | $E_2$ implant |
| LH: | Pre-Ovx | 0.48a | 0.46a |
| | 20 days post-Ovx | 1.38b | 0.53a |
| FSH: | Pre-Ovx | 11.7a | 12.3a |
| | 20 days post-Ovx | 53.1b | 15.6a |

**Table 22.** The effect on post-partum anoestrus intervals of Spike feeding with or without weaning 7-10 days post-partum

| Supplementation | Lactation | |
|---|---|---|
| | Suckled | Weaned |
| No supplement | $70 \pm 10.3$ | $25 \pm 4.6$ |
| Spike fed | $43 \pm 5.1$ | $29 \pm 4.4$ |

The major outcomes from these experiments were:

. Ovarian factors have a much greater influence on early postpartum LH secretion in *Bos indicus* cross cows than ovary-independent effects of suckling (Expt 3).
. In nutritionally-replete cows, ovarian dependent mechanisms (primarily $E_2$ feedback) have a profound effect on resumption of cycling postpartum, while weaning effects on cyclicity appear mediated by ovarian independent mechanisms (Expt 1).
. In extended postpartum anoestrus, both chronic $E_2$ feedback effects and ovarian independent mechanisms may suppress increases in LH secretion (Expt 2).
. Spike feeding effects, as seen in the postpartum cow, appear to be mediated by LH-independent mechanisms (Expts 1,2, and 3).
. Short-term supraphysiological levels of $E_2$ early postpartum do not accelerate postpartum resumption of cyclicity (Expt 4).
. Vaccination of cows against the $E_2$ precursor, androstenedione, to reduce the PPAI by decreasing $E_2$ negative feedback effects on LH secretion warrants investigation.

**Figure 2.** Postpartum plasma LH levels for *Bos indicus* cows:
(a) Spike fed [continuous line] or unsupplemented [broken line]
(b) suckled [open circles] or weaned [shaded circles] one week postpartum
(c) ovariectomised one week post-partum [triangles] or intact [circles]
(d) Combined effects of suckling and ovariectomy [intact suckled=open circles; intact weaned=shaded circles; Ovx suckled=open triangles; Ovx weaned=shaded triangles]

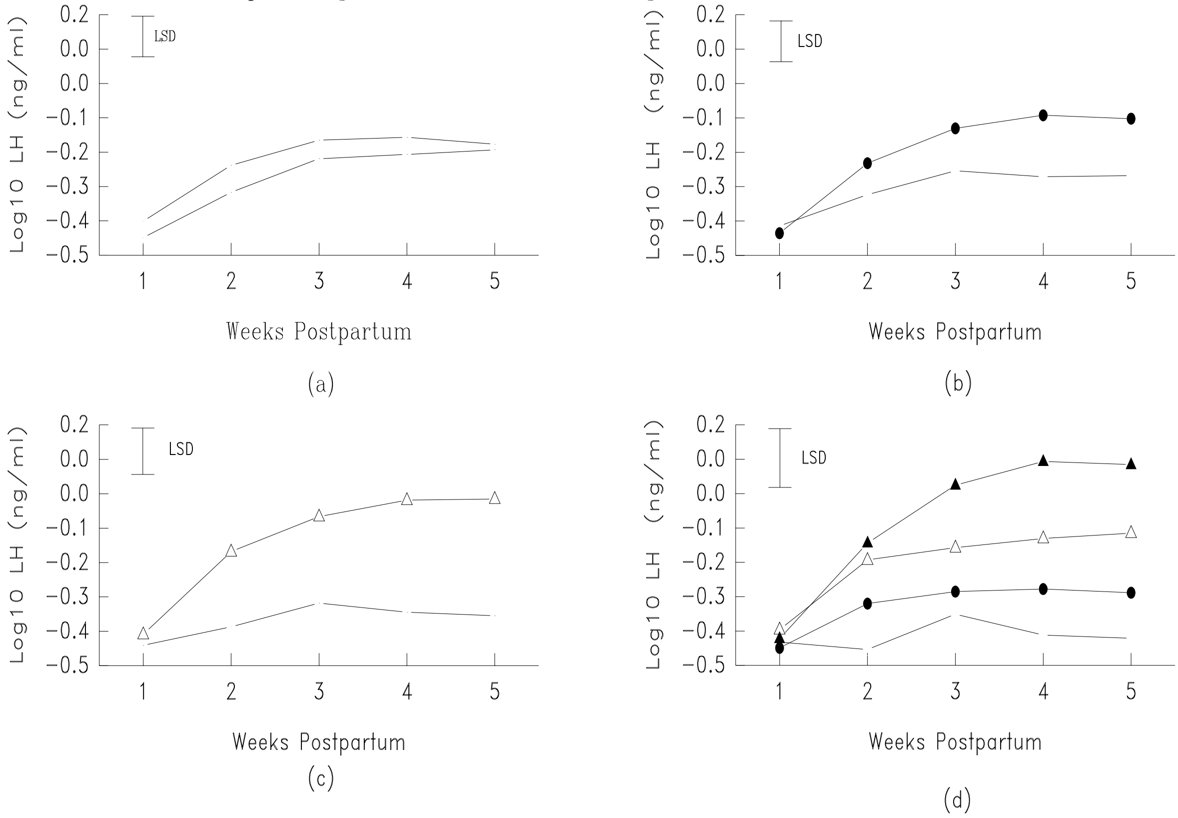
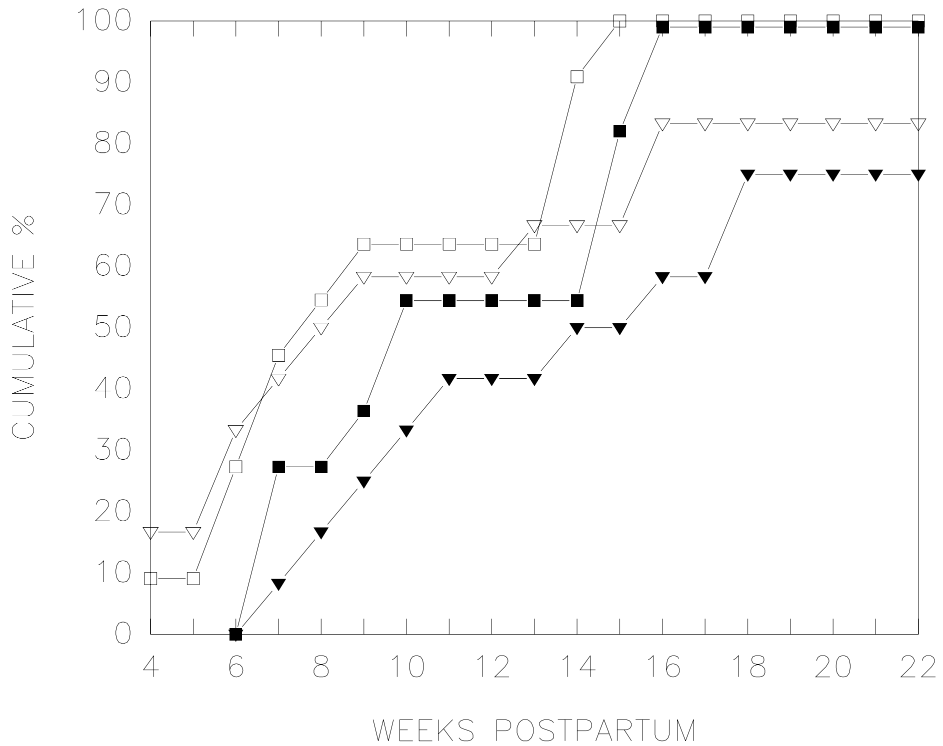



**Figure 3.** Cumulative percentage cycling (open points) and cumulative pregnancy rates (shaded points) in *Bos indicus* cows which were either implanted (circles) or not (squares) with $E_2$



### *Conclusions*

These studies clarified the relative importance of $E_2$ negative feedback and ovary-independent effects of suckling on postpartum gonadotrophin secretion, and thus the resumption of ovarian cyclicity in *Bos indicus* cows.

## Economic evaluation

No practical strategy was developed.

## Practical implications for north Australian beef producers

No practical strategy has yet evolved which can directly suppress $E_2$ negative feedback to a degree sufficient to advance postpartum cyclicity.

# SUCKLING EFFECTS ON OVARIAN/PITUITARY FUNCTION IN POSTPARTUM BRAHMAN CROSS COWS
(UNQ.009 Task 9)

Task leader:Prof Keith Entwistle (To Dec 1992)
Dr Lee Fitzpatrick (From Jan 1993)

## Background

Prolonged postpartum anoestrus is an important factor limiting pregnancy rates in *Bos indicus* cows in the dry tropics of north Australia, where cattle may experience submaintenance nutrition for up to six months of the year during the dry season. Reduction of lactation via early weaning is a major practical management strategy to improve cow fertility in northern herds.

The fertility response to early weaning is not always positive. A better understanding of the some of the basic physiology and endocrinology of the postpartum cow was required to provide explanations for failures in some early weaning programs and to improve the efficiency of weaning.

Hypothesis: *The effect of suckling on ovarian and pituitary function in postpartum Bos indicus cows is modulated by previous and current nutritional status, thus creating variability of the postpartum anoestrus interval.*

## Task objectives

To develop a more detailed understanding of the modulating effects of suckling and lactation on postpartum physiology and endocrinology in Brahman cross cows

Determine interactive effects of nutrition and suckling on postpartum ovarian/pituitary function

Through application of this information, improve prediction of success of early weaning programs and enhance responses in such programs

## Research

Experiments were conducted in the dry tropics of north Queensland over four years using grade Brahman or Brahman crossbred cows grazing native tropical pastures or fed maintenance or submaintenance diets of low-quality tropical roughages.

*Experiment 1*

This study was conducted at Lansdown and utilised first calf, 3-year-old Brahman-cross (Droughtmaster) cows. Cows were allocated to two levels of nutrition, Maintenance (M, n=11) or Low (L, n=5), fed from at least 40 days before calving to 120 days postpartum. Nutritional treatments were designed to simulate moderate to harsh seasonal conditions for cows grazing mature tropical pastures in the subcoastal spear grass region of northern Australia. Before calving, cows grazed low-quality tropical pastures and weight was recorded every 10 days.

Precalving nutritional treatments were imposed through differences in stocking rate and the supplementation of M cows with medium-quality hay. After calving, cows and calves were housed individually in pens and fed M or L diets, of chopped hay fed *ad libitum* or 65% of *ad libitum* DM intake, respectively. Calves were allowed to suckle *ad libitum*. At 70 days postpartum, calves from half of the M cows (MW, n=6) and from all of the L cows (LW, n=5) were weaned; the remaining M cows (MS, n=5) served as suckled controls. Plasma progesterone ($P_4$) profiles were used to determine the onset and pattern of luteal activity in cows during the postpartum period until 180 days postpartum.

*Experiment 2*

This study was also conducted at Lansdown and utilised first calf, 3-year-old Brahman-cross (Droughtmaster) cows. Cows were managed as one group on pasture under typical dry-season conditions until 1-5 days after calving. At this time, cows were housed individually with their calves in pens, and allocated at random to be fed either High (H, n=12) or Low (L, n=12) diets of chopped hay fed *ad libitum* plus a supplement, or restricted amounts of chopped hay only.

Diets aimed to maintain cow weight, or to induce marked weight loss during the early postpartum period. Calves were allowed to suckle *ad libitum* and weight was recorded weekly. At 52 days postpartum, all calves were weaned. At this time, half of the cows fed the H diet were changed to the L diet and vice versa. The onset and pattern of luteal activity postpartum was determined as for Year 1. at 42 days after weaning, all cows were run with two bulls as a single group on good quality pasture. Time of conception was determined from plasma $P_4$ profiles.

*Experiment 3*

This study was conducted at Fletcherview, and utilised multiparous, grade Brahman cows. The aim was to determine the relative importance of ovary-dependent control mechanisms and ovary-independent suckling effects in the suppression of LH secretion in the postpartum *Bos indicus* cow. At 7-10 days postpartum, cows were allocated to groups either ovariectomised (Ovx) and their calves weaned, Ovx and suckled by their calves, intact and their calves weaned or intact and suckled by their calves. At weekly intervals, commencing 7-10 days postpartum, cows were bled by coccygeal venipuncture for plasma LH determination. The ovaries of intact cows were examined weekly by ultrasonography to determine the time of first postpartum ovulation.

*Results*

Postpartum *Bos indicus* cows are particularly sensitive to the negative effects of lactation/suckling on postpartum anoestrus intervals. However, when isolated from the influence of the calf, these cows are capable of recommencing cyclic ovarian activity soon after calving (25±5 days v 70±10 days; $P<0.05$). While nutrition/body condition can interact with lactation/suckling to exacerbate postpartum anoestrus intervals, the negative effects of the latter predominate.

The absence of cyclic ovarian activity for more than six months after calving in maintenance-fed suckled cows compared to maintenance-fed weaned cows suggests prolonged inhibitory effects of lactation and(or) suckling. Despite low weight at calving, weaning calves at 70 days of age, resulted in resumption of cyclicity within 50 days, although the time taken for this response varied considerably (14-48 days). In contrast, marked weight loss during late gestation and the early postpartum period in nutritionally-stressed cows, totally inhibited this effect of weaning whilst cows continued to lose weight. However, once weaned, cyclicity resumed in these cows about 30 days after nutritional conditions improved.

In cows that calved in good body condition, marked levels of postpartum weight loss did not affect resumption of cyclicity in response to early weaning or subsequent conception. Reduced milk yield and calf weight gain in groups of underfed cows were associated with greater amounts of time per day spent suckling and higher suckling frequencies. Acyclic interval after weaning was negatively related to body condition score at weaning, and positively related to preweaning suckling intensity, suggesting that effects of undernutrition in suckled cows may operate at least in part through interactions with milk yield and suckling intensity. Lactation and(or) suckling inhibition appeared to predominate over effects of undernutrition *per se* in prolonging postpartum acyclic intervals in these *Bos indicus* cows.

In maintenance-fed suckled cows, anovulation at 45 to 65 days postpartum was most likely due to failure of the mechanisms governing final follicle maturation and ovulation. In contrast, chronic undernutrition suppressed the growth of large dominant follicles, suggesting inhibition of the mechanisms responsible for follicle recruitment and(or) selection, due to a high level of sensitivity to ovarian negative feedback at the level of the hypothalamus and pituitary.

These studies support the central hypothesis that prolonged postpartum anoestrus in *Bos indicus* cows in the dry tropics results from interactive effects of chronic undernutrition and suckling that inhibit hypothalamic GnRH secretion, hence pulsatile LH release and the maturation of large, dominant ovarian follicles. While ovarian $E_2$ negative feedback is the predominant mechanism involved, additional inhibitory mechanisms that are at least partly independent of ovarian feedback control may be involved. Opioidergic mechanisms that suppress GnRH secretion may be influenced by chronic suckling, while the somatotrophic axis may play a role at the level of the hypothalamus/pituitary or have direct intraovarian effects.

*Conclusions*

.Prolonged postpartum anoestrus intervals have been shown to be predominantly due to lactation/sucking effects that result in an increased sensitivity of the hypothalamo/pituitary axis to ovarian negative feedback, although other ovary-independent mechanisms may be involved. These effects were increased under conditions of nutritional stress.
.In *Bos indicus* cows, chronic lactation/suckling effects were shown to result in prolonged postpartum anoestrus intervals, an inherent survival mechanism in *Bos indicus* cows.
.Acyclic interval of cows after weaning was found to be negatively related to their body condition at weaning.
.Weaning calves from postpartum *Bos indicus* cows in moderate to good body condition was found to result in a return to cyclic ovarian activity within 50 days, but weaning calves from cows in poor body condition may not result in a return to cyclic ovarian activity until about 30 days after an improvement in nutritional conditions.
.It has been illustrated that understanding of the physiological mechanisms associated with postpartum anoestrus in *Bos indicus* cows can lead to the development of technologies/management strategies to limit the impact of this inherent survival mechanism on reproductive performance.

## Economic evaluation

This research has contributed significantly to Task 8 in both DAQ.062 and UNQ.009.

The findings indicate that, if seasonal conditions are poor early in the year when cows would normally have a fertility trigger response to weaning, segregating and feeding cows in poor body condition for a minimum of 30 days will substantially increase the number of calves weaned from these cows in the following year. If 100 such cows were fed 1 kg of cotton seed meal for 40 days (Cost $2,000) producing 50 extra calves in the following year, there is a calculated 400% return on investment when these progeny are sold (as surplus females at 2.5 years and steers at 4.0 years).

## Practical implications for north Australian beef producers

Suckling has a profound negative effect on postpartum cycling. The period to resumption of cycling after weaning is inversely related to body condition at weaning. Cows weaned in medium-good condition resume ovarian cycles within about 50 days. But in cows in poor condition, ovarian cyclicity is only achieved about 30 days after an improvement in nutritional conditions following weaning of their calves. This indicates appropriate nutritional management to achieve target conception rates and enables a consistent positive economic response to early weaning.

# Calf output

## INCREASING PRODUCTIVITY THROUGH STRATEGIC PRODUCTION SUPPLEMENTARY FEEDING OF HEIFERS AND YOUNG COWS (DAQ.062 Task 2)

Task leader: Bill Gulbransen

### Background

Because of nutritional inadequacy, branding rates of cattle grazing native pastures in the Burnett region average around 70%, with lactating heifer branding rates often below 40%. Yearling mating increases breeding efficiency in more favoured environments. In consultation with beef producer representatives in the region, it was considered that combining this strategy with targeted supplementation may achieve the same in the Burnett.

Hypothesis: *Supplementing heifers and mating them earlier will increase calf output by one calf by 4.5 years of age*

### Task objectives

Through supplementation of heifers, reach 300 kg when initially mated at 15 months and 400 kg during lactation at 27 months of age, thereby maximising calf output.

### Research

*Treatments*

Three breeding herds were established. The normal mating period is December-February. Empty maiden heifers were culled after 2-year-old mating. All empty cows older than 3 years were culled. Heifers were either:

. Yearling-mated: Supplemented in dry seasons as weaners (Averages: CSM: 46 kg; Grain-based concentrate: 257 kg) and pregnant yearlings (Average CSM: 163 kg) and mated at 15 months.

. Early-mated: Mated at 24 months with early weaning prior to second mating. Survival supplementation only.

. Normally-mated: Mated at 27 months with weaning after mating. Survival supplementation only.

*Outcomes*

Harsh seasonal conditions over the trial reduced weaning weights to 145 kg which was 30 kg below average. Heifers responded well to supplementation (weaners: +57 kg), but with low starting weights, combined with poor seasons, target weights were not achieved in the Yearling-mated herd (1 year: 257 kg v 300 kg; 2 years: 366 kg v 400 kg). This is reflected in conception rates (Table 22). Under average conditions, target weights and fertility would have almost certainly been achieved.

Despite overall low branding rates, combining supplementation with yearling mating increased calf output by about 0.3 calves, and advantage which appears to be persistent. For a herd with a usual branding rate of 70% and culling at 9 years, this is equivalent to an overall increase in branding rates of 6%.

There appears to be no significant advantage in calf output of mating 2-year-old heifers three months early, especially in view of increased management requirements. However, a useful response may have been achieved had the seasons been less extreme.

Table 22. Mating management and supplementation effects on weights and fertility

| Parameter | Age (years) | Treatment | | |
|---|---|---|---|---|
| | | Normally-mated | Early-mated | Yearling-mated |
| Average weights | 1 | | | 257 |
| | 2 | 361 | 335 | 366* |
| | 3 | 365* | 361* | |
| Average conception rates | 1 | | | 58% |
| | 2 | 96% | 88% | 16%* |
| | 3 | 58%* | 81%* | |
| Calf output | 4.5 | 1.3 | 1.4 | 1.6 |
| | 5.5 (Projected) | 2.0 | 2.0 | 2.3 |

* Wet cows only

## Economic evaluation

Within the Yearling-mated herd, the average cost of supplement per weaner which commenced the program was $90. A partial budget to estimate the return using actual inputs and responses (calf output: +0.3 calves), showed that the strategy was not viable (Table 23). Increasing long-term calf output by 0.5 calves or reducing feed costs to $50 per heifer in this management system achieved a small return. This level of return may be considered close to the break-even point, to cover the risk on investment. Herd modelling using BREEDCOW confirms this analysis.

The response to supplementation and yearling mating would be much greater in average and good years; as well, the required inputs would be much less. Therefore, it is likely that the yearling-mating strategy examined in this study would be economically viable in better years than in the very poor seasons experienced during this project.

With the poor seasons precluding a useful response to the early-mating strategy, economic evaluation was not considered.

Table 23.Economic evaluation of supplementation and yearling mating of 100 weaner heifers

| Parameter | Input/Output | | |
|---|---|---|---|
| | Actual | Lower cost | Extra calves |
| Extra calves | 30 | 30 | 50 |
| Feed cost per animal | 90 | 50 | 90 |
| Feeding costs (transport,labour,vehicles) | $1,500 | $1,500 | $1,500 |
| Annual losses of progeny | 1.5% | 1.5% | 1.5% |
| Age at which extra progeny sold | | | |
| Females | 2.5 | 2.5 | 2.5 |
| Males | 4.0 | 4.0 | 4.0 |
| Annual variable costs of raising progeny | $20 | $20 | $20 |
| Interest | 8% | 8% | 8% |
| Extra females sold | 15 | 15 | 24 |
| Cost/female progeny to point of sale | $541 | $354 | $345 |
| Net sale value/female progeny | $349 | $349 | $349 |
| Extra males sold | 14 | 14 | 24 |
| Cost/male progeny to point of sale | $644 | $429 | $418 |
| Net sale value/male progeny | $662 | $662 | $662 |
| Total costs | $17,024 | $11,249 | $18,267 |
| Total return | $14,492 | $14,492 | $24,154 |
| Benefit | ($2,531) | $3,244 | $5,887 |
| Profit | (15%) | 29% | 32% |

## Practical implications for north Australian beef producers

Supplementation combined with yearling mating in the Burnett region is very likely to increase breeding efficiency and profitability, as long as it is not attempted in very poor seasons. Viability of this strategy may be enhanced, and risk reduced, by targeting the heavier, older weaner heifers as replacements. This is because target weights and calf output can be more readily achieved.

# Benefit to north Australian beef producers

Within each task report, economic analyses of the impact has been evaluated using partial budgeting and whole herd simulation modelling (BREEDCOW and DYNAMA, Bill Holmes, QDPI, Townsville). For the simulation modelling, we established six base herd situations in north Australia. These were relatively low, medium, and high management with either yearling store (Average: 1.5 years) turnoff or heavy bullock (Average: 4.5 years) turnoff (Table 24; Base herds). For this modelling, we assumed that:

. Herd size was 3,000 Adult Equivalents (AE)
. Initial mating age was 1 year for low management, and 2 years for medium-high management
. All surplus heifers are sold at 2.5 years of age
. Extra inputs to heifers up to 3 years increases net return at sale by $10
. Culling age was 11 years under low management, and 9 years under medium-high management

We assessed the implementation of strategies where appropriate, using data derived from our research and from best estimates. No changes were made to steer, bull, or mature cow parameters when changes were made. A brief synopsis on the conclusions of economic viability discussed under each task is shown in Table 25.

All strategies investigated involve extra costs. However, these costs are offset by higher sales. The major component of extra sales is females and not steers. This effect has the further impact of reducing the period taken to recover costs. DYNAMA analyses show that, for most strategies, the investment is recovered within two years of commencing the transition from the basic situation to new management; this is well ahead of the time taken to sell extra progeny generated by better management.

It is recognised that in most situations, specific strategies are not implemented discretely. The focus of the project was on females up to 3.5 years of age. All useful outcomes were incorporated into an improved management system for females up to 3.5 years (discussed in Technology Transfer section). The economic benefits of this are shown in Table 24.

The final outcome is that profitability of north Australian breeder herds at all levels of management will be significantly improved through adoption of improved young female management practices developed in this project. Increased returns for a 3,000 AE herd vary from $30,000 for low-management herds to $10,000 for better managed herds (Table 24).

The overall increase in profit for the industry given 20% adoption is a minimum of $10M annually for north Australian beef producers. This is unlikely to be fully realised within 5 years due to the usual slow rate of adoption and the lag to return from adoption.

**Table 24.** Effects of improved young female management (IYFM) in north Australian beef herds

| Parameter | Level | Low management | | | | Medium management | | | | High management | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Yearling t/o | | Bullock t/o | | Yearling t/o | | Bullock t/o | | Yearling t/o | | Bullock t/o | |
| | | Base | IYFM | Base | IYFM | Base | IYFM | Base | IYFM | Base | IYFM | Base | IYFM |
| Herd size (3,000 AE) | | 3410 | 3446 | 3372 | 3394 | 3405 | 3488 | 3367 | 3318 | 3429 | 3516 | 3379 | 3433 |
| Mortalities | 0-1 yr | 10% | 3% | 10% | 3% | 4% | 3% | 4% | 3% | 2.5% | 2.5% | 2.5% | 2.5% |
| | 1-2 yr | 8% | 3% | 8% | 3% | 2% | 2% | 2% | 2% | 1.5% | 1.5% | 1.5% | 1.5% |
| | 2-3 yr | 15% | 5% | 15% | 5% | 8% | 5% | 8% | 5% | 5% | 5% | 5% | 5% |
| | 3-4 yr | 8% | 5% | 8% | 5% | 5% | 5% | 5% | 5% | 4% | 4% | 4% | 4% |
| | Mature cows | 9% | 9% | 9% | 9% | 5% | 4% | 5% | 4% | 4% | 4% | 4% | 4% |
| Mated | 2 yr heifers | 352 | 280 | 255 | 197 | 385 | 338 | 267 | 247 | 320 | 292 | 216 | 191 |
| | All females | 2176 | 1885 | 1580 | 1324 | 1635 | 1900 | 1134 | 1268 | 1543 | 1778 | 1041 | 1160 |
| Brandings | 2 yr | 10% | 30% | 10% | 30% | 0% | 30% | 0% | 30% | 0% | 30% | 0% | 30% |
| | 3 yr | 60% | 75% | 60% | 75% | 75% | 75% | 75% | 75% | 83% | 78% | 83% | 78% |
| | 4 yr | 35% | 62% | 35% | 62% | 35% | 62% | 35% | 62% | 50% | 73% | 50% | 73% |
| | 2-4 yr | 32% | 53% | 32% | 53% | 57% | 53% | 57% | 53% | 68% | 57% | 68% | 57% |
| | Mature cows | 62% | 62% | 62% | 62% | 73% | 73% | 73% | 73% | 79% | 79% | 79% | 79% |
| | All females | 47% | 58% | 47% | 58% | 66% | 62% | 66% | 62% | 75% | 68% | 75% | 68% |
| Sales | Heifers | 74 | 262 | 54 | 184 | 125 | 245 | 87 | 164 | 235 | 323 | 159 | 211 |
| | Cows | 181 | 165 | 131 | 116 | 291 | 263 | 202 | 175 | 254 | 302 | 171 | 151 |
| | Steers | 454 | 509 | 303 | 329 | 514 | 581 | 337 | 366 | 558 | 618 | 361 | 386 |
| | Female/Total | 36% | 46% | 38% | 48% | 45% | 47% | 46% | 48% | 47% | 47% | 48% | 48% |
| | Return | $188,256 | $245,737 | $215,720 | $258,436 | $249,682 | $290,073 | $263,829 | $292,014 | $276,080 | $309,648 | $284,772 | $307,283 |
| Female costs | Weaner | $16 | $36 | $16 | $36 | $26 | $31 | $26 | $31 | $26 | $31 | $26 | $31 |
| | 1-2 yr | $23 | $43 | $23 | $43 | $18 | $28 | $18 | $28 | $18 | $28 | $18 | $28 |
| | 2-3 yr | $23 | $43 | $23 | $43 | $29 | $39 | $29 | $39 | $29 | $39 | $29 | $39 |
| Total costs | Direct | $89,009 | $116,179 | $68,419 | $90,104 | $103,631 | $124,389 | $76,150 | $87,649 | $102,564 | $124,390 | $73,728 | $85,964 |
| Gross margin | Total | $99,247 | $129,559 | $147,301 | $168,332 | $146,051 | $165,684 | $187,680 | $204,365 | $173,516 | $185,258 | $211,044 | $221,319 |
| | per AE | $33.08 | $43.19 | $49.10 | $56.11 | $48.68 | $55.23 | $62.56 | $68.12 | $57.84 | $61.75 | $70.35 | $73.77 |

**Table 25.** Summary of economic evaluations for each task

| Task | Economic evaluation |
|---|---|
| **Heifer fertility** | |
| A. The influence of dry season growth and supplementation of prepubertal and lactating Brahman cross heifers on their subsequent fertility | Gross margins increased by 4-5% through improved post-weaning dry season nutrition |
| B. Long-term effects of early weaning of heifers on growth and fertility | GM increased by $1-2/AE from ensuring a minimum of low positive growth in early-weaned heifers |
| C. Nutritional interactions on fertility responses to prepubertal steroid immunisation in heifers | No economic benefit is available. Studies contributed to D |
| D. The biology and timing of critical prepubertal development of the reproductive system in Brahman cross heifers | Basic studies which contributed to A and B |
| E. Define relative importance of different nutrients in influencing ovarian activity, and subsequently fertility, in maiden Brahman cross heifers | Basic studies which contributed to A, B, F, and K |
| F. Define critical premating growth pathways in Brahman cross heifers in the dry tropics to achieve optimal fertility levels | Contributed to A |
| G. Suppression of oestrus during the second half of the year in continuously-mated Brahman cross heifers and cows | No suitable product available |
| **Lactation anoestrus** | |
| H. Appropriate dose levels for melatonin to ensure continued elevation of circulating melatonin levels for a period of at least four months | Basic studies which contributed to I |
| I. The use of melatonin to improve wet season conception rates of lactating Brahman cross cows | The small response achieved did not justify the cost |
| J. Creep feeding effects on postpartum anoestrus and cattle behaviour | No biological response was achieved |
| K. Strategic supplementation and hormonal feedback controls to reduce the postpartum anoestrus interval in Brahman cross cows | |
| K1. Spike feeding | GM increased by at least $1/AE when targeted at first-calf cows |
| K2. Wet season nitrogen | N+S in wet season licks may increase GM by a $3/AE<br>Late lactation CSM may achieve similar responses to spike feeding |
| K3. Oestrogen feedback | No practical strategy was developed |
| L. Suckling effects on ovarian/pituitary function in postpartum Brahman cross cows | Contributed to K. Increased efficiency of early weaning |
| **Calf output** | |
| M. Increasing productivity through strategic production supplementary feeding of heifers and young cows | Likely to increase GM if not implemented in poor seasons |

# Technology transfer

The outcomes of this and other research has been incorporated into a management system for heifers under extensive management in the dry tropics. The management system has been designed to increase production efficiency of heifers.

Achieving adoption of the outcomes from this project is not a component of this project. However, project staff are actively involved in extension of the outcomes, most of which is managed by regional extension staff.

There is considerable general awareness of the research project by all sectors of the beef industry in north Australia. Many producers are aware of recommendations made from outcomes of this project. Exposure has been achieved:

. at field days. Research staff have participated in breeder management field days throughout Queensland and the Northern Territory. These days (some of which have been associated with PDS) include:

. `Alcoota' Alice Springs
. `Lucky Downs' Greenvale
. `Watson River' Weipa
. `Wambiana' Charters Towers
. `Hazelwood' Richmond
. `Morungle' Richmond
. `Afton Downs' Hughenden
. `Homeleigh' Prairie
. `Kangaroo Hills' Charters Towers
. `Haddington' Julia Creek
. `Esmeralda' Croydon
. `Strathalbyn' Collinsville
. `Stratford' Mt Coolon
. `Mt Aberdeen' Bowen
. `Proserpine Stn' Proserpine
. Meat Profit Day, Townsville

. through producer visits to the stations where the research is being conducted. In recent years, a large number of producers have learned of the outcomes of this research following visits in small groups.

. with handouts on specific strategies. Numerous handouts have been developed for specific extension activities. However, the principle handout material to date is on spike feeding and heifer management which are included in this section.

. by direct extension. Producers seeking information on many aspects of breeder herd management and fertility frequently contact project staff directly, or are referred by extension staff. As well, the research staff have been contracted on several occasions, mainly by large pastoral companies, to deliver recent developments in breeder management technology.

. through newsletters. These include regional QDPI newsletters such as the Northern Muster and Insufferabulletin, as well as that of the Australian Association of Cattle Veterinarians. Reference to this project has also been made in NAP newsletters which are widely distributed.

. at meetings of RD&E advisory committees associated with each organisation. These committees include beef producers who report back to their industry organisations.

. via the mass media. Numerous interviews have been conducted with principle investigators in the project for both radio and television presentation. An example is the `Cross Country' presentation on spike feeding. Many newspaper articles covering aspects of this project have also been printed, especially as outcomes from field days where the information has been discussed.

. when producers have participated in the development and conduct of specific experiments. This has occurred with the wet season N studies at Swan's Lagoon, and with the melatonin studies.

. at conferences. Papers discussing this project and its outcomes have been presented to the scientific community at Australian Society of Animal Production conferences in 1990, 1992, and 1994, at the annual Australian Society for Reproductive Biology conferences, at Australian Veterinary Association conferences, and at Vet Update 1993.

. at workshops. An annual technology sharing workshop for the NQ beef group (research and advisory staff) occurs each year.

Response of producers to changing market situations must be rapid for male castrate and surplus female turnoff. However, for breeding herds in north Australia, short-term market changes have little impact on breeder herd management. Seasons and the requirements of good basic husbandry have the dominant influence on short-term management decisions. A further reason for the low impact of market fluctuations on breeder herd management is that changes in management to achieve higher fertility generally do not return the investment for two years.

It is unwise to change breeder herd structure rapidly in response to market fluctuations, as restructuring and acclimatising a herd to achieve optimal performance takes considerable time. It is advisable for producers to evaluate management options and implement those which make a significant contribution to maintaining satisfactory profitability in the long term. Calf output will vary and cow survival should remain high, but with good management, the lowest levels should ensure sufficient cash flow to maintain viability.

Over short periods, it is difficult to gauge adoption of recommendations and the impact of these, particularly as no established system is in place to monitor change. However, in recent years, technical information on cattle fertility is being increasingly sought from research staff within this project. Following the exposure as outlined above, feedback from the industry suggests that some significant changes are occurring. Probably the most significant is not the extra calves, but the increasing numbers of surplus females that producers have available. To date, probably much of this could be attributed to improvements in weaning and weaner management, with some effect of strategies such as spike feeding. This project should stimulate major changes in young female management which will further increase breeder efficiency.

We have recognised for a long while that improved management will increase available surplus females, and provide a major source of income to cover costs of management changes. Provision for this effect following improved management has not been made in many situations, though extension personnel attempt to highlight it whenever discussing breeder herd management.

# A MANAGEMENT SYSTEM FOR HEIFERS IN NORTH AUSTRALIAN BEEF HERDS

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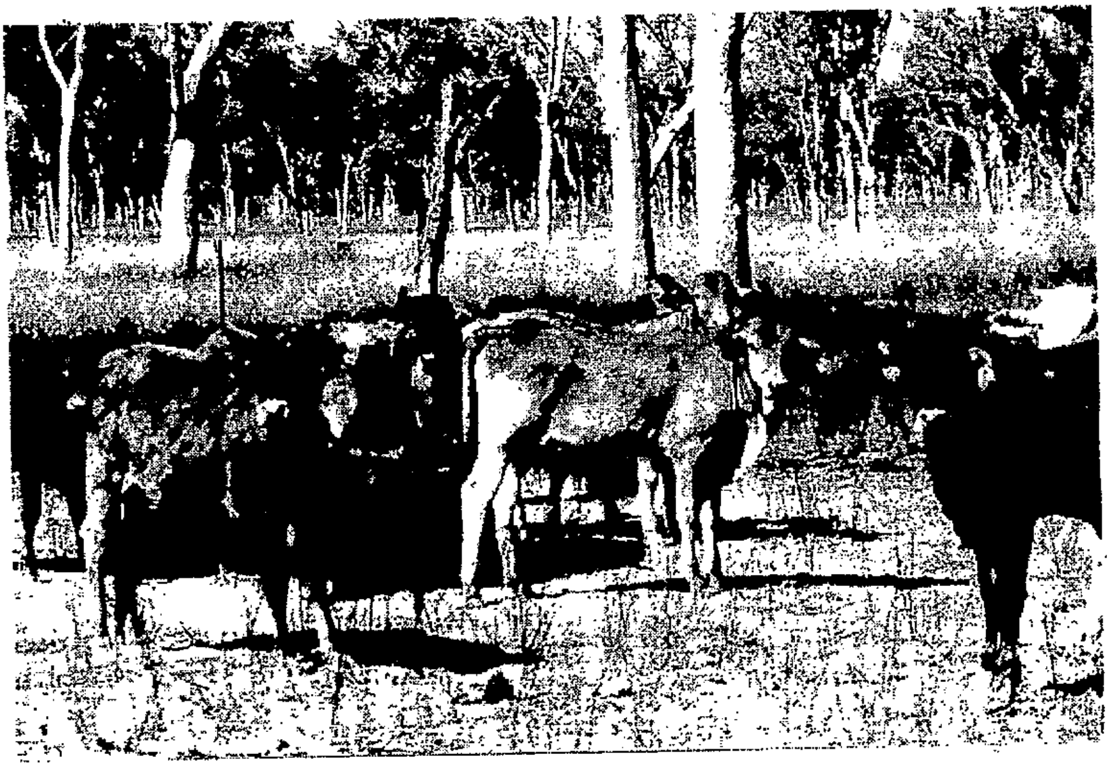
September 1994

Productivity of heifers in many north Australian herds is not high. There is generally little targeted management of heifers.

Research in recent years (supported by the MRC) has indicated that there is significant opportunity for improvement in heifer productivity (growth, survival, fertility) with substantial financial returns. As steer turnoff ages reduce, consistently-high fertility must be achieved to sustain profitability. Improving markets for surplus females also provide opportunities to increase profitability from increased productivity.

A management system for heifers in north Australia is proposed and is based on recent research and economic analyses. It recognises the difficulty of segregating maidens from bulls till 2 years of age.



**Supplementing heifers in the dry season after weaning**

**The management system**

*Paddocks*

**Weaner paddock**: Heifers are held in a weaner paddock till early in the following wet when they are transferred to the heifer paddock for mating. The weaner paddock is then spelled until the first weaning round.

**Heifer paddock**: At about 14 months of age (start of mating), all heifers in the weaner paddock are either transferred to the heifer paddock where they remain till 3.5 years of age, or are culled. Three age groups will be in the heifer paddock over the growing season, and 2 age groups over the dry season, thus creating obvious dry season nutritional advantages for a group that needs it. This paddock must have good bull security.

Where infrastructure development allows, efficiency will be improved if further segregation based on age and pregnancy status can be achieved.

**Mature breeder paddocks:** At 3.5 years of age, selected heifers are transferred to the mature breeders.

**Cull heifers:** Culls are transferred to a cull female paddock. This `paddock' could be the same with heifers being spayed.

*Nutrition*

**Weaner paddock**: Train heifers to supplements in the yards at weaning. At weaning, young weaners need to be segregated. Over the dry season, weights of older heifers need to be at least maintained; young weaner heifers need to continue growing, at least at a low rate (eg, 100 g/day). Professional advice should be sought on appropriate supplements to achieve this. Supplements could be replaced by a spelled improved pasture.

**Heifer paddock**: Wet and dry season licks should be fed in the heifer paddock as required. Incorporate nitrogen and sulphur into all licks.

Spike feed in the heifer paddock each year; ie, 50 days, starting 6-8 weeks before calving is due to commence. In most years, empty heifers will also benefit: conception rate will be higher in those rising 2 at their next mating; those rising 3 will have weaned a calf mid-year and are likely to be in poor condition late in the dry season.

In poor wet seasons when expected conception rates of lactating heifers are low, late-wet season supplementation with 2 kg/day of a protein meal for a month will achieve similar responses to spike feeding. However, this should only be considered if lactating heifers are segregated.

*Mating*

Use seasonal mating in the heifer paddock to cover 1, 2, and 3 year-old heifers. Determine the optimum time to start mating (often around late January). Work on a maximum 4-month mating period; ie, finish at the first round. Even if expected conception rates are low, inclusion of yearlings achieves good animal control and prevents out-of-season conceptions.

When females join the mature breeders at 3.5 years of age, seasonal mating of longer duration (minimum of 5 months in most situations) or continuous mating would be used.

*Selection and culling*

Calculate the number of replacement breeders required at 3.5 years of age. This enables estimates of the number of heifers that can be culled in each phase.

At 14 months (ie, when moved to the heifer paddock, generally in January), cull those with poor conformation, physical defects, poor temperaments, and those which experience the highest loss of condition in the post-weaning dry season.

At 18 months (at the first round in April/May), cull those with low growth.

At 2.5 years (2 months after bulls are removed), cull those which have not previously conceived; alternatively, cull heifers which fail to rear a calf by 3.5 years (first round).

Use the tagging system to identify reproductive record of individuals.

*Weaning*

Weaning all calves from the heifer paddock at the first round means only one weaning muster is required. Heifers will hold condition better. The cost is the management requirements for young weaners. Good weaning practices in mature breeders will help maintain the efficiency of the females.

*Herd health*

Herd health, such as botulism vaccination, is a vital component of management. Professional advice should be sought for each region.

**Benefits of this system over traditional management**

. Mortality rate is lower because of supplementation and controlled time of calving.
. Calf output to 3.5 years of age, and for life, is significantly higher.
. Segregating heifers enables targeted and more efficient husbandry.
. Tight calving patterns allow efficient nutritional and weaning management.
. Selection and culling are efficient. This enables targeted management of culls for profitable marketing.

Economic evaluation of this management system for a high proportion of north Australian herds shows an average annual increase in Gross Margins of $10,000 for a typical herd of 2,000 head.

**Supporting research findings**

*When heifers reach puberty is highly variable*. Within a year and management group, the range for most heifers is about 200 kg and 20 months in weight and age.

Poorer post-weaning nutrition delays the average age at puberty which can be as late as 2.5 years. The average weight needed to reach puberty is 4-5 kg higher for each month delay from poor nutrition; eg, if reached at 1.5 years, the average weight is about 270 kg, and if reached at 2.3 years, the average weight is about 310 kg.

*Keeping heifers on above-maintenance nutrition in the dry season after weaning* simulates improved seasons. It *advances age at puberty and reduces weight required to reach puberty - a double bonus.* In average-poor seasons, this can almost ensure that at least 80% of heifers can conceive within the first 3 months of mating as maiden 2-year-olds.

*Weaning age does not affect age and weight at puberty*. Therefore, puberty is at a later time in early weaners simply because they are weaned younger.

*Maiden heifers which conceive in the first 3 months of mating have higher long-term fertility and survival.* Following poor seasons and no supplementation, 80% of heifers may not reach puberty till beyond 2.5 years of age. Therefore, as few as 50% conceive within the first 3 months. High conception rates in this period are achieved in all years when dry season growth of weaner heifers is improved. This also advances puberty sufficiently in early weaners to achieve high conception rates as maiden 2-year-olds.

*About a third of Brahman cross heifers conceive when mated as yearlings* following good dry season nutrition as weaners. Conception rates are 15% lower in those with poor weaner nutrition. *This advantage in calf output is maintained through to maturity and can be as high as 0.5 calves.* After several years, these heifers are only about 10 kg lighter than similar heifers mated initially as 2-year-olds.

*Short seasonal mating is recommended.* Yearlings conceiving late and then calving when fat and immature in the middle of the following wet season often experience severe calving problems leading to death. Older heifers conceiving at the start of the wet (before January) will calve in the dry season and may perish.

*Spike feeding*, which is the feeding of a high quality supplement to late pregnant heifers for a short period in the late dry season, *increases conception rates in lactating cows* in the following year by an average of 15% and increases lifetime calf output by 0.3 calves on average; ie, herd branding rates increased by 5%.

Incorporation of nitrogen and sulphur into wet season licks (generally based on phosphorus) throughout north Australia in recommended. Protein levels in tropical pastures drop rapidly in the wet season. *Supplementing lactating cows over the wet season with urea & sulphur increases pre-weaning conception rates by up to 25%, even at very low intakes.*

*Short-term supplementation of lactating cows with 2 kg/day of a protein meal in the late wet season increases pre-weaning conception rates by at least 10%.* Astute timing may increase the response to 20%. However, it has clearly been shown that this type of supplement in the early to mid wet season when cows are in peak lactation, will not enhance fertility, despite having significant effects on both cow and calf growth.

# N.Q. BEEF INDUSTRY GROUP NOTES

April 1992

## SPIKE FEEDING

Geoff Fordyce, Swan's Lagoon Beef Cattle Research Station, Millaroo, 4907.
Keith Entwistle, James Cook University of North Queensland, Townsville, 4811.

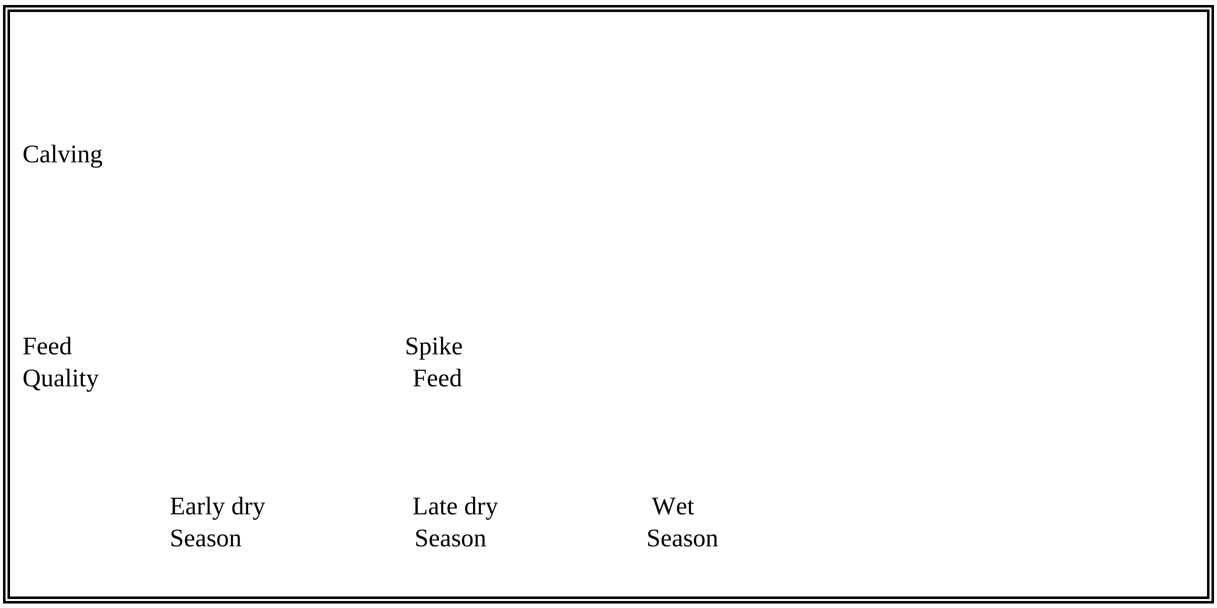
The interval between calving and cycling should average about 2-3 months for a cow to have a calf every year. However, this interval is generally far longer in north Australian herds; in first-calf cows, it may extend for up to a year.

Most of the problem is due to poor nutrition. Research at Swan's Lagoon and Fletcherview has shown that short-term feeding with a suitable supplement to cows in late pregnancy can significantly reduce the interval from calving to cycling; this increases branding rates.

For some 70% of pregnant heifers and cows, this feeding time coincides with the end of the dry season when feed quality is low. Supplementation causes a short-term increase in feed quality, hence the term `spike' feeding (Figure 1).

Spike feeding mimics early storms. Cattlemen for generations have recognised that early storms, before the calving season, lead to better calf crops. Recent research has shown why.

**Figure 1**. Changes in feed quality in relation to seasons, calving, and spike feeding



During the dry season, the reproductive system `shuts down' (other than the `bits' which keep pregnancy going). A lot of cows calve around the start of the wet season. Cows then put all their energy into lactation and often lose weight. This drain prevents an early `recovery' of the reproductive system.

The effect of spike feeding (or green pick after early storms) is to stimulate `recovery' of the reproductive system before lactation commences. This allows cows to cycle much sooner after calving. Once `recovered', the system does not generally `down-regulate' again unless very adverse seasonal conditions cause prolonged stress in the early lactation period.

Research shows clearly that supplementation of cows after calving tends to increase milk yield, and therefore weaner weights; because of this, it has much less effect on fertility than spike feeding. The simple message is that it is better to try and hold fat on the cow's back before calving than to try and put it back on after calving.

`Energy' drives the reproductive system. Therefore, spike feeding must be with an energy-rich supplement. Examples of suitable supplements are:

- *ad lib*. M8U (molasses with 8% urea). Heifers eat about 2 kg/day, and cows about 2.5 kg/day.

- 1.5 kg/day of cotton seed meal. This is fed twice weekly as a 3-day ration (4.5 kg) and a 4-day ration (6 kg).

Spike feeding effects have been achieved by placing cattle onto spelled, high-quality pastures (buffel - Barcaldine).

Spike feeding must be for at least 50 days. It should commence about six weeks before the main calving season starts; in much of northern Australia, this means a September/October feeding period.

The practical benefits of spike feeding are:

- increased branding rates. Experiments done so far show responses in first-calf cows in the order of 15% extra pregnancies, even in good seasons. Similar responses occur in mature cows when they would normally have had low fertility. The effects of spike feeding may be negated if cows suffer prolonged stress after the start of calving, eg, if there is a very late break followed by extremely wet conditions (eg, 1990/91).

- lower breeder death rates. This is initially because of the survival feeding effect at the end of the dry season. But it is also due to a greater percentage of cows conceiving before the first weaning round. Therefore, in the following year, their calves will be old enough to wean. Cows conceiving after weaning go into the dry season in the following year with a calf at foot, thus greatly increasing the death risk of both cow and calf.

We recommend that heifers late in their first pregnancy be targeted for spike feeding as good responses occur in these in almost all years. This means, that for a producer to consider spike feeding, the infrastructure and level of management must be sufficient to enable segregation of target cattle.

The economic return following a typical response to spike feeding is shown in Figure 2. To break even on the cost of spike feeding, the minimum fertility response required is about 5-7%, depending on the effect on cow deaths.

We do not recommend that spike feeding be used across the entire breeder herd as the feeding costs for mature cows which will not respond will erode potential benefits.

Spike feeding of heifers in their first pregnancy may not appear 'quite right' as these cattle are often in the best body condition of any in the herd. But it is these heifers which lose condition rapidly after calving and then have major problems cycling again.

The concept of spike feeding should be considered when feeding breeder herds with molasses- or protein-based supplements in severe dry seasons. Previous observations show that well-timed drought feeding can also have significant spike feeding effects, ie, higher fertility than anticipated.

**Spike feeding heifers in their first pregnancy**

**Figure 2**. Spike feeding 100 pregnant heifers

| | |
|---|---|
| Extra calves | 15 |
| Reduced mortalities of cow-calf units | 2 |
| *Costs* | |
| Feeding: M8U at 2 kg/day x 12.5 c/kg x 50 days | $1,250 |
| Labour : One man week | $400 |
| Therefore, at 8% interest, costs of extra progeny due to feeding: | |
| . females when marketed at 2.5 years | $150 |
| . males when marketed at 4.5 years | $175 |
| Variable costs of rearing progeny | |
| . females | $40 |
| . males | $50 |
| Losses of progeny | |
| . females (3%) | $61 |
| . males (6%) | $279 |
| ***Total cost*** | ***$3449*** |
| *Returns* | |
| Net return on female progeny | $270 |
| Net return on male progeny | $620 |
| Reduced losses in breeders and progeny | $600 |
| ***Total return*** | ***$6935*** |
| **Return on investment** | **201%** |

# Intellectual property and commercial exploitation of results

There is no intellectual property arising from this project which could be directed at patenting.

There are no significant opportunities for commercial exploitation of the results of this project by either the Queensland Department of Primary Industries, James Cook University, or the Meat Research Corporation.

It is recommended that all results and outcomes be freely available to the Australian beef industry and community as a public service.

# Appendix 1: MRC funding

MRC funds (Table 26) contributed an estimated 22% to the overall costs of DAQ.062 and UNQ.009, with the balance being provided by the Queensland Department of Primary Industries (47%) and James Cook University (31%).

**Table 26.** MRC funding of DAQ.062 and UNQ.009

| Year | Contract | |
|---|---|---|
| | DAQ.062 | UNQ.009 |
| 1989/90 | 74,988 | 85,449 |
| 1990/91 | 84,088 | 80,784 |
| 1991/92 | 89,672 | 83,208 |
| 1992/93 | 91,161 | 85,484 |
| 1993/94 | 93,500 | 50,852 |
| 1994/95 | | 25,426 |

# Appendix 2: Publications

## Refereed journals

Doogan, V.J., Fordyce, G., Shepherd, R.K., James, T.J. and Holroyd, R.G. (1991). The relationships between liveweight, growth between weaning and mating and conception rate of *Bos indicus* cross heifers in the dry tropics of north Queensland. *Australian Journal of Experimental Agriculture* **31**, 139-144.

Fitzpatrick, L.A., Fordyce, G., and Entwistle, K.W. (1994). The effects of pre-partum supplementation in *Bos indicus* cross cows. 2. Ovarian function. In preparation.

Fordyce, G., Fitzpatrick, L.A., Mullins, T.J., Cooper, N.J., Reid, D.J. and Entwistle, K.W. (1994). The effects of pre-partum supplementation in *Bos indicus* cross cows. 1. Growth, postpartum anoestrus, and pituitary function. In preparation.

Jolly, P.D., McDougall, S., Fitzpatrick, L.A., Macmillan, K.L., and Entwistle, K.W. (1994). Physiological effects of undernutrition on postpartum anoestrum in cows. *Journal of Reproduction and Fertility (Supplement)* **49**, In press.

Rhodes, F.M., Fitzpatrick, L.A., Entwistle, K.W., and Kinder, J.E. (1994). Pulsatile hormone secretion during the first ovarian follicular wave in *Bos indicus* heifers. *Journal of Reproduction and Fertility (Supplement)* **49**, In press.

## Refereed abstracts

Feng, Y.H., Entwistle, K.W., and Fitzpatrick, L.A. (1991). The effect of melatonin implants on plasma melatonin, prolactin and LH and levels in *Bos indicus* cows. *Proceedings of the Australian Society for Reproductive Biology* **23**, 151.

Fitzpatrick, L.A., Jolly, P.D., and Entwistle, K.W. (1992). Down regulation of ovarian function in *Bos indicus* heifers following treatment with bovine follicular fluid. *Proceedings of the Australian Society for Reproductive Biology*. **24**, 25.

Fitzpatrick, L.A., D'Occhio, M.J., Entwistle, K.W., and Kinder, J.E. (1994). Decreased interval from calving to first postpartum ovulation following prepartum dietary supplementation of *Bos indicus* cows is not in response to an increase in circulating plasma luteinising hormone. *Journal of Reproduction and Fertility (Supplement)* **49**, In press.

Fitzpatrick, L.A., Fordyce, G., and Entwistle, K.W. (1994). Prepartum supplementation of *Bos indicus* cows enhances postpartum ovarian function and fertility. *Proceedings of the Australian Society for Reproductive Biology* **26**, In press.

Fitzpatrick, L.A., D'Occhio, M.J., Rhodes, F.M., and Entwistle, K.W. (1993). Effects of ovariectomy and/or weaning on plasma LH in postpartum *Bos indicus* cows. *Proceedings of the Australian Society for Reproductive Biology*. **25**, 11.

Fordyce, G. and Entwistle, K.W. (1992). Improving breeder herd efficiency in north Queensland. *In*: Sullivan, M.T. `Changing Beef Markets - Should North Queensland Producers Change Management to Meet Them'. *Proceedings of the Australian Society of Animal Production* **17**, 53-60.

Jolly, P.D., Fordyce, G. and Entwistle K.W. (1990). Oestradiol suppresses gonadotrophin secretion in anoestrus but not cyclic *Bos indicus* cows postpartum, with no effect of suckling. *Proceedings of the Australian Society for Reproductive Biology* **22**, 121.

Rhodes, F.M., Fitzpatrick, L.A., Kinder, J.E., and Entwistle, K.W. (1993). Changes in ovarian morphology associated with dietary intake in *Bos indicus* heifers. *Proceedings of the Australian Society for Reproductive Biology*. **25**, 35.

Rhodes, F.M., Fitzpatrick, L.A., De'ath, G., and Entwistle, K.W. (1994). The effects of follicle wave numbers per oestrous cycle on the ovulatory follicle in *Bos indicus* heifers. *Theriogenology* **41**, 284.

**Conference**

Fitzpatrick, L.A., Fordyce, G., McSweeney, C.S., Schlink, A.C., Jolly, P.D., and Entwistle, K.W. (1989). Nutritional and managerial techniques for controlling postpartum anoestrus in tropical beef cattle. In *Proceedings of the First Coordination Meeting and Training Workshop. Strengthening Animal Reproduction Research in Asia Through the Application of Immunoassay Techniques*. FAO/IAEA. Kuala Lumpur, 22-31 May.

Fitzpatrick, L.A. (1990). Postpartum anoestrus in *Bos indicus* cattle. In *Proceedings of the Australian Veterinary Association Annual Conference: Cattle Program*. Australian Association of Cattle Veterinarians. Townsville, 21-25 *May*.

Fitzpatrick, L.A. (1993). Advances in the understanding of postpartum anoestrus in *Bos indicus* cows. In *Proceedings of the final research coordination meeting of the FAO/IAEA coordinated research program. Strengthening Animal Reproduction Research in Asia Through the Application of Immunoassay Techniques*. FAO/IAEA. Bangkok, 1-5 February.

Fordyce, G. (1990). Management of beef cattle for optimum fertility. Proceedings of the Australian Veterinary Association PANSIG Conference, Townsville, 20-26 May 1990.

Fordyce, G. (1992). Opportunities to increase productivity of north Australian breeder herds. Proceedings of the North West Pastoral Conference, Katherine, Northern Territory, 27-29 October 1992.

Fordyce, G. (1993). Management for optimal reproductive performance in north Australian beef cattle. Proceedings of Vet Update 93, Townsville, July 1993. In press.

**Theses**

Feng, Y. (1992). Seasonality of reproduction and effects of melatonin on female beef cattle reproductive performance. MSc Thesis. James Cook University of North Queensland.

Fitzpatrick, L.A. (1994). Aspects of postpartum anoestrus in *Bos indicus* cows. PhD Thesis. James Cook University of North Queensland.

Jolly, P.D. (1992). Physiological and nutritional aspects of postpartum acyclicity in *Bos indicus* cows. PhD Thesis. James Cook University of North Queensland.

Rhodes, F.M. (To be finalised). Effects of nutrition on folliculogenesis in *Bos indicus* heifers. PhD candidate. James Cook University of North Queensland.

Richards, G.F. (1992). Fertility in Brahman cross heifers in northern Australia. MSc Thesis. James Cook University of North Queensland.

Rodrigues, H.D. (To be finalised). Aspects of puberty in *Bos indicus* heifers. PhD candidate. James Cook University of North Queensland.

**Extension**

Fordyce, G. (1990). Improving breeder fertility by understanding nutritional effects on cycling. *In* Field Day Proceedings, `Alcoota' Station, Alice Springs, 28th March 1990. Queensland Department of Primary Industries, Millaroo.

Fordyce, G. (1990). Aspects of heifer and cow management in north Australia. Australian Association of Cattle Veterinarians Newsletter, August 1990, pp. 19-24.

Fordyce, G. (1994). A management system for heifers in north Australian beef herds. North Queensland Beef Division Advisory Note, September 1994. Queensland Department of Primary Industries, Swan's Lagoon Research Station, Millaroo.

Fordyce, G. and Entwistle, K.W. (1992). Spike feeding. North Queensland Beef Industry Group Note, April 1992. Beef Sub-Program, Queensland Department of Primary Industries, Swan's Lagoon Research Station, Millaroo.

# Appendix 3: Mid-term review: Terms of reference and report

**NAP2**

**Mid term review of reproduction projects**
**UNQ.009, CS.120, DAQ.062, DAN.044**

***Brief:***

The above program was approved in April 1989 in the 1989/90 financial year. This proposed program work extended beyond the time frame for NAP1 (completion by 30 June 1994) and was referred back to the MRC for consideration. The projects were considered to have sufficient merit to be approved in their own right and were approved by the MRC Board on the understanding that they were to be later incorporated into the NAP2 program which was only under consideration at that point in time.

NAP2 goals in the area of reproduction are restricted to the "harsh" and the "intermediate" areas. The goals are:

Harsh area

To increase the average long term weaning rate by 20% from the present 38% to 58% and increase the average cow survival rate from 93% to 94%. (These figures are derived from the NAP2 producer survey. The breeder mortality figures are known to be much higher in many areas).

Intermediate area

To increase the average long term weaning rate by 17% from 55% to 72%.

The above reproductive research projects from a collaborative program aimed at improving the reproductive efficiency of the northern Australian breeding herd in line with the overall objectives of the NAP2 program.

The collaborators are:

| | |
|---|---|
| James Cook University of Northern Queensland | UNQ.009 |
| CSIRO, Division of Tropical Animal Production | CS.120 |
| Queensland Department of Primary Industry | DAQ.062 |
| NSW Department of Agriculture | DAN.044 |

The specific objectives of each of the component projects of the reproductive program are listed within the individual project.

The work is both applied and basic. The basic work underpins the more applied field studies.

The research work is co-ordinated across research organisations by Associate Professor Keith Entwistle of James Cook University. There is close relationship between the collaborating organisations as different organisations provide personnel and a service role to each other, eg, reproductive hormone assays provided by UNQ to the QDPI (DAQ.062).

The northern herd is made up of a high percentage of animals containing bos indicus infused animals (<70%). Animals of breeding age and weight constitute between 35-45% of total numbers. Within specific areas and production systems the percentages may lie outside this range.

The period over which the work has been performed was preceded by a number of significant changes (which are still occurring) within the northern industry.

Briefly these are:

* improved property infrastructure and increased management awareness, largely as a result of the impositions of BTEC;
* increased application of known and engineering technologies;
    * improved pastures
    * strategic supplementation
    * early weaning
    * ACM (Automated Cattle Management)
* reduction in the number of abattoirs and the contract of these killing facilities to the seaboard;
* new marketing options;
    * live cattle exports
    * expansion of feedlotting activities
* an increasing awareness both by industry and the community of the effects of grazing pressure and management practices on the production resource.

The expectation is that at the end of the period of the contract there are clear guidelines, methodologies and an evaluation format that would enable producers to ascertain the cost-effectiveness of particular reproductive techniques for specific reproductive zones.

The emphasis for the reproductive work, however, has to be the "harsh zone" as defined within the NAP2 preparation report.

## TERMS OF REFERENCE

1. Review and comment on project structure, methodologies, management and progress to date against contract objectives, milestones and stated outputs.

2. Review the project against the overall NAP2 goals recognising the production emphasis and options for the NAP zones. (Set after the approval and implementation of DAQ.062; DAN.044; UNQ.009; CS.120).

The specific goals are stated above.

3. Comment on the economic evaluation and likely producer uptake of the technologies currently being developed.

4. Review the presentation of results keeping in mind the need (for producers, extension personnel and consultant) to be able to quickly evaluate management practices in response to changing input prices and market returns.

5. Identify any new potential opportunities and constraints to be investigated or evaluated which are relevant to the intended project outcomes that have become apparent since the commencement of the original project.

6. Identify flow-on effects of potential additional turn-off from the project by way of impact on the beef cattle industry.

7. Make recommendations, as considered appropriate, to the MRC in order to strengthen potential project outputs which are directly relevant to the producer given the changing production and marketing environments (live cattle exports, grass finishing, feedlotting).

8. Review the future proposal of the work co-ordination and management structure given the resignation of Associate Professor Keith Entwistle from the University of North Queensland at or about the end of calendar year 1992.

***Potential Reviewers:***

Need:

Practical applied reproduction background with a knowledge of northern production systems and constraints. It is also important to have some understanding of the overall production and marketing options facing breeders in the northern industry.

A critical constructive review is required focussing on outputs for industry needs an contribution to NAP2 goals.

***Review Personnel:***

The review personnel who have accepted the task of reviewing and reporting on the above project are:

| | | | | |
|---|---|---|---|---|
| Dr Leo Cummins | Phone | (055) 730 909 | Fax | (055) 711 523 |
| Mr Geoff Neithe | | (076) 711 799 | | (076) 712 781 |
| Dr Grahame Cavaye | | (07) 371 2606 | | |

# NAP2 MID TERM REVIEW OF PROJECTS UNQ 9, DAQ 62, CS 120, DAN 44

10-13 NOVEMBER 1992

Review team**L. Cummins,**Department of Agriculture, Victoria
**G. Neithe,**University of Queensland
**G. Cavaye,**Research Consultant Cattlemen's Council

The NAP 2 goals in the area of reproduction are restricted to the harsh and intermediate areas. The goals are:

Harsh area. To increase the average long term weaning rate by 20 percentage points from the present 38% to 58% and to increase the cow survival rate from 93% to 94%.

Intermediate area. To increase the average long term weaning rate by 17 percentage points from 55% to 72%.

## OVERVIEW

One of the first problems with a review of this nature is to determine if the initial premise was reasonable. It proved very difficult to obtain reliable estimates of weaning rates and cow loss rates in the dry tropics. The breeder mortality figures in particular are considered to average closer to 10% per year in both regions. The extreme nature of the climate, the severe consequences of out of season calving, the need for a relatively high Brahman component in the cattle and the very extensive nature of cattle husbandry all make this a very difficult project. The magnitude of the problem can be illustrated by the fact that one reason why Brahman blood cattle are not widely used in southern Australia is due to poor reproduction in young cattle.

Another major problem for the review team was to consider how this program added to the bank of knowledge developed under NAP AP 1 and other previous research, and how it helped in the industry adoption of this information.

The review team had some trouble in addressing some of the terms of reference and in agreeing completely with the relevance of the goal which had been set. These related to the prediction of long term markets and the impact these might have on developing research priorities and production systems. For example, what is the likely impact of a Foot and Mouth free Argentina on the world beef trade, or are current beef production systems with mortalities at these levels, likely to remain acceptable to the non-rural community? Another problem the review team faced was that this group of projects dealt specifically with reproduction. Improved productivity requires consideration of the whole grazing system which includes finishing and processing and marketing. We recognise that other research projects are examining these aspects, but a total understanding of the importance of each of the components of the system is required if maximum value is to be achieved from the research dollar.

The review team was impressed by the nature of the projects and the interim results presented. We felt that the overall project had been ambitious, in that it attempted to put together a large joint program with a good combination of basic and applied research. The program had been well resourced and there had been good co-operation between people and organisations. Management seems to have been based on co-operation more than structure and seems to have resulted in harmonious and productive relationship.

The project workers have made the point that they are one of very few groups internationally who are working with Brahman cattle in the tropics so that there are few alternative sources of specific information available. Brahman cattle are a little different from *Bos taurus* cattle in the way they utilise resources. The viability of the climate in Northern Australia is more severe than those seen in Southern Australia there is no doubt that research will also provide useful leads to some problems in the south.

The project itself has developed into themes and tasks and the workers appear to have developed a series of clear hypothesis for particular experiments. The problem of projecting forward milestones 3-5 years in advance has been highlighted by the early termination of some projects (eg. melatonin and creep feeding) which on the basis of preliminary information seemed worth investigating. The project co-ordinators have shown good judgement in this aspect of the work.

The main findings from the project seem to be as follows:

a. Successful Strategies

1.Early Weaning. This is based mainly on the ability of weaning to initiate ovarian cyclicity . This is effective over quite a range of conditions, but is modified by nutritional history and current weight and condition of cows. Early weaning requires the development of successful calf feeding and heifer management strategies. The idea of weaning calves at 3 months of age or 100 kg or even less seems quite radical but clearly this does work and is being greatly reducing breeder mortality.

2.Supplementary Feeding. Several versions of supplementary feeding have been shown to be cost effective. These include low levels of protein supplements at Grafton and Spike feeding heifers late during their first pregnancy.

These two strategies were developed and initially recommended in NAP AP1. The current project has greatly extended our knowledge of the circumstances when they are likely to be effective. For example, cow weight at weaning determines the rate of return to cycling within 6 weeks and if the cow is below the optimum weight at weaning time supplementation with either energy or protein improves the rate of return to oestrous. Similarly the calf feeding work has involved a number of supplements including monensin, grain treatments and pen studies considering roughage quality. Work in the current project is extending our knowledge from demonstrating simple responses to developing ways of predicting the expected response and thus deciding questions such as “how much” and “when” to apply a treatment.

b. Possibly useful Strategies

3.Wet season Nitrogen supplementation. Based on some positive results and indicators and a highly favourable pre-experimental economic analysis, it seems surprising that work on this aspect is not further advanced.

c. Failed Strategies

4.Creep Feeding. Although the problem of getting calves into the creep area was solved, they did not eat enough supplement to reduce their suckling time on the cow. This was considered to be a herd behavioural problem with no ready solution at this stage.

5.Melatonin. Effective doses were established and mating experiments were carried out. These did not show any effect on fertility in this environment.

6. In many instances, supplementary feeding has proved uneconomic.

Creep feeding and Melatonin treatment were both recommended for further evaluation following NAP AP1.

d. Strategies not yet well tested

7.Anoestrus control. Here the workers have reviewed the products which might be used to prevent conceptions in the second half of the year and have considered that none are worth testing. They consider that the economic benefits of a successful project should be quite large. It seems a little unusual to have this included in the project, but it does give the researchers the opportunity to respond quickly to any likely commercial development.

8.Genetic Effects. Here they should consider breeds, crossbreeding and selection. The workers consider much of the environment they deal with to be even harsher than Rockhampton, necessitating a higher degree of Brahman blood. they are also disappointed that the CSIRO Fertility selection lines at Lansdowne have been dispersed.

e.Mechanisms. A considerable effort has gone into attempting to gain an understanding of the mechanisms involved in the interactions between nutrition and reproduction. The effort has involved detailed metabolic studies and endocrinology (including oestrogen negative feedback) and ovarian follicular development. It has demonstrated the complexity of the relationships and the role of homeostasis but has not yet lead to the definition of simple treatments. The group has developed ovarian ultrasound techniques and a neat method of collecting ovarian venous blood for hormone assays. The laboratory and field studies with androstenedione vaccinated heifers prior to puberty should lead to an important advance in our understanding of the events triggering puberty.

In many locations the ability to trigger puberty and hence conception in heifers, at an earlier age will probably require further modifications to heifer management to ensure successful outcome. It is possible that advancing puberty may be more relevant in the South rather than in the North.

f. Application. Substantial investment will be involved to implement the techniques eg. supplementary feeding, mustering costs, improved pastures, subdivision. Therefore, not only will demonstration of the cost-benefits be necessary but the cash flows involved in proceedings through the various stages needed to set up the systems must be coped with. The economic models presented to the review seem adequate but confidence is lacking in the conditions required for some of the outcomes and the modelling needs to account for the range in management, financial requirements and planes of nutrition available to individual producers eg. recommendations on spike feeding. Everyone involved in research and extension should realise that some producers will not adopt new technology even though it is clearly indicated from a profit point of view. The BTEC program and other developments have caused a number of recent changes in the Northern Industry. It is not clear if this rate of change will continue. It is worth reflecting on how long it took to get a high level of acceptance of *Brahman* cattle in the region.

The impact of climatic variability needs to be approached in two related ways. One is to develop better long range forecasting methods, the other is to properly incorporate climatic variability in experimental design and any recommendation made to the industry. Techniques utilising maximisation of expected utility should be developed to deal with this climatic uncertainty.

g. Consequences. The obvious consequence of successful application of these strategies is the potential for increased beef output. While the NAP 2 goals emphasise the increased weaning rate, all the participants felt that there would also be a considerable increase in the cow turnoff. A major risk which should be considered is the possibility that this increase in breeder numbers will not be slaughtered and this will lead to the potential for overstocking and consequent land degradation. The wider public may be interested in the improvements in animal welfare and reduced environmental degradation even if these do not improve graziers' returns.

Another point to consider is the general marketing aspect. A considerable increase in store cattle production from northern areas is likely to have an impact on the prices of southern store cattle particularly since many would be targeting a lot feeding phase prior to slaughter. The increased availability of females from the north will also present some new marketing challenges.

<u>Response to terms of reference</u>

1. The project has worked towards a number of reproduction themes utilising the facilities from 4 organisations. The MRC role in ensuring co-ordination has meant that for a modest amount of money (from MRC, compared with that spent by various institutions) a well integrated program has been developed. In general the methodologies and progress were considered satisfactory by the review team. The withdrawal of the CSIRO from the project is of some concern, but the research done under CS 120 has provided very useful information. The failure of several interesting leads to stand up to large scale field experimentation highlights the need for recommendations to flow from adequate and well designed experiments.

Planning such experiments requires a knowledge of the basic physiology and science involved. I tis necessary that basic and applied research be very closely co-ordinated.

2. The individual components of management being investigated in this project are unlikely to increase weaning rates by the amounts suggested in the goals for NAP2. However these goals are currently achieved in well managed northern herds as demonstrated by the Swan's Lagoon continuously mated herd when a whole range of techniques is used together. A number of other herds have also already achieved these goals.

It is always difficult to predict the rate of adoption of new technology by the industry. this program has a very practical component particularly at Swan's Lagoon and Grafton and is being supported by work on Producer Demonstration Sites. It is also demonstrating and improving recommendations developed in previous research. For these reasons the review team felt the overall project will contribute very significantly to the NAP 2 goals. The specified reduction in breeder mortality should be easier to achieve than the improvement in weaning rate.

It is perhaps unfortunate that none of the research sites are west of the ranges in the "hash" environment. Presumably, this deficiency can be made up by contact with producers in these areas.

3. The economic evaluations clearly need to look at whole herd systems and evaluate a range of options. Several models have been developed and are in use to evaluate this research. Partial budgeting is also being used in several of the projects.

The results presented to the review team were necessarily incomplete but indicated that the workers were planning an adequate evaluation.

Points of great interest to producers contemplating management changes would include a clear understanding of the extra cost involved. In many cases, a major component of the extra sales has been an increase in females and not steers and because of this, in many cases, the investment is recovered within 2 years.

Producer uptake depends on property development. For example, techniques such as heifer management and spike feeding need adequate subdivision so that only the most likely responders are fed. It also depends on understanding the herd dynamics in the existing management scheme and in the new scheme. This then allows the producer to assess likely returns in view of the ever changing market situation.

A point to remember is that this research program builds on other knowledge and improvement is really a package deal involving a number of components, each with relatively small effects. The consequences of one change may be to require a number of other changes. This means that producers may need considerable support to adopt what turns out to be quite a large change in management. Sympathetic and comprehensive extension is required with producers learning from each other at producer demonstration sites. The reviewers are very impressed with the role of non political graziers organisations (such as the Beef Improvement Association) in helping to get the message out.

4. A major problem with the presentation of results is to ensure that the presenter is fully aware of the benefits and limitations of the information being given (ie. the message should be clear and simple but you need to be able to answer difficult questions convincingly). From a research point of view this means that the initial observation must be followed up by field information. In this context for example, the extensive set of data from research stations and private properties on spike feeding now allows a good estimation of when it is likely to work and when the results are likely to be poor. Even so, the reviewers still felt there were opportunities to more precisely target spike feeding ) this might involve long range weather forecasting and pregnancy testing).

Another major requirement is the ability to integrate pieces of information into a n understanding of the implication for whole herd productivity. There are several computer models available which have been developed for the northern areas. The reviewers were presented with production and economic outputs from these models but were not in a position to evaluate their ease of use, their validity, nor the way management options could be manipulated with them.

In many ways, because of the sparsity of information, the importance of modelling is even more important in the north than in the south, but in both cases the problem is to ensure the validity of any model being used.

The program had developed a great deal of information on calf feeding admittedly with a tropical bias (ie. the role of molasses in the diet etc.) however, this information would be very useful if there were more generally available. Early weaning is an important drought strategy in the south and it is also relevant to the production of dairy beef. In addition the reviewers felt that some of the cow supplementary feeding work required a better explanation of the interactions between energy, nitrogen and true protein. These are issues which have been around for quite a while and are not well understood by many advisers on the periphery of nutrition and certainly not by many cattle producers (in either northern of southern Australia).

5. The review team felt that the work presented was reasonably complete but there was a number of opportunities for refinement. Relatively simple things such as the number and timing of musters could be very important. Given the importance of environmental degradation and the role of nutrition in reproduction, it seemed that stocking rate (and associated factors such as pasture improvement, fertiliser and weed control) should receive more attention. Modelling and research should continue to look at age at turnoff,

performance of older cows and culling strategies. Given that the work is likely to lead to a larger number of cow and heifers available for slaughter, then simple methods of identification of poor performance and fishing systems for these stock are needed (nutrition and pregnancy prevention). Early weaned calves require high quality supplements. In some areas at least, special purposes pastures might be developed to reduce the cost of supplementation. The review team felt that the basic endocrine/metabolic studies should continue as this will eventually lead to an understanding of how body condition score/lactation effects really work and how new treatments can be developed.

A slight change in emphasis could usefully involve more research and extension into breeder mortality (in the project to date, this has tended to be a secondary issue which has nevertheless been recognised as a very important result). Another area of research and extension is the availability to recognise and respond appropriately to the pasture position at the end of the wet season (good managers already do this and adjust stock numbers accordingly).

The review team agreed that the issue of a cheap practical anoestrus control method had a lot to offer, but the researchers considered that nothing presently available was suitable. The issue is really larger than this, involving the ability of simple and cheap strategies to turn reproduction on or off. This would allow conceptions to be timed to ensure optimum cow and calf survival and in some cases at least, the weaning rate may be unchanged or even decreased. Obviously this opportunity requires detailed understanding of basic reproductive physiology. Vaxstrate® and steroid immunisation are important tools to help our understanding but at their present state of development at least, are not likely to be commercial products. Timing of mustering for weaning is also an important component of this.

Heifer management work is based on the hypothesis that post weaning nutrition and management can effect fertility independently of weight at mating through effect on pubertal hormonal activity. Progesterone assays on collected samples will provide essential information on factors affecting puberty. Following this understanding it may then be easier to manage for earlier or later puberty to match the environmental limitations.

New areas of work would include basic research into predicting reproductive potential. This would probably be genetic and would be coupled with improved bull selection and probably more extensive use of Artificial Insemination. (Some of the existing work suggested that a better understanding of the relation between nutrition and weaning could lead to a high degree of oestrus synchrony).

AI is not likely to be used for commercial beef production but should be encouraged in bull breeding herds (studs or commercial herds breeding their own bulls and applying appropriate selection to their own gene pool). Predicting reproductive performance might follow from the work on the endocrinology of puberty or it might require more basic genetics studies. The newly imported tropical breeds should offer some opportunities for crossbreeding.

Genetic improvement should utilise between and within breed methodology and should consider meat quality as well as growth, reproduction and adaption (one reviewer initiated discussion on Brahmans and meat quality).

A major constraint with any program dealing with grazing livestock is seasonal variation. The extreme climate variation in the north means that the applied programs need to run for a long time to utilise statistical methods to allow for this variation. Similarly, long term programs are needed to identify the effects of this variation. Similarly, long term programs are needed to identify the effects of heifer management on cow longevity.

Another major constraint for the grazing industries both north and south is the continuing erosion of support for agricultural research, development and extension needs. This is occurring in all Departments of Agriculture. Educational institutes are also diverting resources into other areas of scientific research.

6. The review team considers that the project will increase the flexibility of production systems in the north. The major change is likely to be the increased number of female cattle available for sale. Suitable markets will be needed for these. A major consequence of the project will be the need for producers to understand and manipulate their herd structures. For example a younger turnoff age means more breeders in the herd and thus a higher drought risk. This is only partly compensated for by the better herd control required by the new management system.

Present market prices suggest that bullock production will often be more profitable than yearling production. For this reason, the reviewers feel that some of the potential for additional weaner yearling turnoff may be achieved. Industry change will depend on market factors.

Competition for lot feeding space and even live export exists between northern and southern producers. The balance of northern and southern beef industries should not overlook the ongoing wool crisis, the opportunities in Southern Australia, or meat quality (real or perceived [with emphasis on fatness and toughness]) in local and export markets. Considerations of international beef supply are also important.

7. Research and development should be mainly located in the environments where the information is to be used, but often bureaucratic and staffing issues make this difficult. The 4 projects involved here are a good example of how successful a combination of collaborative applied and basic research can be, but the mid term withdrawal of CSIRO illustrated the problem.

One of the issues MRC and others must face is the need to ensure that locations outside capital cities are sufficiently well supported to allow an appropriate level of basic and applied research to continue and to maintain a “hands on” contact with the beef industry.

All the participants in this project are doing some extension. The range of information and opportunities which have arisen from this project and other sources are complex and a great deal of effort will be required to ensure most producers understand the implications. The role of computer models and the type of schools Rod Strachan has described to introduce Breedplan to Queensland producers (ASAP 1992) or the Victorian “Beef Manager” program may be appropriate. In any case, the QDPI and NSWA or other information transfer agencies need to consider the best way to inform producers (NB Technology transfer was not a specific component of this project).

The short time frame of research projects is a serious limitation to their credibility when they are dealing with applied research. One suggestion is that the MRC and appropriate producer groups co-supervise a limited number of long term research herds on public facilities. To the extent that basic research provides an understanding of the mechanisms involved, this may explain some of the variation in response between years as well as opening up new areas for applied research. The review team strongly supports a balance between good science and the attempted short term demonstration of commercially relevant results.

Budgetary Considerations

1,JCU The resignation of Keith Entwistle will have significant effects on both JCU and the QDPI due to the collaborative work involved. The upgrading of Mr Fitzpatrick's position as recommended (point 8) until 30/07/94 will cost an extra $73,000. The review team strongly recommends MRC fund Mr Fitzpatrick's position.

2.NSWA The NSWA wishes to extend their lease until the end of October at a cost of approximately $5,000. Their advisory officers have also suggested that around $11,000 be spent on extension material such as videos.

Dr Hennessy has indicated that the additional leasing costs will be met by the NSWA. The review team agrees that this additional time is important to allow calving to occur this year (bearing in mind the severe effects of drought in the first years of the project).

The review team would like to recommend that the project participants plan a technology transfer program for the whole project. This would involve preparing video footage etc. while the various projects are still running . This should be the subject of further negotiation, however the cost of the total program is likely to be more than $11,000.

8. Future Co-ordination and Management

The review recommends that Mr G. Fordyce be the new project co-ordinator because he has been closely involved with the program since its inception, has a major role in the research program at Swan's Lagoon and with JCU and CSIRO collaborations, his appointments with QDPI is presumably permanent and also involves extension responsibilities.

The project now faces a difficult time with the project co-ordinator, Professor Entwistle moving on and the CSIRO Townsville group closing down. These changes need not affect the overall project in terms of achievements and milestones etc. but mean a smaller group of people will be interacting. The co-operation between the various institutions and the shared use of resources and interdependence has been an important aspect of the work to date. Professor Entwistle's departure would seem to leave JCU in a potentially difficult position, particularly if there was any delay in filling this position or any change in the role of this position within the University. The review therefore recommends that the hiatus should be partially covered by upgrading the appointment of Lee Fitzpatrick from part time research fellow from January 1993 to the end of his current appointment on 30 June 1993 with an extension of a full time appointment for a further 13 months until 31 July 1994 to enable completion of all projects tasks and submission of a final report.

Appendix - Report on projects reviewed during the review (to be read in conjunction with material handed out during the review).

**DAN 44**

Project Objectives

By June 1994, demonstrate for the Northern Rivers district of NSW cost effective supplementation strategies to achieve weaning percentages of a least 80% of breeders joined to produce weaners by 6 months of age weighing 200 kg.

Background

These subtropical areas tend to calve earlier in order to allow the weaned calves to be sold off to more favourable areas for finishing. This marketing requirement puts the cows under considerable nutritional stress in late pregnancy and early lactation. Previous work at Grafton has demonstrated the benefits of Brahman cross in this environment and also that a response to protein can be expected in Hereford cattle. This experiment is looking at the question of how much supplement should be fed to provide an economic response.

This is a large applied experiment which addresses all three (ie. lactation anoestrus, heifer fertility and calf output) of the tasks identified in the overall project. It is the only project in the series which includes genotype as an experimental treatment.

Report

This project commenced in 1989 and the final report is due in 1993. This is a short time for a field experiment of this nature where seasonal effects can have a major influence on the result.

The use of leased sites around the district should increase the credibility of the results.

The review team felt that this was a well managed, large trial and that the interim results indicate interesting, industry relevant results. The final results will need to consider site differences in both pasture quality and cattle performance and also consider the economic assessment of the whole performance, as opposed to the partial budgets presented which only consider calf output. Dr Hennessy and Mr Farquharson were well aware of these points and were planning to cover them when more results were available.

The good response to a moderate level of protein supplementation in Hereford cows, the lower response in Brahman Hereford cross cows and the lack of response in Brahman cows is of interest to southern store cattle buyers.

The adverse seasonal conditions experienced during this trial which resulted in early weaning of calves in December 1991 has a considerable influence on the results of such a short term experiment.

Variations sought. The group wish to extend the lease on the experimental site until the end of October 1993 to allow a calving rate assessment of the 1992 mating and time to carry out economic evaluations. This is estimated to cost $5,000 and will be met from NSW Agriculture resources. This group has requested that the completion dates of milestone reports 11 and 12 be extended to 30/01/93. Allowing more time for assessment of results and economic analysis seems reasonable, particularly in the light of the seasonal difficulties experienced.

The experiment so far has utilised heifers and young cows. Questions of lifetime productivity and difficult levels of supplements for different age classes of cows could be usefully addressed in the future.

NSW Agriculture advisory officers are using the sites and results for extension purposes. They have suggested that MRC be approached to fund a Technology Transfer package from this project. They estimate this would cost around $11,000 for videos and pamphlets, etc. While this may increase the rate of adoption in the northern rivers area, the review group felt this aspect was outside their terms of reference and potentially the subject of further negotiations between MRC and NSW Agriculture . A more realistic request might be to develop an information package based on the whole project (ie. including the Queensland components as well).

**DAQ 62 UNQ 9 CS 120**

Objectives

i) By June 1994 to have evaluated a range of cost effective management nutritional and hormonal strategies which will enable north Australian cattle producers to achieve 75% conception rates from matings of maiden heifers and lactating cows.

ii) Quantify the consequences of early weaning and creep feeding on female fertility in continuously mated herds in the dry tropics and develop strategies to optimise animal and economic responses to these management practices.

iii) Develop and evaluate strategic supplementation and hormonal feedback controls which may economically improve conception rates of maiden heifers and lactating cows prior to the end of the wet season in northern Australia by an average of 20% units and reduce out of season conceptions.

Background

These 3 projects are closely integrated with the main experimental sites being Swan's Lagoon and Brian Pastures with QDPI, Fletcherview and Douglas with JCU and Landsdown Davies and Rendel Laboratories with CSIRO. CS 120 has already been terminated and a final report submitted to MRC.

Report

The collaborators chose to define a large number of specific tasks within this project which could be grouped into 3 major themes. These themes were lactational anoestrus, heifer fertility and calf output. Another way of looking at the project structure was to consider it in three components.

1) Management - Early weaning/suckling effects (short and long term influences on growth and fertility)

2) Nutrition -Supplements, spike feeding, creep feeding, specific nutrients, pre mating growth patterns

3) Hormonal - Oestrogen feedback (androstenedione vaccination), melatonin, suckling, oestrus suppression

In this section we will briefly review the experimental results presented to the review team.

Age at First Mating

Experiments at Brian Pastures and Swan's Lagoon have examined the feasibility of supplementary feeding heifers to encourage yearling mating. At Brian Pastures under drought conditions the yearling mating treatment was not particularly successful, probably because the heifers although supplemented did not achieve satisfactory weights. The intermediate mating age coupled with early weaning did allow high conception rates at the second mating . This intermediate first mating age is only likely to be feasible in some more favoured areas. At Swan's lagoon in a controlled mating situation, yearling mating with a high level of supplementation feeding can achieve a 50% conception rate. A lower level of supplementation may result in slightly lower conception rates but a more economically favourable results.

Weaning Supplementation

The program on weaner supplementation as Swan's lagoon is large and complex involving 5 year groups of heifers allocated to a total of 12 treatments. These treatments include weaning age, supplementation and androstenedione vaccination and at age mating. The data clearly confirms the hypothesis that enhancing growth during the dry season following weaning will increase conception rates of 2 year old heifers. The practice of early weaning necessitates dry season supplementation and it is important to start early and not allow the calves to slip. A weight gain of 0.2 kg per day is required to advance pre pubertal development. There was a relationship between liveweight at mating and pregnancy rates. In lighter heifers supplementation as weaners increased liveweight at mating and hence pregnancy rate and in addition, at any weight, animals originally fed had a 20% higher chance of conceiving. These effects of weaner feeding were important in allowing animals to achieve puberty in order to conceive at the desired time. There appears to be no carry over effects on fertility at later ages (ie. on post partum anoestrus).

The heifer work at Swan's lagoon also involves steroid vaccination in collaboration with Dr M. D'Occhio of CSIRO. Vaccination is aimed more at understanding the endocrine mechanisms associated with puberty than immediately leading to a successful treatment. There is evidence that vaccination advances puberty but more importantly vaccination allows the expression of elevated progesterone levels between weaning and 12 months of age. These were associated with large ovarian follicles but no luteal tissue (ie. the source of progesterone is not clear). After a period of fluctuating but high levels plasma progesterone levels then fell to low levels until puberty.

Pre Partum Supplementation

Spike feeding research builds on NAP1 results, showing that pre partum feeding increases post partum ovarian activity. It is difficult for southerners to appreciate the degree of anoestrus seen in Brahman type cattle in the dry season. The work on research stations and at producer demonstration sites seems to have lead to a consistent description of the circumstances under which spike feeding will work.

Creep feeding has been based on the preliminary observation at CSIRO that if calves drain less milk from the dams and this could stimulate re-breeding. Over 2 years, creep feeding has failed, primarily because the calves failed to eat enough of the creep feed offered. This approach is not going to be continued.

Wet Season Nitrogen Supplementation

This approach is being tried because of successful results in the Northern Territory, an apparent reduced response to Phosphorus supplementation since the P source has changed from MAP, and some rumen ammonia nitrogen measurements which are sub optimal.

Integration of the components

One of the key aspects of the program at Swan's Lagoon was the successful large scale demonstration of simple management strategies. Essentially these involve early weaning and correctly feeding these weaned calves leading to high conception rates at desirable times of the year hence higher calf output and lower breeder losses.

At Fletcherview and James Cook more detailed studies on the reproductive/endocrine/nutritional metabolic effects were underway. These involved looking at nutritional depletion experiments stimulating moderate or severe dry season weight losses then allowing repletion to stimulate normal wet season. There were effects of these treatments on progesterone levels and on response to GnRH challenge but no obvious effects on ovarian follicular development. There were also experiments looking at nutrition and supraphysiological levels of oestradiol on LH feedback mechanisms.

Melatonin supplementation has been tried in a series of experiments but has failed to stimulate reproductive performance. Based on a small pilot trial this seemed to be a worthwhile hypothesis to check. (It may need rechecking in a southern environment where mating occurs in winter).

The endocrine and ultrasonic techniques in use at JCU present a real opportunity to understand the reproductive physiology of cattle. This level of understanding is required to form the basis for management programs in Northern Australia and will also be very relevant for other areas.

The CSIRO program, now terminated, has concentrated on nutritional and metabolic studies of Brahman cross cows and their calves. Detailed studies of pre and post weaning supplementary feeding effects on body composition and metabolic changes including portioning of nutrients into foetal growth and mid production. The northern perspective focuses attention on the conditions under which early weaning will increase reproductive capacity. At least crudely this can be determined by liveweight at weaning time. This is modified by nutritional effects and it is clear that there are important differences in efficiency and partitioning of energy and protein depending on the supplement supplied. One of the important conclusions was that weaning effects were not simply due to an increased availability of nutrients to the cow. The CSIRO project provided a large amount of very detailed metabolic information much of which indicated surprisingly good homeostasis.

Work on suckling effects was also interesting since the relationship between anoestrus interval and calf growth rate was curvilinear and high calf growth rates were associated with shorter anoestrus intervals. This was a suckling behaviour effect since increased suckling duration was the response which led to the creep feeding experiments.

Studies at JCU on the effects of nutrition on ovarian response in anoestrus cows suggested that several mechanisms may be involved viz - in well fed cows there were oestrogenically active functional dominant follicles suggesting that anovulation was due to failure of mechanisms governing final follicle maturation and ovulation while in poorly fed cows there were few medium and large follicles and more oestrogenically inactive follicles and thus anovulation was due to the inhibitor of mechanisms responsible for follicle recruitment and selection. Understanding of these problems would be extremely helpful in superovulation programs as well as lactational anoestrus and the development of puberty.

Understanding the endocrinology of post partum anoestrus will require an understanding of how genotype, season, nutrition and suckling impact on oestradiol negative feedback. Two ways to effect this are either to reduce endogenous $E_2$ by androstenedione vaccination or by desensitising hypothalamus to $E_2$ negative feedback. (Lee Fitzpatrick suggested the latter may be the mechanism involved in spike feeding). A series of experiments are underway to investigate this.

Early weaning of cows clearly is as important tactic to increase the reproductive performance of the breeder herd. CSIRO has undertaken a fairly detailed study of the nutrition of these weaned calves. Again from a Southern Beef Production perspective weaning claves at between 50 and 100 kg liveweight is a major challenge. The problem lies in the intake limitations of these small calves, the aim is to achieve at least a moderate growth rate and the need to minimise ration costs. A series of experiments has been carried out. Some of the major conclusions are that weaning down to 50 kg (or about 2 months of age) is possible but the calves will need pellets, at around 100 kg the calves can be treated as normal weaners and a protein supplement will usually suffice. Experiments have dealt with level of molasses in the ration, use of monensin, alkali treated grains etc. The point to remember is that these early weaned calves probably need high quality pastures, but only relatively small areas and the appropriate level of concentrate supplement in relation to body weight and pasture type. Further work on supplements for dry season pastures is required. Many producers will need to consider infrastructure development to carry this out well. Nevertheless many other producers have adopted this technology successfully already.

An area of proposed work which looks economically attractive but has not been attempted is technology to suppress oestrus during the second half of the year in continuously mated herds. A number of approaches have been considered, including Vaxstrate® which has turned out to be not very useful. This area is really looking for new technical developments suiting the severe management limitations in the region.

A considerable effort has already been put into considering the economic consequences of any proposed management changes. The availability of models such as BREEDCOW and DYNAMA have allowed whole herd assessments to be made. These models seem to generally indicate that Bullock turnoff is more profitable than yearling turnoff. They also indicate that much of the increase in returns is due to improvement in survival rates of cows not fertility. The most serious consequence of this is that an increase in the proportion of cows in the herd greatly increases the risks associated with adverse seasons.

Modelling so far indicates quite early returns to changed management procedures (this is due to increased female sales).

Any prediction of economic returns must consider future markets. Much of the discussion is based on the idea that young stock will be moved to more favourable environments for finishing leaving the northern areas for breeding operations. This conclusion is speculative but none-the-less attractive in the long term. The present high level of store turnoff is influenced by drought conditions and financial stress (ie. people may go back to producing a higher proportion of bullocks). An increase in lot feeding in the south would require store cattle prices to fall. This in turn would mean that store production systems would need to improve reproduction and reduce mortality. Risk management would be a major part of nay management system. The group has indicated that vertical integration of properties is a major factor occurring within the industry. Another factor is the turnoff of breeding heifers and feeder steers to the Asian markets.

In terms of transferring information to the industry the integrated nature of the project is a major advantage. All the people involved in the project have been involved in technology transfer but the major thrust has been through the QDPI and the NSWA extension staff. The project has a substantial post graduate training program associated with it. Internationally it is one of the few groups working in the tropics with *Brahman* cattle.
Individual producers and producer demonstration sites have allowed the industry to become involved in the project and it was felt that there was a wide general awareness of the project.