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Northern Australian Beef Fertility project – Wean-a-calf

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Abstract

Following a series of project team meetings and meetings/consultation with Regional Beef Research Committee's (RBRC's) in northern Australia during the second half of 2006 and early 2007, the final draft of the Northern Australian Beef Fertility Project application was submitted to MLA in April, 2007.

Executive Summary

This project was initiated to enable the comprehensive planning and industry consultation required to develop a full research application to be submitted to MLA early in 2007. A comprehensive assessment of the logistics of conducting this very large project was made. A list of potential co-operating veterinarians was established and a number of crush-side data capture systems assessed and quotes for their implementation in the planned research received. Critical feedback from a range of industry stakeholders and collaborating researchers was collated and incorporated into the final research application. The net benefit for industry was submission of an accurately costed comprehensively planned research project application.

Contents

1 Background

During 2005 as part of the Northern Beef Programmes strategy development a series workshops were held with regional industry stakeholders, the Northern Pastoral Group and researchers. Producers ranked beef cattle reproduction equal third in the ranking of priority issues. However it was recognised that there was a serious lack of data on what were achievable levels of breeder mob reproductive performance by broad geographic region, and how much of the variation in mob reproductive performance could be explained by known factors.

A recently completed MLA funded project (NBP.336) concluded that if northern beef cattle producers achieved breeding mob pregnancy rates per cycle of 65% and perinatal losses of <10%, the direct benefits to their businesses could be of the order of $15M per annum. There has been no systematic study of the reproductive performance of breeding herds in northern Australia or of the factors affecting performance. Rather there have been a number of case studies and producer surveys which although providing some very useful data are limited in their application to the industry as a whole.

In mid-2006 the Northern Beef Programme held a meeting with selected beef cattle reproduction researchers and epidemiologists to discuss the logistics of conducting a large scale research project to define and quantify the factors affecting breeder mob reproductive performance and what were achievable levels of performance across northern Australia. A project development team was subsequently established to develop a full research application to be submitted to MLA.

2 Project Objectives

The Consultant will achieve the following objective(s) to MLA's reasonable satisfaction:

By 28th February 2007: a detailed, full project proposal for Northern Australia Beef Fertility Project (Wean-a-Calf) completed.

3 Methodology

A series of project development meetings were held leading to the development of a preliminary proposal which was submitted to MLA in October, 2006. A series of telephone and face to face meetings were held with the members/ chairperson of the majority of RBRC's to discuss the projects objectives, logistics of carrying out the project and the benefits to the industry. This generated extensive feedback which was synthesised and incorporated into the full application.

4 Results and Discussion

Major outcomes of the project development were:

1. identification of a group of some 36 cattle veterinarians from across all regions of northern Australia which were, a) prepared to participate in the study, and b) provided a beef reproductive management service to clients who also would be prepared to participate in the study
2. identification of several electronic data capture systems which had the capacity to capture the data required by the project

5 Success in Achieving Objectives

The application for funding of the Wean-a-calf project was submitted in April 2007, was considered by the NBP and MLA board in May and has subsequently been approved and funded by MLA.

6 Impact on Meat and Livestock Industry – now & in five years time

The detailed planning which has been put into the development of this project has the laid the foundation for the long-term delivery of the project objectives and thus the benefits to industry which have been outlined in the project application (Appendix 1).

7 Conclusions and Recommendations

This project development project has enabled the timely submission of a fully costed, comprehensively detailed research application to MLA. The scale and the complexity of the project (154 breeding mobs consisting of some 96,000 head) required significant dedicated time to be put into the project development by researchers, cattle veterinarians, DPI officers and producers.

8 Bibliography

The following MLA final reports and ongoing projects (*) were used in the preparation of the research application:

- North Australia Beef Producer survey 1990 – O'Rourke, Winks and Kelly (1992)
- Minimising pregnancy failure and calf loss – Fordyce, Burns and Holroyd (2006)
- Improved diagnosis of reproductive disease in cattle – Lew et al (2006)
- Impact of infectious disease on beef cattle reproduction – Kirkland et al (2007)*

9 Appendices

9.1 – Full application for the Northern Australian Beef Fertility project – Wean-a-Calf

PART 2: FULL APPLICATION FORM

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9.1.1.1.1

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PROJECT

Project Title

Northern Australian Beef Fertility Project – (suggested 'badging' - Wean-a-calf)

Background of Research Work

A recently completed MLA funded project (NBP.336) concluded that if northern beef cattle producers achieved breeding mob pregnancy rates per cycle of 65% and perinatal losses of <10%, the direct benefits to their businesses could be of the order of $15M per annum. There has been no systematic study of the reproductive performance of breeding herds in northern Australia or of the factors affecting performance. Rather there have been a number of case studies and producer surveys which although providing some very useful data are limited in their application to the industry as a whole. Further the current lack of a common 'language' to describe performance of breeding mobs prevents accurate comparisons between mobs, properties and regions.

The causes of sub-optimal reproductive performance in northern Australian beef herds are multi-factorial. However, although our knowledge of specific causes of lower than expected/predicted performance has improved considerably, quantification of the contribution of each to the overall performance of breeding mobs and herds is lacking. The latter information is critical to enable producers to be able to focus management changes and investment on those factors which have been shown to be contributing most to mob/herd reproductive outcomes. This information is also needed to guide investment by research funding agencies, e.g if 75% of the difference between mobs/herds can be explained by known factors then investment should target technology transfer or development of improved approaches to managing these factors; however if only 30% of the difference can be explained then investment should target further research to define the causes and factors associated with sub-optimal performance.

In northern Australia over the past 25years there have been considerable improvements in nutritional and herd management practices which have resulted in improvements in branding rates of the order of 15%. The results of a recently completed MLA study (NBP.336) of a sample of commercial and research station herds found that the established pregnancy rates per cycle ranged from 40 to 70% indicating some herds are achieving physiological targets of performance. However the economic benefits of improved conception rates can only be realised if there is minimal losses between confirmed pregnancy and weaning. Data from case studies conducted in northern Australia indicate that losses between confirmed pregnancy and weaning in heifer herds of 15% to 20% and 5% to 10% in cow herds are not uncommon. Although in some cases the causes of these losses have been determined, the relative contribution of each cause to overall loss at an industry level **has not** been defined. A recent study by Brown et al (2002) found that only 79.2% of Brahman heifers (n=207) on a pastoral company property on the Barkly Tableland successfully raised a calf, with 63% of the losses being perinatal loss, primarily due to dystocia, mismothering and unknown causes. Even where appropriate, good quality foetal and maternal samples have been submitted to comprehensive pathological and microbiological investigation a definitive diagnosis of the cause of perinatal mortality could only be obtained in about 50% of cases.This proposed project will use epidemiological analyses to identify the risk factors significantly associated with perinatal mortality, and these findings will then be used to design studies to improve our ability to define the causes of these unexplained losses.

The planning and design of this proposed project has utilised the findings from the following MLA funded projects:

- North Australia Beef Producer survey 1990 – O'Rourke, Winks and Kelly (1992)
- Minimising pregnancy failure and calf loss – Fordyce, Burns and Holroyd (2006)
- Improved diagnosis of reproductive disease in cattle – Lew et al (2006)
- Impact of infectious disease on beef cattle reproduction – Kirkland et al (2007)

9.1.1.1.2

9.1.1.1.3 Project Description

The proposed project has been designed to answer 2 key questions:

1. Why do some breeding mobs have good reproductive performance, and others significantly poorer performance
2. Why do some breeding females readily conceive and wean a calf , whilst other either take significantly longer to conceive and/or fail to wean a calf

A 4year prospective population-based epidemiological study of region-, property-, mob-, and animal-level factors affecting the reproductive performance of breeding mobs is proposed. A selected population of commercial properties will be enrolled. A pilot study will be conducted to inform the design and management of the population-based study. Heifer mobs from two properties from the seven major beef breeding regions of northern Australia will be enrolled (n= 14) in this study, which will enable evaluation of the data capture systems and establishment of the project database. The pilot study (Study I) will monitor reproductive performance of females from enrolment at pregnancy testing (1st round muster or after bull removal) through to weaning (1st round branding muster the following year). It is envisaged that all the pilot study herds will continue to be monitored as part of the main population-based study (Study II). Study II will monitor performance of 154 mobs of breeding females from enrolment at pregnancy testing through to weaning of their second calf or culling, in the case of those that fail to conceive or calve.

This project will have strong linkages with relevant Beef CRC projects (e.g the Lifetime Female Reproductive Performance project) and other related MLA funded projects such as the proposed study of variation in post weaning liveweight gain. The Beef CRC breeding mobs are located in 4 different sites broadly representative of northern Australian environments and the females in these mobs are examined by transrectal ultrasonography approximately once a month from calving to subsequent calving. Breeding females in these mobs will be monitored for six calvings. It is proposed that the reproductive performance data and recorded risk factors from these mobs be subjected to epidemiological analyses as part of this project. The intensive monitoring of the Beef CRC mobs enables very accurate estimates of the timing, magnitude and impact on subsequent performance of post partum anovulation, late embryonic mortality and perinatal mortality. This data will be able to be used to construct models to more precisely define the outcomes in the commercial mobs which can only be monitored twice a year. In addition analysis of the Beef CRC data will enable more informed interpretation of findings from Study II.

During the project an evaluation will be made of the usefulness of analysing existing data bases likely to contain the findings of examinations similar to those that will be used in Study II. One important outcome of this retrospective analysis could be an improved understanding of the magnitude of annual variation in reproductive performance of mobs for which there has been no changes in management.

Objectives and Outcomes of Project

Objectives

By November 2011

1. Define reproductive performance in a selected population of northern Australian commercial properties (study population) over 3 consecutive years using a range of measures. The primary level of selection will be at the property, and the main unit of analysis will be the 'mob'.

2. Establish outcome measures for monitoring and comparing the reproductive performance of breeding mobs and properties in northern Australia.

3. Define typical and achievable performance using (2) in the study population.

4. a) Estimate variation in reproductive performance at animal-, mob-, property- and region-level.

   b) Identify causes of variation in reproductive performance between animals, mobs, properties and regions.

   c) Quantify the proportion of variation explained by identified risk factors.

   d) Identify those risk factors which explain the greatest amount of the variation between mobs, properties and regions.

5. Develop cost benefit framework to estimate the economics of changing the major mob-level factors affecting reproductive performance.

6. Make recommendations on:
   - A benefit cost study to assess the production and economic impact of changing well defined inputs and management practices that affect key risk factors.
   - Extension priorities for changing well defined inputs and management practices that affect key risk factors
   - Research priorities for inputs and management practices (that affect key risk factors) for which the impacts are not well defined.
   - The feasibility of establishing strategic ongoing reproductive performance monitoring 'systems' to enable the longitudinal evaluation of the impact of implemented changes in management practices and inputs.

Outcomes

The project will establish achievable levels of breeder mob reproductive performance by broad geographical region and management system. New, readily derived, unbiased measures of overall performance of breeding mobs will be developed to enable producers to accurately monitor herd performance and determine when changes in management or inputs maybe required. These new measures will be related to current commonly used measures to facilitate adoption by producers and advisors. A practical system for the crush-side electronic capture of data will be established, and a range of analytical tools developed to support decision making about management of mobs/groups of cattle.

The major factors affecting the reproductive performance of breeding mobs will be defined and the relative contribution of individual factors and groups of factors to variation in performance quantified. The impact of changing key drivers of breeding mob performance and controlling major mob-level factors affecting performance will be assessed enabling the development of economically based decision support tools to improve the reproductive performance of Northern Australian breeding herds.

The project will create a unique industry owned database which will enable producers and their advisors to accurately determine the impacts of changing or manipulating reproductive management. This database should be available for interrogation by funding agencies, researchers, producers and their advisors to inform

decision making within the northern Australian beef industry to 2020.

Method

Project management

Study design, execution and reporting will be the responsibility of the project management team which will receive inputs from the project advisory committee.

The project management team will consist of:

- the project leader (Professor Michael McGowan) who will have primary responsibility for financial management of the project and submission of milestone reports as well as input into the study designs and interpretation of findings
- the project manager (Sandi Jephcott) who will be appointed to co-ordinate each of the studies with primary responsibility for execution of study protocols, data capture and collation and preparation of reports
- Drs John Morton and Nigel Perkins who will oversee study design, epidemiological analyses and interpretation of findings
- Kieren McCosker from the Northern Territory Department of Primary Industries and Mining, Katherine Research Station will co-ordinate and support data capture in the Kimberleys, Victoria River District and Barkly Tableland and will be responsible for conducting much of the analyses in Study I & II as part of his Phd programme. The proposed title of his thesis is, 'Risk factors affecting the percentage of wet cows pregnant at first round muster in continuously mated herds'.
- Associate Professor Dennis Poppi who will advise on assessment of the nutritional status of mobs and interpretation of findings and identified associations
- Dr Bruce Hill who will advise on aetiology of reproductive losses and the component of study design and data capture related to perinatal losses
- Dr Kishore Prayaga who is the project leader for the Beef CRC Female Lifetime Productivity Project
- Geoff Fordyce who will advise on study design, the logistics of data capture and specifically additional mob- and cattle-level factors which may be able to be investigated in the Beef CRC breeding mobs
- Dr Brian Burns who will advise on assessment of possible genetic impacts and interactions
- Nominated MLA project liaison person(s)

The project management team will meet formally twice a year in conjunction with the annual scheduled meetings with co-operating vets and the Northern Beef Program Industry Committee (NBIC). The NBIC will be provided with an annual project progress report prior to their scheduled annual meeting with feedback from this meeting being discussed at the following project management team meeting. It is anticipated that specific study meetings would be held approximately monthly, or as required. In addition, the team will receive inputs from consultants specifically to assist with electronic data capture systems and statistical analyses.

Power analyses to determine number of mobs and breeding females to be enrolled in Study II

The outcome measures which were assessed were, a)the proportion of wet cows at either first round muster or branding muster which had conceived in the first 2 to 3months after the bulls were put with the females or after the occurrence of a significant improvement in pasture quality and quantity sufficient to enable a significant number of females to commence cycling, and b) the proportion of replacement heifers which became pregnant in the first 2 to 3 months after bulls were added to the mob.

Mob-level exposures

Wet Cows – assume standard deviation (SD) of 0.11 (i.e. 11%)
The number of herds required to have 80% power (generally accepted level of power for this type of epidemiological study) to detect as significantly (P < 0.05) different mean differences ranging from 2.5% to 10% for the above outcome measure are shown below:

Difference between means %	mobs exposed[a] %	No. mobs required
2.5	10	1700
2.5	50	610
5	10	430
5	50	154
10	10	110
10	50	42

[a] for example mobs using or not using a management practice such as early weaning or a disease control measure such as vaccinating against vibriosis

Heifer mobs may have smaller SD so would require smaller number of mobs enrolled. Using the above findings, enrolment of 154 mobs
into Study II would enable small effects (around 5% differences) of factors common to these mobs to be detected. However power to detect less common (around 10% of mobs exposed) mob-level factors will be lower. Study II will enrol 2 mobs from each of 77 properties, 36 from southern and central Queensland and 41 from far north and west Queensland and the Northern Territory and northern Western Australia. While this should provide adequate power for common property level exposures such as mating practice there will be only moderate power to detect region–level effects.

Cattle-level exposure

Number of animals required if the study is to have 80% power to detect as significant (p < 0.05) a difference between cattle either exposed or not exposed to a factor and where the actual proportions of cattle pregnant vary between 52.5% and 90% are shown below:

Cows/heifers exposed %	Proportion exposed[a] %	Pregnant not exposed %	Total no. cows/heifers required
10	-	52.5	34840
50	-	52.5	12550
10	50	55	8670
50	50	55	3130
10	50	60	2130
50	50	60	776
10	80	85	4840
50	80	85	1812
10	80	90	990
50	80	90	398
10	80	85	20890
50	80	82.5	7652

[a] for example females lactating or dry

Based on the above analysis, power to detect cattle-level effects will be very good given the estimated number of breeding females to be enrolled in Study II will be approximately 96,000 head.

Property selection

The proposed outline of the numbers of properties by region and the potential co-operating veterinarians is presented in Table 1. The regional divisions have been modified from the 1990 North Australia Beef Producer. It is proposed that a total of 77 commercial beef cattle properties across Northern Australia be enrolled in the project. The co-operating veterinarians selected are those that are currently providing a pregnancy diagnosis/herd health service to producers, are willing to participate in the project and are accredited members of the Australian Cattle Veterinarians National Cattle Pregnacy Diagnosis Scheme - members must pass a practical exam in which they accurately assign cattle according to their pregnancy status and stage of gestation. The use of cattle veterinarians with demonstrated skills in foetal aging is critical as this data will be used to estimate conception and calving dates.

Table 1 Outline of number of properties per region, and list of veterinarians who have agreed to participate in the study

Region	No. properties per region	No. mobs per property	Prop per vet	Property Veterinarians
Victoria River District/Kimberley	8*	2[a]	3 – 5	Peter Letchford (Kununurra); Tony Hayne (Darwin)
Tennant Creek /Barkly	5*	2[a]	5	Ian Braithwaite (Mount Isa)
West Queensland	10**	2#	2 - 3	Peter Johnson (Longreach), Michael Flynn (Charleville) ; Paul Vetter (Charleville)
North West Qld	10**	2[a]	1-5	Ed Butterworth (Mount Isa); Lindsay Alllen (Cloncurry); Glenn Kenneally (Charters Towers);
North Qld	8**	2[a]	2 – 3	Libby Lynch (Charters Towers); Ian Hosie (Malanda); Brad Pullen (Mackay);Geoff Fordyce
Central Qld	20**	2#	2	Alan Guilfoyle (Clermont); Rod Howard (Roma); Colleen Buckley (Roma); Ian Tucker (Rockhampton); Christine Powell (Taroom); Annie Donoghue (Monto); Carole Meurant (Willows Gemfields); Carlie Ward (Dingo), Andrew Morley (Moura); Alec Breckenridge (Theodore)
South Qld (incorporating South/South East)	16***	2#	1-2	Chris Goodwin (St George); Chris Braithwaite (Murgon); Ian McInnes (Monto/Gayndah); Peter Atkinson (Allora), Sandi Jephcott (St George); Greg Cavanagh (Gympie); Anna Gates (Goondiwindi); Libby Egan (Dirranbandi); Mac Kneipp (Goondiwindi); Dave Thompson (Killarney); Kylie Schooley (Mundubberra); Kathryn Webb (Nanango); Kirstin Widderick (Stanthorpe);

* 3,000 to 20,000 breeders per property [a] 300 to 1000 females per mob

** 500 to 10,000 breeders per property
*** 200 to 1,000 breeders per property # 100 to 500 females per mob

Key selection criteria will be that the property owner/manager is keen to participate in the study, and prepared to fully support and facilitate the capture of all required data (see appendix 1 for detailed outline of property selection criteria). Given that approximately 80% of properties north of the Tropic of Capricorn continuously mate, then for each of these regions only one property which uses a restricted mating period in the cow herd will be selected per region. For regions south of the Tropic of Capricorn at least 60% of the properties selected should mate both their cows and heifers for a restricted period. The owner/manger should be prepared to provide an undertaking that the mobs initially recruited will remain on the property for the duration of the project, which for the Study I mobs will be 4years and for the Study II mobs is 3years. The properties selected should be typical of cattle properties within their region with respect to pastures and herd management. Only properties which are clients of the selected project veterinarians and have their veterinarian pregnancy test their mobs at least annually will be selected.

As the findings from previous MLA funded research in northern Australia has shown it is not uncommon to find incidences of subfertile/infertile bulls in breeding mobs of 30 to 40%, co-operating producers will be requested to muster all bulls to be mated to each breeding mob prior to the first mating period of the Studies I & II, to enable breeding soundness examinations (BSE) to be carried out – in subsequent years only replacement bulls added to the bull mob will undergo a full BSE, with previously examined bulls undergoing a physical exam only unless otherwise indicated.

Mob selection

On each selected property one mob of replacement heifers and one mob of cows (may include parity 1 females) will be selected in Year 1. All cattle in both mobs will be primarily of the same breed or breed composition and be electronically identified. In Year 2 a new heifer mob and the previous years heifer mob (now parity 1 females) which may or may not have been added to a cow mob will be monitored. In year 3 the heifer mob from Year 2 and a cow mob (containing ≥ Parity 2 females) will be monitored. For continuously mated mobs the mob must be able to be mustered at least twice a year at an interval of approximately 6 months for pregnancy testing and wet/dry examination. Mobs mated for a restricted period must be able to be mustered at least three times, for pregnacy testing after the bulls are withdrawn, for pregnancy testing and wet/dry examination at branding and for wet dry examination at weaning. Only mobs using exclusively natural mating will be recruited. Wherever possible an estimate of the previous reproductive performance of the cow mob will be obtained from property records, as well as the mean performance of the heifer mobs for the last 5 years. It is expected that during the project the mobs selected will achieve reproductive outcomes across the full spectrum observed by the northern industry – *it is just as important to understand how mobs achieve high levels of performance as it is to understand why mobs achieve low outcomes.*

Data Capture

A practical system for crush side electronic capture and collation of reproductive and production data from large numbers of breeding females has recently been developed for northern Australian herds. It is proposed that this system be used for capture of all cattle level data for this project. Co-operating veterinarians will be offered the opportunity to purchase the software and hardware required (special price to be negotiated for both by project management), or the project will fund purchase of these and all participating veterinarians will receive training via a workshops and one-on-one tutoring to enable them to enrol their study mobs using the new system and export the data to the database. However, it is recognised that in some cases it will be more efficient to have an appropriately trained data entry person to capture the data crush-side to enable the veterinary examinations to be carried out quickly and efficiently. The majority of regional-, property- and mob-level data will be captured using standardised templates. This data will then

be electronically (via the web) uploaded to the project database**.** A project electronic network will be established to facilitate secure and accurate uploading of data to the database**.**

To ensure an acceptable level of uniformity between veterinarians in the estimating of body condition score, lactation status, gestational age, conducting bull breeding soundness examinations, selection of sentinel cattle, and collection of samples for infectious disease testing, NIRS and soil testing all co-operating veterinarians will attend a workshop where the project's standard operating procedures for each of the above will be demonstrated and practiced.

Longitudinal monitoring of mating outcomes

For continuously mated herds this will be dependant on how many times a year the selected mobs are mustered. However, given that over half of these properties muster at least twice yearly (O'Rourke et al, 1992) the following monitoring protocol will be used:

- First round muster (April – June) – heifer and cow mobs pregnancy tested by per rectal palpation and stage of gestation of pregnant animals estimated to the nearest month. This data will be used to define conception and predicted calving patterns and proportion of herd confirmed pregnant. A mating start date (MSD) will be estimated from modelling of the conception pattern, monthly rainfall pattern and predicted pasture growth for the paddock. This will enable calculation of the proportion of the mob pregnant by 3, 6, 12, 18 & 21 weeks after MSD. Weighing the weaned and unweaned calves off these cattle and using standard calf birth weight and growth rate data will provide an estimate of the previous calving pattern for each mob. For females diagnosed as not detectably pregnant any palpable reproductive tract pathology will be recorded. The lactation status of all females will be assessed.
- Second round muster (August - November) – heifer and cow mobs pregnancy tested again and stage of gestation of pregnant animals estimated to the nearest month. The lactation status of all cows will be assessed. Palpation of the uterus, external observation of the udder and perineum, and attempted expression of milk will be used to define those females which have either recently calved or recently aborted. In Study II the selected replacement heifer mob will be examined to determine gestational losses and the status of the reproductive tract of those not detectably pregnant – heifers will be categorised as having a palpably normal reproductive tract with or without palpably active ovaries (i.e cycling or not cycling), or an abnormal tract.
- Once the longitudinal monitoring is completed retrospective analysis of the foetal aging and wet/dry data will enable classification of cattle into the following categories; 1. W/D female diagnosed pregnant (E/L), calved and weaned a calf; 2. W/D female diagnosed pregnant (E/L), calved, but did not wean a calf; 3. W/D female diagnosed pregnant (E/L) but did not calve 4. W/D female not diagnosed pregnant – W= wet; D= dry; E = early in breeding season; L = late in breeding season.

For heifer and cow mobs which are mated for a defined period, the timing of the pregnancy test examinations depends on the length of the mating period. If the mob is mated for < 4months then pregnancy testing 6 weeks after the bulls are withdrawn should allow accurate definition of the conception pattern. In addition, when the females are mustered for branding they will also be pregnacy tested to enable estimation of the incidence of pre- and post-natal losses. Mobs joined for longer than 4months will need to be pregnancy tested at branding and then again after the end of mating.

Developing recommended outcome measure for monitoring and comparing reproductive performance of mobs

Different methods of describing the reproductive performance of mobs will be critically reviewed. Sources of bias for individual measures will be identified and the potential effects on estimating performance modelled. Economic models will be used to investigate the usefulness of individual measures in defining mob performance. However, as there is no consensus amongst industry as to a standard measure to define output from a breeding mob several different measures will be used in the economic models, and sensitivity

analysis used to determine which is most correlated with economic performance of a beef breeding enterprise. An example of a mob output measure which may be use is:

Total annual kilograms of beef turned off (determined by summing weaning weights of calves removed at each muster during the period Jan to Dec and any females culled from the herd) divided by total adult equivalents (mean of total weights of females at each muster divided by 450kg) =
Annual kg beef turned off per AE (account will need to be made of additions of breeding females to the mob)

Longitudinal monitoring of cattle, mob, property and region level risk factors

. The risk factors which will be investigated include :

- Region-level – mean annual rainfall, cattle tick status

- Property-level – herd size; primary cattle activity; primary output from breeding herd; joining system used; timing and duration of joining; ownership; duration of present ownership/management; heifer rearing and management practices; culling practices; bull and female replacement practices; mustering practices and mustering efficiency

1. Mob-level – **nutritional factors** - number of females in the mob; paddock area; stocking rate; paddock geography; pasture composition; mean annual NIRS profile (where NIRS is not calibrated, will need to use wet chemistry analysis); difference in NIRS profile wet season v's dry season; pasture condition and estimated dry matter yield end of wet and dry seasons; supplementary feeding practices (timing, types, amounts fed) total annual rainfall and rainfall pattern; annual paddock mortality rate; known mineral deficiencies
   – **bull factors** - bull percentage; bull group fertility ranking (see Appendix 3); incidence of bulls infected with *C.fetus venerealis* and *T.foetus* categorised as either low (< 20%) or high (>20%)*;* source of bulls; bull age; mean bull body condition score; mean change in condition score 1st round to 2nd round; bull vaccination practices (timing of vaccination in relation to commencement of mating, vaccines used, vaccination administration score – based on property protocols for transport and handling of vaccines)
   - **recognised infectious disease factors** - although defining the impact of endemic infectious diseases on mob reproductive performance is desirable it is likely that in only about 10 to 20% of herds that infectious disease is having a significant effect on mob performance. Therefore the approach that will be used in Study II will be to select sentinel groups of cattle (n=30) in each mob which will be sampled at each pregnancy test muster (i.e twice yearly approximately 6months apart) in the first and third years of the study – only samples from mobs with significantly poorer and better reproductive performance than the median for the population will be submitted for laboratory analyses – only serological testing for BVDV , *L.hardjo and pomona* and *C.fetus venerealis* and testing for *T.foetus* has been included in the budget.
   During the course of the project a serological 'bank' will be established at the University of Queensland with samples being able to be accessed for other serological testing on request to the project management team.
   Female vaccination practices (timing of vaccination in relation to commencement of mating, vaccines used, vaccination administration score – based on property protocols for transport and handling of vaccines)

   - **perinatal loss risk factors** - the adaptive characteristics of the mob (estimated Bos indicus content); maximum and minimum daily temperatures during breeding and calving seasons;); origin of cattle; wild dog numbers; evidence of wild dog predation; paddock mustering and/or relocation during calving period; occurrence of environmental disasters (floods, bush-fires etc) mustering efficiency; fence security score; observed occurrence of dystocia;

- Cattle-level – body condition score; lactation status; udder/teat conformation score; age/year brand; breed (in the case of composites the breed composition will be recorded); live-weight and possibly live-weight change; general health status; reproductive tract status; occurrence of peripartal disease

As the project will be conducted over 3 to 4 years it is expected that management changes will occur. At the second round or branding muster veterinarians will review the management of the mob and record all changes, why they were made and when they were introduced.

Data analyses
Data will be analysed using multinomial logistic models and multilevel logistic models with individual animals nested within mobs within properties. Using multilevel models, variances will be estimated at each level and the proportions of variance at each level calculated. Multivariable models will then be constructed to identify risk factors associated with suboptimal reproductive performance and to estimate the strength of association for such risk factors.

Incidence/prevalence of potential risk factors will be calculated and, in conjunction with risk or odds ratios, used to estimate population attributable risks and fractions for each risk factor (or group of risk factors), allowing ranking of each based on the estimated impact on reproductive performance across all study mobs.

Interest (IP proportions)

MLA	75%
Research Organisation	25%

Milestones

Milestone Number	Achievement criteria	Due date
Milestone 1	Final list of co-operating veterinarians, names and addresses of co-operating properties, and breeding mob details (number of females per mob, mating system, joining dates, mustering dates), property and mob survey templates prepared – budget reviewed using these details and report sent to MLA	3months *
Milestone 2	Data capture system and database established and demonstrated to co-operating vets and MLA	6months*
Milestone 3	Study I completed, new measures of reproductive performance developed and report of preliminary analyses submitted to MLA, vets and producers	12months*
Milestone 4	Data capture, checking and descriptive analyses for Year 1 of Study II completed – preliminary benchmarking of reproductive performance - report sent to MLA, vets and producers	24months*
Milestone 5	Data capture, checking, and descriptive analyses for Year 2 of Study II Completed – preliminary report of findings of analyses of mob- and cattle-level risk factors completed and sent to MLA vets and producers	36months*
Milestone 6	Data capture, checking, and descriptive analyses for Year 3 of Study II Completed – preliminary report of findings of analyses of mob- and cattle-level risk factors and benchmarking of reproductive performance completed and sent to MLA vets and producers	48months*
Milestone 7	Final report submitted to MLA	54months*
	* after the project commences	

Nominated Person(s)

Title/First Name/Surname	Professor Michael McGowan
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Project Budget and Funding – Indicative Budget

Wean-a-calf Project budget					
Categories of expenditure	**Year 1***	**Year 2**	**Year 3**	**Year 4**	**TOTAL**
Project management:					
Post graduate student stipend support	14 000	14 000	14 000	14 000	
Part-time project manager	28 000	28 000	28 000	28 000	
Data capture, data collation, database management, training and support	40,000	47000	47000	47000	
Epidemiological consultation	9 000	9 000	9 000	9 000	
Project leadership	6 000	6 000	6 000	6 000	
Advisory committee (5 persons for 1 day p.a)	1500	1500	1500	1500	
SUB-TOTAL	**$98,500**	**$105,500**	**$105,500**	**$105,500**	**$385,000**
a) Second round / branding and preg.testing ($150/hr; avg.50 head/hr first year then 70/hr in subsequent years)					
northern sites (800 head/mob - $2400/$1700 x 82)	24 000	206400	139400	139400	
central sites (500 head/mob – $1500/$1100 x 40)	3000	60000	44000	44000	
southern sites (300 head/mob – $900/$650 x 32)	3150	25200	20800	20800	
SUBTOTAL	**$30,150**	**$291,600**	**$204,200**	**$204,200**	**$730,150**
b) Bull breeding soundness examinations[1] ($150/hr; 4% bulls/mob; 10 bulls/hr) - in year 2 of Study II only about 1/3 bulls will require full BSE, thus time reduced by half					
northern sites (2624 bulls)	4 800	39360	19680	19680	

central sites (800 bulls)	960	12000	6000	6000	
southern sites (384 bulls)	300	5760	2880	2880	
sperm morphology assessments ($10/sample including freight)	1920	38080	12693	12693	
SUBTOTAL	**$7,980**	**$95,200**	**$41,253**	**$41,253**	**$185,686**
c) NIRS monitoring [4 bulked samples/paddock/yr x $48 (analysis $18, freight $30) x 154],chemical analyses where NIRS not calibrated, soil testing	2 688	29 568	29 568	29 568	
SUBTOTAL	**$7,688**	**$ 59,568**	**$ 39,568**	**$ 39,568**	**$146,392**
d) Sentinel animal monitoring for infectious diseases					
(i) Sample collection[2] - 30 animals/mob x 2 samplings/yr x 154 mobs x $5 (consumables, sample processing, freight)		$46200		$46200	
(ii) Strategic serological testing** - 20% of mobs		$93000		$93,000	
SUB-TOTAL	**$0.00**	**$139,200**		**$139,200**	**$278, 400**
e) Travel					
(i) project management travel to sites	5 000	5 000	5 000	5 000	
(ii) 2nd round/branding visit ($1/km)					
northern sites (300km return x 86)[3]	3 000	25800	25800	25800	
central sites (200km return x 40)	400	8000	8000	8000	
southern sites (100km return x 28)	200	2800	2800	2800	
(iii) BBSE visit ($1/km)					
central sites (200km return x 40)	400	8000	8000	8000	
southern sites (100km return x 28)	200	2800	2800	2800	
(iv) Project planning and review meetings ($300 return flight to Rockhampton x 35)	10 500	10 500	10 500	10 500	
SUB-TOTAL	**$19,700**	**$62,900**	**$62,900**	**$62,900**	**$208,400**

f) Data collection and submission (one day/property x twice/yr x 77 x $150)	3 000	23 100	23 100	23 100	
SUB-TOTAL	**$ 3,000**	**$ 23,100**	**$23,100**	**$ 23,100**	**$72,300**
g) Project planning and review meetings (one/yr at Rockhampton)					
1 night accommodation @ $60/person 35	4200	2 100	2 100	2 100	
Lunch @ $15/person x 35	1500	525	525	525	
Time @ $300/day x 27	8 100	8 100	8 100	8 100	
SUB-TOTAL	**$ 13,800**	**$ 10,725**	**$ 10,725**	**$ 10,725**	**$45,975**
ANNUAL TOTALS	**$180,818**	**$787,793**	**$487,246**	**$626,446**	
				Overall Total	**$2,082,303**
* = Pilot study					
** = BVDV AGID ($11.65); C.fetus veneralis ELISA ($9); T foetus PCR ($16); L.hardjo & Pomona ($8.35) sampling and storage cost$5/sample					

[1] These costs may be able to be reduced if producers are prepared to meet some of the costs of the examinations

[2] These costs may be able to be reduced if the samples collected can also be used for other surveillance purposes

[3] These travel cost may be able to be reduced if vets are already visiting these properties to do other scheduled work

Contributors/Other Funds

Funding Breakdown (only if applicable)

Party	Amount of Contribution	Type of Contribution	Amount of Interest in Intellectual Property
MLA	nil	nil	nil
Other Contributors Beef CRC	nil	Access to data base on reproductive performance of CRC breeding herds in northern Australia	nil
Research & Other Organisations (in kind) School of Veterinary Science, The University of Queensland	$27,000p.a	Supervision of post graduate students, study design, publication of project findings	See above
Co-operating property owners and managers	Will vary between properties	Support of data capture	As per standard MLA practice
Co-operating veterinarians	$3,000 1st year, $23,100 2nd to 4th years	Identification and setting up of study sites and gathering of baseline and annual property data	To be determined
NTDPI&M	$47,000p.a for 3 years	Salary for Phd student	As per standard practice for Phd students

Communications and Delivery

Target groups

Group	Total Potential Number of People
MLA members	**Entire membership**
Australian Cattle Veterinarians	**Entire membership**
DPI in Queensland, Northern Territory, Western Australia	**All involved in beef cattle breeding and production**
Beef CRC	**Programme 4**
International beef cattle reproduction researchers	

Awareness/Participation/Adoption Objectives

Due to the scale of the proposed project and involvement of producers veterinarians and advisors from across northern Australia awareness of the project within 2years of commencement will be high. Within 3 to 5years of completion of the project it is expected that 70% of producers and 90% of advisors will be using the new measures of reproductive performance and beef herd output developed in this project. Adoption of systematic monitoring of reproductive performance utilising electronic data capture systems and databases is likely to increase steadily over the course of the project again due to the fact that a relatively large number of properties will be utilising this approach as part of the data collection for the project – expected that 25% of properties would be using this approach within 3 - 5years of completion of project with a further 25% using some form of routine monitoring based on the findings from this project. Development of a system for annual benchmarking of performance is likely with an estimated 50% of producers using the data to judge performance of their breeding mobs. Within 3 to 5 years of completion of the project it is expected that 60% of veterinarians and consultants/advisors will be using the analytical tools developed or derived from this project.

Communication Products/Tools/Services

Using a similar approach to that used in the large epidemiological study of reproductive performance in the Australian dairy herd (funded by Dairy Australia) conducted in the mid '90's, project reports, updates and short papers on particular topics (e.g use of new measures of mob reproductive performance) will be adapted for publication on relevant websites and in appropriate publications. It is envisaged that interactive decision support tools will be developed from the output from the project. The project will develop the methodology for analysing and reporting reproductive performance and a range of statistical models for determining the impact of individual/groups of risk factor(s) on mob performance and the impact of controlling these factors - many of these could be incorporated into commercial packages for use by veterinarians, consultants, producers and managers. Also data and findings form the project will be used to update MLA training tools such as Breeding EDGE. It is expected that a series of internationally refereed scientific papers will be published from the project – some of these will be published as part of the Phd student's thesis.

Cost estimate included in budget? Part only | Yes | | No

Communication/Delivery Channels

It is proposed that a site be created on the MLA website for uploading of project reports, updates and ultimately to enable access to analytical tools created in the project. In addition the findings from related studies addressing factors affecting the reproductive performance of northern Australian breeder mobs could also be placed on this site. This information will also be published in MLA producer news letters, the Australian Cattle Veterinarians (ACV) newsletter, DPI newsletters and would be provided to the major media publications covering beef cattle production in northern Australia. In years 3 and 4 of the project it is expected that field days and producer workshops could be run to discuss the findings of the benchmarking and risk factor analyses. Further over the course of the project it is expected that a series of conference papers will be presented at ACV and AAABG conferences. Participating cattle veterinarians and producers will gain training in the application of an electronic data capture system, application of crush side data analysis programmes to support producer/manager decision making.

Cost estimate included in budget? Part only | Yes | | No

Other Capacity Building

Need to develop an ongoing programme of monitoring of reproductive performance of herds across northern Australia to enable benchmarking data to be generated annually and to also track changes in performance in response to implementation of strategies developed from this project

Cost estimate included in budget? | Yes | X | No

Timelines

The Milestones list when reports from the project will be provided to MLA and then subsequently be adapted/modified for publication.

Appendix 1

10 PROPERTY SELECTION CRITERIA

1. Clients of selected project veterinarians

2. Property owner / manager keen to participate & support the project and capture all required data.

3. Property owner / manager prepared to keep the mobs initially recruited on the property and easily tracked for the duration of the study. Fencing needs to be in good repair and mustering techniques adequate so that at least 90% of each selected can be mustered twice yearly..

4. Property owner / manager keeps reasonable records so we can capture property and mob level data e.g, vaccinations given (what and when); herd structure (age etc); paddock moves; supplementary feeding (what, how much, when); pasture quality and quantity; stocking rates; rainfall data (also other climate data from nearest BOM site); date bulls out & in etc etc

5. Typical of cattle properties in the region, in particular with respect to size, breeder numbers, pastures, herd management (including breed, mating regime) and performance.

6. Commercial breeder properties – exclude studs and fattening or trading properties. For mixed properties, breeder size and income needs to be a significant proportion of the income.

7. Breeder herd is pregnancy tested at least once annually, and the owner / manager would be willing, with financial assistance, to pregnancy test the selected mobs twice yearly.

8. Pregnancy testing facilities (in reasonable working condition) are available

9. Weighing facilities for weaners at least are available.

10. All working bulls have previously undergone a BBSE examination and all newly purchased and bulls following one joining are tested annually. If this has not been done, the participating producer is willing to have it done (at his expense or a subsidized rate?)

11. If NLIS tags are not already in the breeder herd, producer is willing to pay to apply NLIS (EID) tags to all cattle in the selected mobs. The project budget will provide for the electronic capture of the EID in combination with individual data.

12. Mobs available for selection are joined naturally without any artificial breeding

Appendix 2

11 Data to be collected by co-operating veterinarians from each property and mob

Property level	Mob level	Animal level (at each visit)
Owner / Manager & the length of time they have both been in those roles	Paddock ID and area	Cow ID
Exact location – longitude / latitude	Exact location of paddocks (may change year to year) – longitude / latitude	Age
Geographic / rangelands description	Paddock geographic / rangelands description	Breed
Climate - rainfall; where this is recorded on the property; nearest BOM site.	Climate – individual paddocks – may need to set up rain gauges on the paddocks the trial mobs are in, particularly on big properties	BCS (standard amongst vets)
Any recent significant changes to the property	Stocking rate – LSU or AE/ha & per 100ml rainfall. Stock days?	Lactation Status (wet, dry, lost calf or weaner mum – combination of reducing udder and BCS of cow)
Enterprise (eg breeder only; trading & breeding; cattle & cropping; cattle & sheep)		Pregnancy status (incl any comments on palpation of reproductive organs)
Herd size	Mob size	Live-weight
Herd structure / stock inventory – age & number of breeders; no. of bulls; number & age of dry cattle	Mob structure / stock inventory – age & number of breeders; no. of bulls. Changes year to year – culls; turn-off (culls), mortality rates; breeders added	Comments on health of cow
Joining system (controlled – how many months; continuous; breeder segregation)	Length of joining period – bulls in, bulls out	Some blood samples and swabs will be taken
Heifer management – post-weaning; yearling to joining; joining to calving	Records of any unusual occurrence like fetuses found in paddock; weather events	
Bull management	BBSE – fertility of bulls	Bull ID and BBSE assessment results
Genetic strategy – bull & heifer selection	Breed (cow & bull) & any other description of cattle – introduced (origin) or homebred etc	
Culling practices – bulls & cows		
Herd modelling including replacement nos. / % for bulls & heifers		

Main income generator, eg sale of weaners; sale of feeder heifers & steers; turn-off rate; weight gain		
What do they use as their KPI – key profit indicators	Weight of cattle turned off every year (weaners and culls)	
Any significant outside influences, eg RCS		
Mustering practices and efficiency	Mustering efficiency in the mob	
Nutritional / sustainability strategies - pasture management; drought; supplementary feeding	Monitoring of pasture quality & quantity – kg DM/ha at set times of the year (monitor sites); type of pasture; NIRS; wet chemistry	
	External nutrition – supplementary feeding; fertilizer (??)	
Health management – vaccinations; drenches, HGPs, biosecurity	Vaccinations and other treatments – initial; annual boosters etc	
Wildlife (kangaroos, dingoes, goats, feral pigs etc) and their management	Calf predation?	

Appendix 3 Bull group fertility rank

This ranking was devised using the Australian Cattle Veterinarians definition of a fertile bull (a bull is considered fertile if when mated to 50 normal fertile females it is able to impregnate at least 90% within 2 months) and assuming a bull percentage of 2% for a mob of 500 normally fertile females – it has been assumed that each bull in the group will each mate with 50 different cows . The pregnancy rates after a 2 month joining period for the different fertility ranks are as follows:

- Fertile bull group - 90%
- Mainly fertile bull group (9 fertile and 1 subfertile bull[a]) – 86%
- Moderately fertile bull group (7 fertile and 3 subfertile bulls) – 78%
- Moderately subfertile group (4 fertile and 6 subfertile bulls) – 66%

[a] the degree of subfertility for each bull ranged from mild to severe with the estimated pregnancy rate after 2 months being 70%, 50% and 30% for mild, moderate and severely subfertile bulls respectively. The pregnancy rates quoted above are for mobs mated to bull groups containing varying incidences of moderately subfertile bulls or equal numbers of mild, moderate and severely subfertile bulls