# CRCII Project 2.3 ~ Links between the genetics of beef quality and components of herd profitability in northern Australia

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## Abstract

*CRCII Project 2.3 is a logical follow-on from research results derived in CRCI. It targets the pivotal issue in Australia's beef genetic improvement dilemma: Can we change carcase and beef quality attributes of beef cattle without unduly compromising key fitness traits like reproductive performance and adaptation to harsh environmental stressors? Industry outcomes from the project are targeting multiple traits and multi-faceted strategies including carcase and beef quality, feed efficiency, female fertility and adaptation to tropical environments using a range of tools such as Estimated Breeding Values (EBVs), genetic (DNA-based) markers and meat processing and cattle management strategies that will impact on most sectors of the Australian beef industry. The major winners of the project will be cattle breeders in the tropics and subtropics of Australia, although the results will also have flow on benefits for cattle breeders world-wide.*

## Background

CRCI results identified breeds and sire lines with the capacity to consistently produce beef of guaranteed eating quality when their progeny were grown in relatively benign environments in Central Queensland. However, if herd productivity is not to be compromised, female progeny from these breeds and sire lines must be able to grow and reproduce well in harsher environments than Central Queensland. CRCI results show that traits such as retail beef yield percentage and marbling will respond well to genetic selection and significant improvements in profitability can be made by such selection. However, moderate to strong antagonistic genetic relationships exist between retail beef yield percentage, marbling, fat thickness and feed efficiency, with higher yielding animals being more efficient but leaner and marbling less than lower yielding animals. Hence, selection to improve retail beef yield percentage or feed efficiency is likely to reduce fat deposition at all sites throughout the body. Body condition is an important factor in female reproductive performance and a minimum fat cover may be necessary for puberty and conception. Selection of beef cattle for increased beef yield or improved feed efficiency that results in reduced fat cover in breeding females may therefore reduce female fertility and such relationships may be stronger in harsh environments, and be exacerbated by seasonal conditions and in *Bos indicus* breeds that suffer more from lactational anoestrus than other breeds. A specially designed breeding project was therefore established to test this hypothesis, as described in the following section.

## Breeding Program

All breeding to generate experimental progeny in collaborating herds is now complete, with three calf crops weaned and transferred to properties under CRC control and the fourth calf crop now being born. Breeding program design aspects that needed to be considered include:

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- Breed: 2 tropically adapted breeds (Brahman and Belmont Red/tropically adapted composite) representing the extreme between-breed differences amongst the tropically adapted breeds for adaptation to tropical environments, male and female fertility and carcase and beef quality;
- Number of progeny per sire: largely determined by the minimum number of female progeny required for subsequent joining in the breeding herds. The program was designed to produce 50-60 progeny (25-30 progeny of each sex) per sire;
- Minimum number of progeny: ~2400 progeny (1200 steers / 1200 heifers) per breed;
- Genetic linkages: specific sires were required to link different groups of cattle (e.g. AI / natural mating groups; across years and across herds within breeds). As well, sires were used to link this project with other projects (e.g. CRCI) and with industry (some high profile Brahman sires were used to provide better genetic linkages between this project and non-CRC Brahman herds);
- Types of sires: to maximise value of the project to the Northern Pastoral Group of Companies (NPG) 2 "types" of sires were used: i) sires nominated by CRC and ii) sires nominated by NPG. The number of sires nominated by NPG was proportional to the number of cows provided by them for the project;
- Selection of sires: sires selected by CRC were selected primarily on divergence for EBV for retail beef yield (RBY%) and intramuscular fat (IMF% ~ marbling). Secondary criteria included known informativeness for gene markers identified in CRCI and NAPCO's START project, EBVs for scrotal size or days to calving and, in Brahman sires, whether they were prominent sires within the Brahman breed that also met some of the other selection criteria.
- Herds: collaborating herds included:
  - Stanbroke Pastoral Company (Weetalaba and Beresford)
  - NAPCO (Kynuna and Alexandria)
  - AACo (Alcala)
  - Consolidated Pastoral Company (Mimong)
  - Geoff and Estelle Maynard (Mt Eugene)
  - Jenny and Graeme McCamley (Tartrus)
  - Caroline and Ra Briggs (Cona Creek)
  - Belmont Research Station

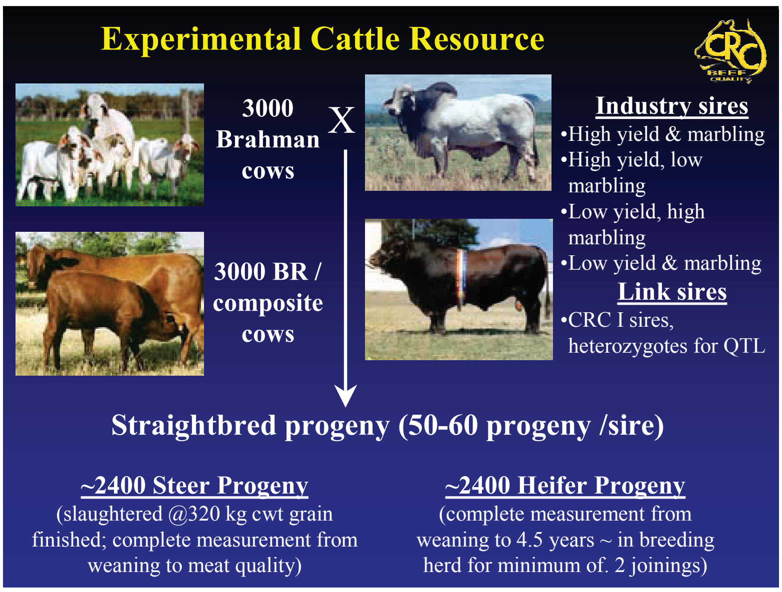



Figure 1. Project 2.3 breeding program design

**Funding**

The project has received significant funding from the following sources:

- Northern Pastoral Group of Companies ~$3.1 million cash and in-kind resources from the collaborating breeders named above and S. Kidman & Co.
- ACIAR ~$1.3 million cash ($600 k to be spent in Australia)
- Meat and Livestock Australia ~$1.2 million cash
- CRC Commonwealth Funds ~ $1.1 million cash
- Very significant in-kind resources (salaries, laboratories, computing resources etc) from CRC core and supporting partners

**Planned Project Outcomes**

Planned outcomes from the project will:

- encourage better designed breeding programs, specifically targeting northern beef production systems;
- provide informed decisions on the economic viability of changed management practices to improve carcase and beef quality attributes or female fertility;
- allow incorporation of gene marker profiles into genetic evaluation schemes like BREEDPLAN to increase genetic progress;
- through the South African component of the project, identify genetically superior animals for economically important traits that could be used to enhance productivity of beef herds in northern Australia.

**Mission**

To increase the knowledge of genetic and phenotypic relationships between components of herd profitability in northern Australian environments, to improve efficiency and product quality without unduly compromising breeder herd performance or adaptability.

**Goals**

- Determine the correlated responses to selection for retail beef yield percentage and intramuscular fat percentage on body composition, efficiency of feed utilisation, adaptability to stressors of tropical environments and female reproductive attributes and estimate the relationships between these traits in tropically adapted cattle.
- Demonstrate the use of genetic markers to select commercial cattle for carcase and meat quality and adaptability.
- Extend the Australian and South African beef genetic evaluation schemes for Belmont Red and Bonsmara breeds to estimate breeding values for traits of economic importance across both countries.

**Progress to date**

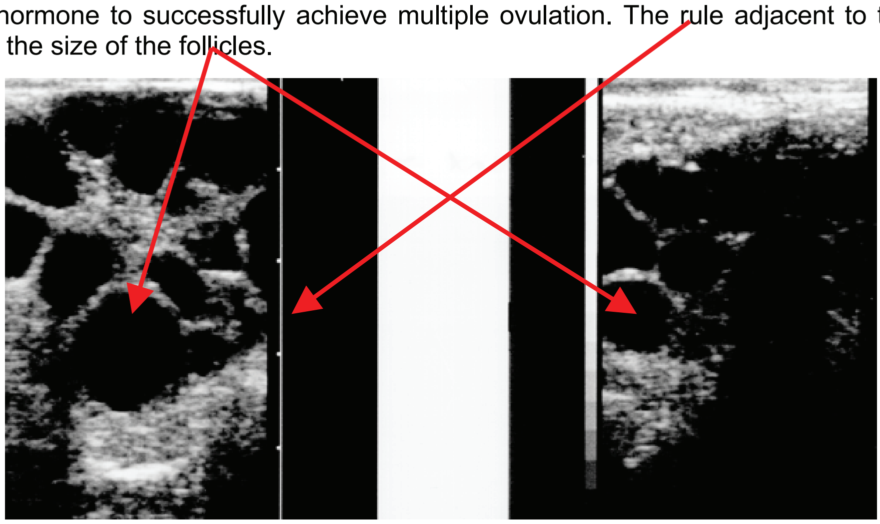
- Preliminary results of scanned fat thickness at start of joining and subsequent pregnancy rate show a significant relationship between rump (but not rib) fat depth and pregnancy for all classes of breeding females (lactating and non-lactating; different age groups), with every 1 mm increase in rump fat at start of joining representing a 1.2% increase in pregnancy rate. Complete analyses will be undertaken in 2002/2003 to provide results that enable beef producers to make informed decisions on the economic viability of changing management practices to achieve target pregnancy rates.

- CRCI feed efficiency and growth data were analysed to determine the most appropriate measures of feed efficiency in tropically adapted cattle. Those analyses show the relative importance of feed efficiency in young sale animals in the tropics is similar to that of young sale animals in domestic production systems in southern Australia. However, the relative importance of cow feed intake in northern Australian production systems is low and inclusion of the trait in tropical cattle breeding objectives is not critical. The results emphasise the need for any test for feed efficiency in tropical cattle to be inexpensive.

Figure 2. Project results show the relative importance of feed efficiency in tropically adapted steers is similar to that in temperate breeds, but the importance of feed efficiency in tropical cow herds is markedly reduced, highlighting the need for feed efficiency tests in tropically adapted cattle to be inexpensive.

- Ovarian scanning has occurred on a monthly basis on all heifers after individual animals achieve live weights of 200 kg to determine factors affecting pubertal traits. Early results in heifers between 10 and 18 months of age show strong breed and environmental effects on age and weight at puberty (see Table 1).

Figure 3. An example of an ovarian scan, in this case of a non-project heifer following 4 days treatment with follicle stimulating hormone to successfully achieve multiple ovulation. The rule adjacent to the scanned image provides a guide to the size of the follicles.



- A panel of 17 genetic (DNA) markers known from CRCI results to be associated with retail beef yield, marbling, tenderness and resistance to ticks and worms and also suitable for simultaneously amplifying with other DNA markers was selected for use in parentage determination. The markers include both the TG5 (marbling) and TEND1 (tenderness) markers (Figures 3 and 4 respectively. Calves from the first 3 calf crops have now been genotyped using this suite of markers and sires have been determined for >80% of calves. A second panel of 8 genetic markers associated with production traits is being used to resolve problem identifications. The principle of using genetic markers for production and resistance traits to also determine calf parentage has been demonstrated, but now needs to be further refined using Single Nucleotide Polymorphisms (SNPs) to bring the principle to commercial reality.

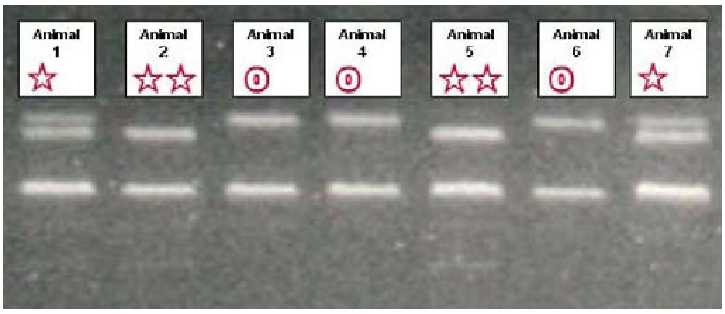
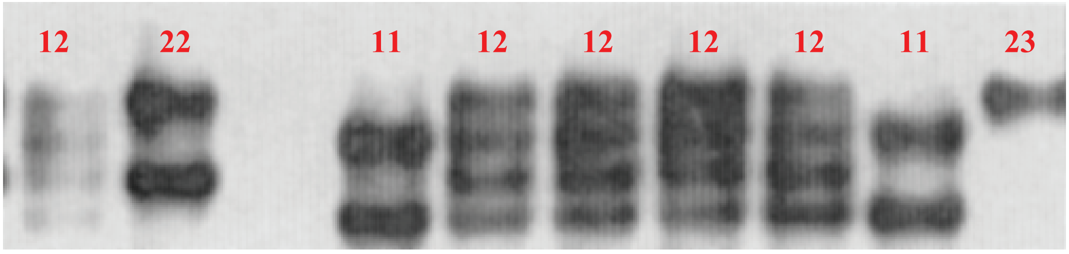



Figure 3. Genestar Marbling ~ a DNA-based test for the TG5 gene. Animals having 2 copies of the desirable allele (2-stars) have significantly more marbling than those with 1 or 0 copies of the gene.

Figure 4. Genotypes for the TEND1 marker. Animals with the '22' genotype have meat that is significantly more tender than animals with the '11' genotype, with tenderness being intermediate for animals having the '12' genotype.




- Early results on the relationships between body fatness and subsequent pregnancy rate, heifer pubertal traits and feed efficiency attributes for tropical beef production systems demonstrate the enormous potential of both the phenotypic and genotypic (DNA) databases being developed through the project. These databases will provide invaluable answers to management-related questions affecting on-property performance and factors affecting processing, as well as answering questions about genetic relationships at the polygenic level (where many genes are known to have relatively small, additive effects on traits of interest, reported as BREEDPLAN EBVs) and the molecular (DNA marker) genetic level.

- Within the stand-alone ACIAR-funded component of the project in South Africa, training of the Project Teams is complete and benchmarking activities in farmer herds are now underway. The main aim of this component is to increase profitability of participating resource-poor farmers by 5% per annum over the life of the project. Steers for a comparative performance experiment have been sourced from resource poor (emerging and communal) farmers, for comparison with steers from the commercial sector, under a commercial production / marketing system. All steers in the comparative study will be grown and finished at the Irene bull-testing (feedlot) centre where full growth, feedlot performance, including feed efficiency measurements and carcase and meat quality measurements will be recorded on steers from a number of indigenous Sanga (adapted *Bos taurus*) breeds and crossbreeds, relative to Bonsmara and Brahman controls. Results from the study will demonstrate the suitability of cattle from resource-poor farmer herds in meeting the specifications of commercial markets in South Africa, with the aim of improving the profitability of resource-poor farmer herds. DNA from representative animals of 5 indigenous Sanga breeds has been collected to allow screening for genetic markers discovered in CRCI, to determine whether favourable alleles for carcase and meat quality traits are segregating in those populations. The results will also benchmark the indigenous southern African Sanga breeds for their potential to improve the productivity of northern Australian beef herds by replacing a proportion of the *Bos indicus* content in the northern herd with adapted *Bos taurus* genes to increase female fertility and improve meat quality and temperament without compromising adaptation to tropical environments.

Table 1. Summary of Ovarian Scanning Status of No 1 heifers at different research stations in August (Swans Lagoon) and September (other stations) 2002.

| Location | Origin[1] | Breed | Number of animals | Age | P8 fat depth[2] (mm) | Weight[2] (kg) | %CL[3] |
|---|---|---|---|---|---|---|---|
| Belmont | Belmont | Brahman | 110 | 655 | 3.8 (0.5 – 8.0) | 293 (232 – 348) | 9.1 |
| | Belmont | Composite | 112 | 665 | 2.3 (0.5 – 6.0) | 301 (222 – 368) | 5.4 |
| Brian Pastures | Alcala | Composite | 48 | 669 | 3.0 (1.0 – 6.0) | 335 (242 – 396) | 60.4 |
| | Alex | Composite | 98 | 693 | 2.9 (1.0 – 6.0) | 323 (200 – 418) | 59.2 |
| Swans Lagoon | Mimong | Brahman | 84 | 543 | 3.0 (1.0 – 5.0) | 270 (206 - 326) | 0.0 |
| | Weetalaba | Brahman | 104 | 581 | 3.3 (1.0 – 7.0) | 276 (202 - 342) | 4.8 |
| Toorak | Acala | Composite | 49 | 676 | 4.4 (2.5 – 8.0) | 376 (249 – 430) | 79.6 |
| | Alex | Composite | 110 | 701 | 4.4 (2.0 – 10.0) | 363 (261 - 466) | 87.3 |
| | Mimong | Brahman | 31 | 582 | 4.9 (2.0 – 10.0) | 330 (261 - 427) | 12.9 |
| | Weetalaba | Brahman | 33 | 626 | 5.0 (3.0 – 8.0) | 329 (271 – 404) | 24.2 |

1 *It is not valid to compare results across properties of origin or breed as the animals were born at different times and were managed separately prior to weaning. The only exception is at Belmont Research Station, where composites and Brahmans have been managed together since conception, except for a 12-week mating period, where their Brahman and Composite dams were managed in adjacent paddocks.*

2 *P8 fat depth is the average P8 fat of animals that have not yet recorded a CL. Fat and weight ranges are shown in parentheses.*

3 *%CL is the percentage of heifers that have achieved puberty (as measured by the presence of a* Corpus luteum*) as at August or September 2002.*