

# Achievements of the Beef CRC ~ A platform for the next 10 years

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## Abstract

The CRC for Cattle and Beef Quality was established in 1993 to identify the genetic and non-genetic factors affecting Beef Quality and other production traits of economic importance. Since 1993 there have been great advances in biology, particularly in the understanding of genes that regulate health and performance of animals, including man and domestic livestock.

At the 2005 Gympie Carcass Classic the Beef CRC will summarise its major achievements to date and present an overview of the new CRC for Beef Genetic Technologies (which commenced on 1 July 2005). The idea will be to paint a picture of how genomics research will influence cattle breeding and management technologies in the next 10 years.

## Introduction

The Beef CRC was established in 1993 to address the major emerging beef issues of the early 1990s – the impending liberalisation of the north Asian markets and the worldwide change in consumer attitudes to beef quality. These forces demanded a radical new research focus to concentrate on the genetic and non-genetic factors influencing beef quality, moving away from a beef commodity focus to one of quality-driven beef products designed to meet the exacting standards of beef consumers in Australia and the 110 countries that import Australian beef. The Beef CRC was a complex undertaking, requiring a vision to establish and complete a comprehensive beef quality progeny test program. It required the proportional contributions of more than 100 Australian scientists from 10 different institutions (including 4 CSIRO Divisions) across 12 research locations in most states. It required industry collaboration and resources on an unprecedented scale: to breed, grow, slaughter, measure and evaluate some 12,000 pedigreed progeny at a cost of \$32 million. The CRC established and managed 2 new research facilities, including Australia's premier Cattle Research Feedlot Facility. Total cash and in-kind resources invested in the two successive terms of the Beef CRC amount to \$146.4 million. Most importantly, the Beef CRC integrated

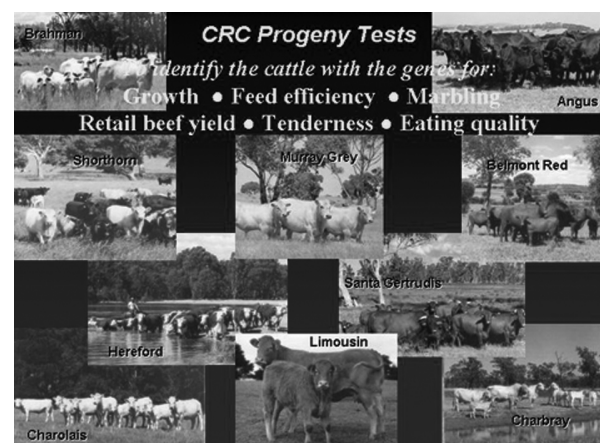
molecular and quantitative genetics, meat science and animal nutrition and health to understand the complex interacting forces that influence growth, development and beef quality to ensure Australia's ability to guarantee the eating quality of its beef. Planning for the Beef CRC's scientific program commenced in 1991 and was a result of collaboration between scientists from CSIRO, UNE, NSW Agriculture and DPI Queensland.

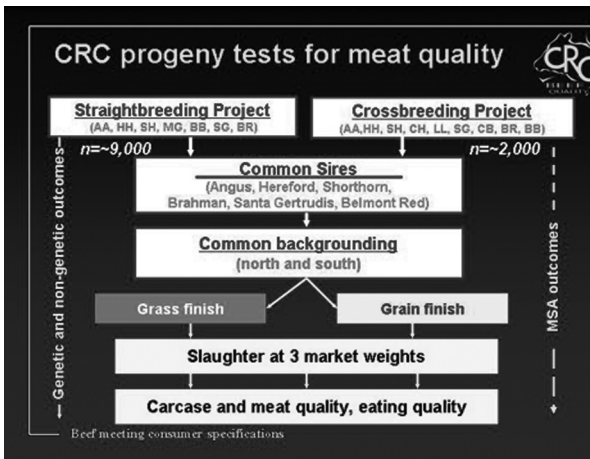
The second term of the Beef CRC will be completed in June 2005, to be followed by the commencement of the new "CRC for Beef Genetic Technologies" on 1 July 2005. That is to be an exciting new venture, recently funded by the Commonwealth and announced on 22 December 2004.

## Achievement Highlights of the Beef CRC

(a) *Genetic Improvement of carcase, beef quality and feed conversion efficiency*

The market forces of the early 1990s demanded that the Australian beef industry improve the consistency of eating quality of its product. In genetics terms this meant a shift from emphasis on cattle growth and adaptation to concentrate on the genetics of consumer-driven carcase and beef quality traits. To do this we set up two progeny test programs (Straightbreeding and Northern Crossbreeding) covering 7 of the major Australian cattle breeds or composites and a Brahman based outcrossing study with 9 terminal sire breeds. In all this meant joining 20,000 pedigree recorded cows to generate some 12,000 slaughter progeny,





measured for many live-animal, growth, carcass, beef quality and feed efficiency traits. This is described on the previous page:

The outputs of this part of the CRC program are many and diverse. In simple terms they include:

- Genetic parameters (heritabilities ( $h^2$ ) and genetic correlations ( $rg$ 's)) which define the limits of genetic improvement of beef quality and efficiency traits and their inter-relationships.
- A blueprint for straightbreeding and (Brahman based) crossbreeding to improve:
  - \* Retail beef yield (RBY%)
  - \* Marbling or IMF%
  - \* Tenderness
  - \* Eating quality
  - \* Meat colour, fat colour, cooking loss etc
  - \* Net feed efficiency

- Indirect selection opportunities for difficult-to-measure traits, arising from known genetic correlations between traits. Examples are:

- \* Measurement of "Flight Time" to improve temperament and beef tenderness
- \* Insulin-like Growth factor (IGF-I) to improve Net Feed Intake.

- Estimation of genetic correlations between certain traits studied by the CRC set important guidelines for future breeding directions of Australian beef cattle. An example is shown below, confirming that cattle selected for marbling in a pasture-fed environment will produce progeny that also perform highly on feedlot diets. This means we don't need two separate breeding schemes for grain- and grass-finishing production systems.

- The CRC's progeny test program yielded EBVs for some 600 sires across 7 breeds for many traits. This information has been delivered to industry for adoption by:

- \* Initial release to cooperating breeders
- \* Delivery to seedstock sector via breed societies and BREEDPLAN
- \* A CD called "Genetics Findings and Outcomes of the Beef CRC" widely distributed
- \* Many (1,500) scholarly research papers and extension articles frequently presented at CRC industry forums. An example below shows beef eating quality (MSA) assessment



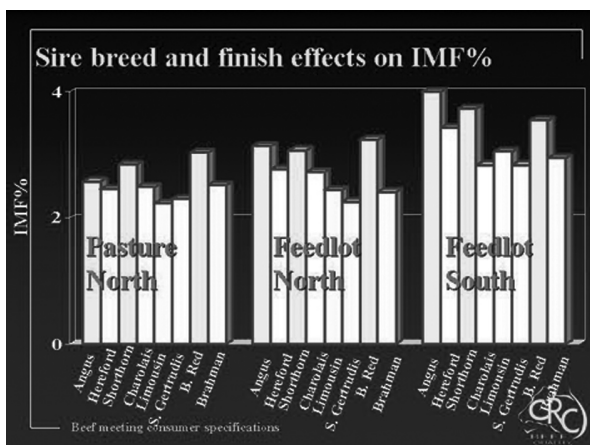
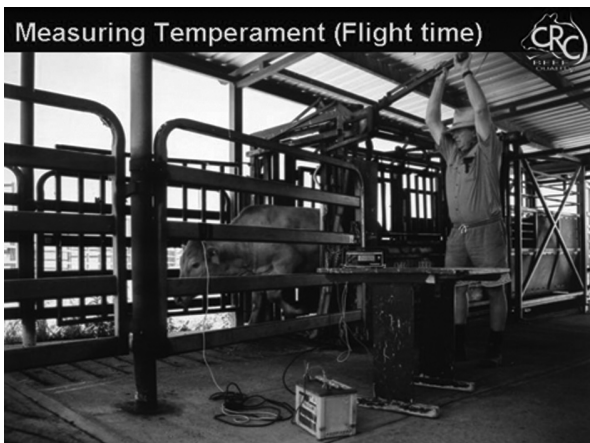
### Genetics and FINISHING system

IMF%	Pasture	Grain
Pasture	.31	1.0
Grain		.42

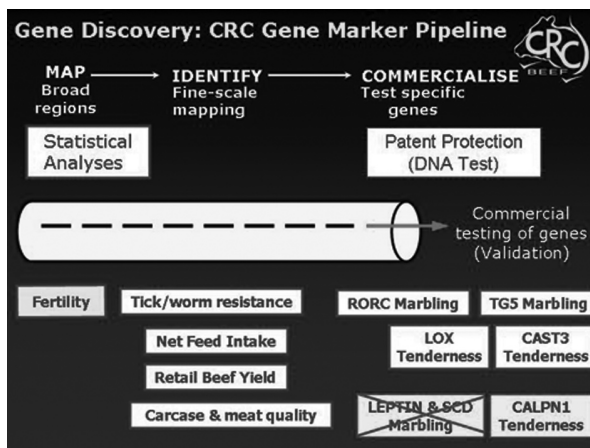
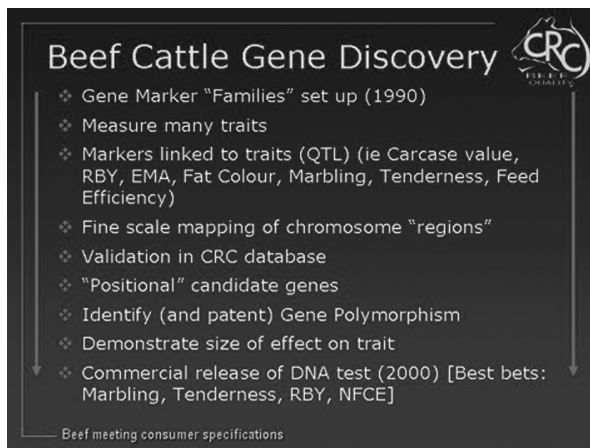
➔ Greater genetic expression in grain finished

➔ No re-ranking of sires across finishing

Beef meeting consumer specifications







from Brahman-cross progeny of the CRC's Northern Crossbreeding project.

(b) *Outcomes from Molecular Genetics and Gene Marker Investigations*

The Beef CRC invested heavily in molecular genetic studies from 1993, building on foundation gene marker (cattle) families set up in 1990 by CSIRO and MLA. Although in its infancy at that time the field has grown in popularity and potential since then. The CRC's results have been more productive than expected and in 2005 we have been responsible for five patented "Gene Marker Tests" for marbling and tenderness that are beginning to be adopted by Australian and international seedstock breeders. Their commercial impact will depend on their size of effect and on the development of methods to incorporate gene marker and quantitative genetic information to produce an "enhanced" EBV or genetic evaluation for the traits in question. The products are delivered by Genetic Solutions Pty Ltd.

(c) *Growth & Nutrition Outcomes*

Growth and nutrition investigations coordinated the CRC's work on Net Feed Intake genetics and its biological basis, on prolonged steroid growth-promotant effects on growth and beef quality in northern crossbred cattle, on nutritional

intervention strategies to manipulate marbling and on growth path effects on carcase and beef quality. Together with results of CRCII research on marbling these strategies have achieved some distinct scientific and industry outcomes. But many remain unfinished and require more analyses to exploit the experimental results completely.

Some highlights are:

- The "Tullimba" Net Feed Intake recorder, commercialised by Ruddweigh (Australia).
  - "Net Feed Intake" has been confirmed as a heritable trait in British and tropically adapted cattle, with feed efficiency of feedlot cattle a practical end result. EBVs for the trait have been released to industry. Some 300 industry (British) sires have been recorded and results released. Favourable economic evaluation of the technology has been completed. Further work in CRCII, now completed will lead to comparable industry recommendations for tropically adapted cattle.
  - Insulin-like-growth Factor (IGF-I), based on a patented hormone blood test owned by PrimeGRO Pty Ltd has been shown to be genetically correlated with Net Feed Intake and is being used in industry for screening large numbers of sires for NFI, especially in the Angus breed.
  - Repeated implants of northern crossbred cattle with steroid growth promotants (HGP) for up to 300 days achieved continued growth benefits. There was a small but significant negative effect on beef eating quality of these animals, compared to comparable cattle without HGPs.
  - Attempts to increase marbling in British cattle fed a dry-rolled barley diet by careful modification of the diet using canola oil, calcium supplementation, the use of "protected" canola products or by radical modification of the protein level of the diet were not successful. These strategies were put aside in favour of a more thorough theoretical review of adipocyte (fat cell) development. Regrettably, a consistent, novel industry recommendation to improve feedlot performance in marbling has not been possible.
  - Growth path effects on carcase and meat quality, including tenderness from many CRC cattle studied in CRCI and II, have not been fully analysed. A general conclusion, however, is that even radical weight loss during grow-out does not lead to irreversible effects on beef quality, provided that nutritional rehabilitation occurs prior to slaughter.
- (d) *Animal Health and Welfare Outcomes*
- "Pre-boosting" feeder steers to minimise sickness

Dr Lloyd Fell's work in this area during CRCI was most successful. His strategy was to compare radically-weaned (abrupt paddock-separation of calves from their dams) calves with those submitted to yard-weaning and/or yard "training" over five days with or without vaccination with crude respiratory disease antigens. Subsequent feedlot performance of these calves when they entered feedlots some months later showed the following:

- \* yard-weaned calves had significantly better (+25%) weight gains in the feedlot for at least 11 weeks.
  - \* Vaccination of calves prior to feedlot entry improved subsequent weight gain throughout the feedlot finishing period.
  - \* Yard weaning resulted in significantly lower morbidity (sickness-induced removal of cattle from the feed-yard) during feedlot finishing than paddock-weaned calves.
  - \* Overall, yard weaned and vaccinated cattle returned \$30 per head more than their paddock-weaned contemporaries.
- Commercial Bovine Respiratory Disease (BRD) Vaccines

Two BRD vaccines developed in CRCI have now been commercialised. Killed vaccines against pestivirus (Bovine viral diarrhoea) and Mannheimia haemolytica, a significant cause of feedlot pneumonia, have now been registered for sale in Australia through the Australian Pesticides and Veterinary Medicines Authority (APVMA) and marketed by Pfizer



Animal Health Australian and Intervet Pty Ltd, respectively. Pestivirus is a serious cause of cattle infertility and a pre-disposing cause of BRD in feedlot cattle. The vaccine "Pestigard" will offset these effects. BRD is a \$60 million per year problem for the Australian feedlot sector.

"Bovilis MH" vaccine will be a major force in reducing BRD amongst the 2 million cattle fed each year in Australian feedlots.

#### (e) Meat Science Outcomes

Meat Scientists in CRCI and II, led by Prof John Thompson and his colleagues have been major contributors to CRC success. These include:

- Processing of CRCI and II carcasses
- Supervision of slaughter and measurement of more than 12,000 carcasses from progeny test cattle to provide base data for genetic analyses.
- Laboratory analyses of beef samples from these animals.
- Pre-slaughter live animal measures, including scanning for fat depth, eye muscle area and marbling.
- MSA Grading Scheme ~ CRC Meat Scientists carried out much of the underpinning science for the MSA model, including definitive measurements on over 4,000 CRC progeny test animals. The database from some 400,000 MSA consumer taste panel tests resides at UNE and its systematic analyses and interpretation is under John Thompson's control.
- Best practice for pre and post slaughter management of carcasses ~ The CRC had a major role in defining these procedures to enhance eating quality of grain and grass finished cattle.
- HGP effects on beef eating quality ~ The CRC co-ordinated many experiments to define the conditions under which HGPs cause negative effects on beef tenderness and eating quality. Where such effects were confirmed strategies were developed (eg Tenderstretch) to minimise or eliminate such effects.

#### (f) Education and Training Outcomes

The CRC's undergraduate and postgraduate and industry training programs have had a material effect on the skills of the meat industry workforce. These include 60 PhD and Masters students, probably some thousands of undergraduates and TAFE students and many more industry people targeted in diverse CRC courses and schools. It is impossible to quantify the benefits. The CRC was responsible for industry funding of three Chairs at UNE (Meat Science, Animal Breeding Technologies and Meat Marketing) worth \$400,000 per year for five years.

(g) *Feedlot Waste Management Outcomes*

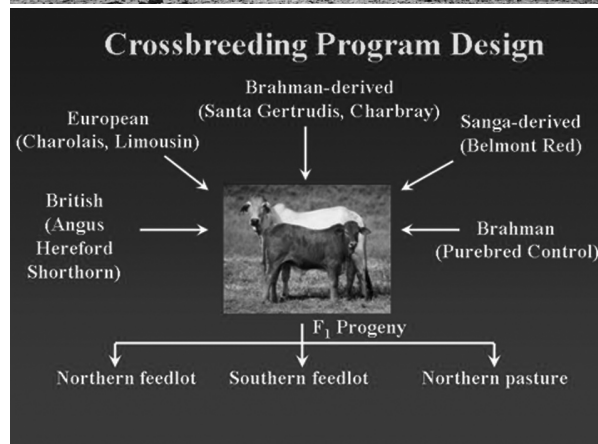
Although not widely publicised, CRCI engineers carried out some excellent research to underpin the feedlot sector’s responsibility to minimise environmental impact of the 850,000-head capacity of Australian feedlots. It cannot be detailed here but a good example of the outcomes is:

Feedlot waste recycling in marginal soil types ~ At Tullimba, which is based on fragile duplex soils, prone to penetration by feedlot effluent, the CRC showed that recycling of manure and liquid effluent onto irrigated soils for forage crops achieved organic matter (soil carbon) build-up to allow the re-capture of high levels of phosphorous and nitrogen in feedlot effluent. The work showed that forage sorghum crops are capable of high yields to maximise nutrient utilisation and to minimise run-off of soil nutrients.

The results have been used by regulatory authorities to set realistic guidelines for Australian feedlot conditions. In the past such figures were adopted from USA dry-land farming situations that would have had unnecessarily restricted effects on Australian feedlots.

(h) *Northern Crossbreeding Outcomes*

The CRC’s terminal crossbreeding experiment at “Duckponds”, Blackwater based on 1,000 Brahman cows donated by QDPI and industry has given us the best understanding of breed effects on beef quality traits for modern markets. The cows were joined over three years to some 96 sires of Brahman, Angus, Belmont Red, Hereford, Charolais (Charbray), Limousin, Santa Gertrudis and Shorthorn breeds. Progeny were either grain or grass finished to domestic, Korean or Japanese market weights. Progeny of each sire were finished either on pasture at Duckponds, on grain at Goonoo Feedlot, Comet or on grain at CRC



Feedlot “Tullimba”, Armidale. All growth, RTUS-scanned, chiller-assessed traits and laboratory measured meat quality traits were measured (see “Crossbreeding Program” design).

*Sire breed results:*

- (i) Growth (HCWT) Age at slaughter (day); P8 fat (mm); Retail Beef Yield (RBV%); Retail primal cuts (kg); IMF% (marbling).

There were significant sire breed effects on all these traits (see Table 1).

**Table 1. Least-squares mean (± s.e.) effect of sire breed on meat quality attributes in steers and heifers. Trait means adjusted to a common HCWT.**

Sire breed	No.	AGE (days)	HCWT (kg)	RBV (%)	RTPM (kg)	HOT P8 (mm)	IMF (%)
Angus	151	726 ± 2	292 ± 2	65.9 ± 0.3	62.1 ± 0.3	13.7 ± 0.6	3.25 ± 0.08
Belmont Red	379	715 ± 2	255 ± 1	66.4 ± 0.2	63.0 ± 0.2	12.9 ± 0.3	3.02 ± 0.05
Brahman	320	713 ± 2	242 ± 2	66.3 ± 0.2	62.9 ± 0.2	12.6 ± 0.3	2.35 ± 0.06
Charolais	225	711 ± 2	296 ± 2	67.2 ± 0.4	64.3 ± 0.4	10.2 ± 0.7	2.53 ± 0.07
Hereford	134	724 ± 3	292 ± 2	66.0 ± 0.3	62.8 ± 0.3	12.7 ± 0.6	2.85 ± 0.09
Limousin	291	713 ± 2	286 ± 2	68.4 ± 0.3	65.0 ± 0.3	9.7 ± 0.5	2.47 ± 0.06
Santa Gertrudis	142	722 ± 3	272 ± 2	66.1 ± 0.3	62.6 ± 0.3	13.4 ± 0.4	2.28 ± 0.08
Shorthorn	115	730 ± 3	289 ± 3	65.9 ± 0.4	62.3 ± 0.4	11.9 ± 0.8	3.05 ± 0.09
	1757	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001



Heaviest carcasses were produced by Charolais sires and the lightest by Santa Gertrudis, Belmont Red and Brahman sires. These differences are the expected result of reduced heterosis in their progeny of Brahman cows. Charolais and Limousin sires produced the leanest lowest (P8 fat) carcasses, as expected.

(ii) Marbling

From Figure 1, it can be seen that highest marbling (IMF%) was recorded in progeny of Angus, Shorthorn and Belmont Red Sires.

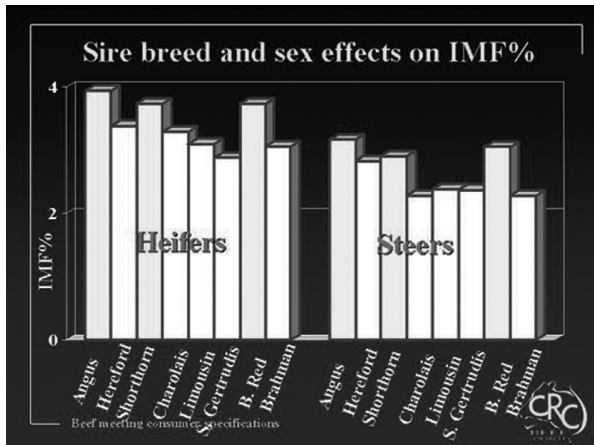


Figure 1

Heifer progeny had consistently higher marbling than their steer half-sibs.

As expected (Figure 2) progeny finished on pasture at Duckponds had lower marbling than those finished on grain at Goonoo or

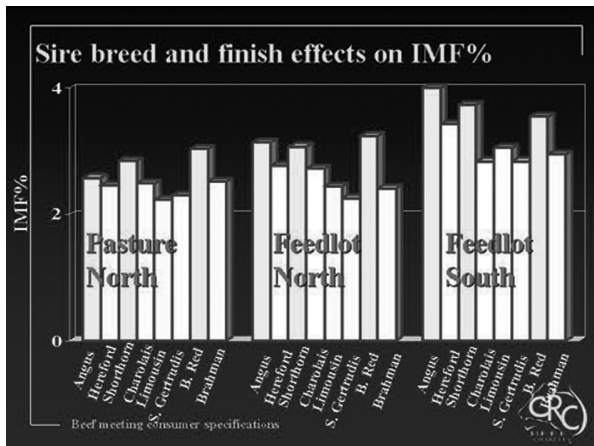


Figure 2

“Tullimba”. It is interesting that there was consistently higher marbling in the “Tullimba” finished animals.

(iii) Laboratory-measured tenderness (shear force)

Figure 3 shows that pure Brahman steers had on average less tender beef as measured by “shear force”, (in which higher shear force represents less tender).

(iv) MSA sensory analyses of eating quality

Figures 4 and 5 show the MSA taste panel

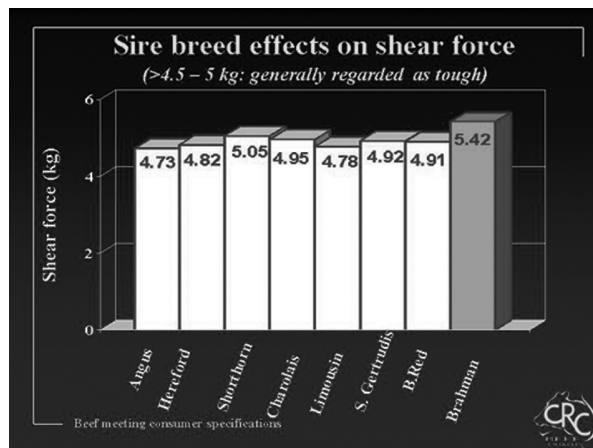


Figure 3

method (MQ4) as applied to samples of all sire breed cross progeny. Figure 5 contrasts progeny finished on pasture and the two feedlot environments. In the pasture finished cattle all crosses except Angus x Brahman failed to meet the 3-Star MSA grade. Those crossbred animals grain finished at Goonoo and “Tullimba” comfortably achieved 3-Star grading, with some “Tullimba cattle approaching 4-Star MSA

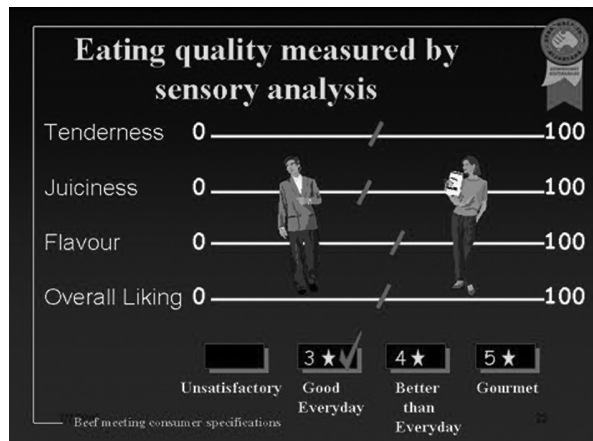


Figure 4

grading. Purebred Brahmans finished on grain did not reach 3-Star grade. (Note however, that these carcasses were not “tenderstretched”).

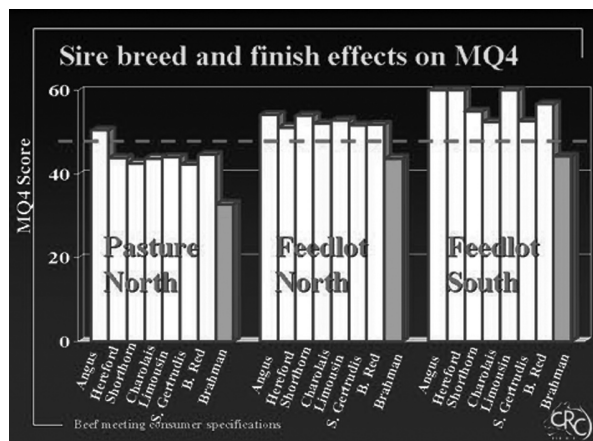


Figure 5

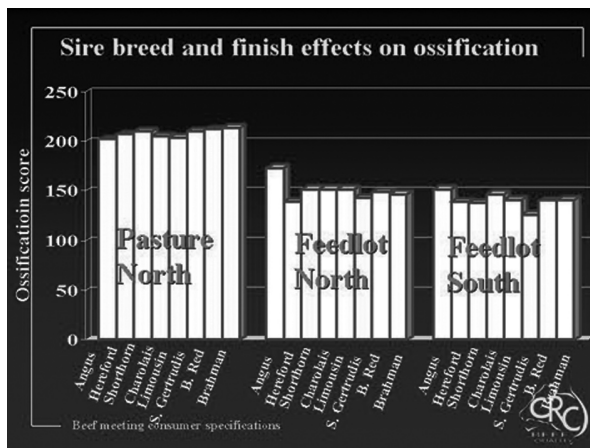


Figure 6

(v) Ossification index

Ossification score (OS) is a component of MSA grading. Higher OS reflects the difficulty of the finishing environment and is associated with reduced tenderness of beef. From Figure 6 it is clear that pasture finished cattle (at “Duckponds” had higher OS scores, confirming their lower MSA eating quality (MQ4) grade (as in Figure 5). Similar OS scores were seen in both feedlot environments.

These results are generally a favourable result for beef quality of tropically adapted crossbreds. When compared to the pure Brahman, breed of sire had large effects on most traits of economic importance. The fact that all crossbred animals finished on grain reached 3-Star MSA grade without “tenderstretch” is reassuring for producers seeking to target higher quality domestic and export markets.

Results from this research have been unincorporated in economic cost : benefit analyses carried out by Garry Griffiths (NSW DPI) and Bill Holmes (QDPI&F) to demonstrate opportunities to move from purebred Brahman enterprises to grass- or grain-finished enterprises running composite breed cattle in central Queensland.

### Delivery of CRC Outcomes to Beef Industry End-Users

The CRC is committed to seeing adoption of CRC results by Australian beef producers. To this end we have deployed additional CRC funding to QDPI&F during 2005/2006 so that their staff can continue their excellent series of industry workshops and seminars designed to increase profitability of Queensland beef producers.

From 1 July 2005 we will see the start of the new CRC for Beef Genetic Technologies which promises new opportunities for genetic improvement of Australian beef cattle.

### What do these achievements mean to the beef industry, beef consumers (and taxpayers)?

These are summarised in Table 2 by examining seven examples where the CRC’s science has helped solve a beef industry problem. Some examples (e.g. No 5) are relatively straightforward: CRC vaccines against Bovine Respiratory Disease address a \$60 million per year problem for which there was only one vaccine against causative organisms. The CRC vaccines will reduce the impact of the disease, save treatment costs, reduce antibiotic residues, improve efficiency of feed conversion and improve feedlot profitability. The vaccines will also generate royalties for the CRC and make a profit for the Australian manufacturer. Other examples are more obscure. Genetic improvement of Feed Efficiency (No 4) will (gradually) increase the efficiency of conversion of grass into beef or grain to beef (in a feedlot). A small increase in efficiency of 12 million breeding cows in Australia will yield extraordinary benefits although difficult to measure.

### The Next 10 Years

*What do we mean by Genomics?*

Genomics refers to:

- “the study of genes and their functions”, or
- “the study of the structure and function of genes”, or
- “the mapping and sequencing of all the genetic material in the DNA of a particular organism as well as the use of information derived from genome sequence data to further elucidate what genes do, how they are controlled, and how they work together”.

*Human and Bovine Genome Projects*

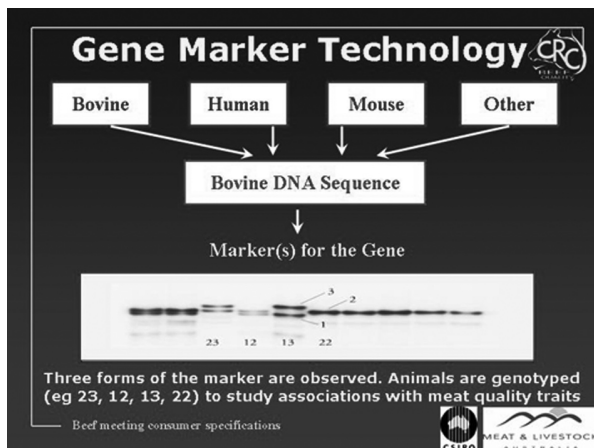
The reason genomics is in the news is that scientists have now identified the biochemical structure (ie DNA) sequence of every gene in the human “genome” – meaning every gene on every chromosome in the human cell. This was completed



Table 2. Examples (7) of CRC achievements, industry impact and major beneficiaries

CRC R&D outputs	Industry Outcomes	Major Beneficiary
1. Improved beef tenderness via genetic and processing technologies.	<ul style="list-style-type: none"> <li>Consistently tender beef.</li> <li>More satisfied beef consumers.</li> <li>Increased beef sales (or a reduction in decline of beef consumption).</li> <li>Increased export earnings.</li> </ul>	<ul style="list-style-type: none"> <li>Beef producers</li> <li>Beef processors</li> <li>Beef consumers</li> <li>Australian taxpayers</li> </ul>
2. Genetic improvement of Retail Beef Yield.	<ul style="list-style-type: none"> <li>More valuable beef carcasses (without increase in production costs).</li> <li>More profitable domestic and export beef trade.</li> </ul>	<ul style="list-style-type: none"> <li>Beef producers</li> <li>Beef exporters</li> <li>Australian taxpayers</li> </ul>
3. Improved achievement of Japanese B3 export targets.	<ul style="list-style-type: none"> <li>More valuable Japanese export carcasses.</li> <li>Increased profit for feedlotters.</li> <li>Increased export earnings.</li> </ul>	<ul style="list-style-type: none"> <li>Beef feedlots</li> <li>Beef exporters</li> <li>Seedstock beef breeders</li> <li>Australian taxpayers</li> </ul>
4. Improved Net Feed Efficiency of Australian cattle.	<ul style="list-style-type: none"> <li>More profitable pasture and feedlot finished cattle.</li> <li>Increased efficiency of production.</li> <li>Increased domestic and export earnings.</li> <li>Enhanced sustainability.</li> </ul>	<ul style="list-style-type: none"> <li>Beef producers</li> <li>Beef feedlotters</li> <li>Seedstock beef breeders</li> <li>Australian grazing resource and feed supplies</li> </ul>
5. CRC vaccines against Bovine Respiratory Disease ( <i>Mannheimia hemolytica</i> and Pestivirus).	<ul style="list-style-type: none"> <li>Less sickness in feedlot cattle.</li> <li>Increased efficiency of production.</li> <li>Less antibiotic use.</li> <li>Less trade barriers.</li> <li>Increased export earnings.</li> </ul>	<ul style="list-style-type: none"> <li>Beef feedlotters</li> <li>Beef exporters</li> <li>Australian taxpayers</li> <li>CRC Core Partners</li> </ul>
6. Gene Marker technology to identify cattle with meat quality traits.	<ul style="list-style-type: none"> <li>Identification of cattle with genetic merit for marbling and tenderness.</li> <li>Sales of DNA tests to Australian and overseas cattle breeders.</li> </ul>	<ul style="list-style-type: none"> <li>Seedstock beef breeders</li> <li>Beef breeders and exporters</li> <li>Beef consumers</li> <li>Australian biotechnology industry</li> <li>CRC Core Partners</li> <li>Australian taxpayers</li> </ul>
7. A more skilled meat industry workforce (from CRC education strategies).	<ul style="list-style-type: none"> <li>Increased efficiency at the levels of beef production, beef processing, beef retailing.</li> <li>Increased profitability of the beef business.</li> <li>Increased export earnings.</li> </ul>	<ul style="list-style-type: none"> <li>All beef sectors</li> <li>Australian taxpayers</li> </ul>





in 2003, just 50 years after the discovery of the double-helix model of DNA which explained how the information encoded in our genes is copied from one generation to another. As one expert said ... "this means we are able to interrogate what is, in effect, the instructional map of life".

Now in 2005 scientists have complete the "Bovine Genome Project", meaning all the DNA sequences of cattle genes in every bovine chromosome are known.

In both species the problem is we do not know the function of most of the genes now coded. This means in the case of cattle we don't understand which particular trait or productive process each genetic sequence controls. The priority now for cattle researchers is to link all this new genetic information to the traits of interest to the beef business: growth; retail beef yield; carcass and meat quality; feed efficiency; disease resistance; reproduction; profitability.

#### Australia's Competitive Advantage

The information from the Bovine Genome Project is publicly available. Its real value can only be realised by having DNA from pedigree cattle populations carefully measured for all the traits of interest. Scientists can then begin to link the known DNA sequences (from the Bovine Genome Project) to these traits in the hope of showing consistent associations between a DNA sequence (or a variant referred to as a "Single Nucleotide Polymorphism (SNP)" and a specific cattle trait (like marbling, tenderness or disease resistance).

The Beef CRC is fortunate to have a database of the following cattle populations which should provide some early advantages in the search for these genetic links. These pedigree populations are:

- (a) The CRCI straightbred Progeny Test experiment involving 7 Australian cattle breeds in which some 10,000 progeny were measured for growth; carcass (eg Retail Beef Yield); meat quality (ie tenderness, marbling, meat colour, fat colour etc); Feed Efficiency (measured as

Net Feed Intake).

- (b) CRCI Northern Crossbreeding Project involving Brahman cows joined to 8 sire breeds, with around 1,800 progeny measured as for (a) above.
- (c) Trangie Angus lines selected for divergent Net Feed Intake - approximately 2,000 bull, heifer or steer progeny measured.
- (d) CRCII Brahman and Composite cattle with some 2,400 steers measured for grain-fed beef quality and NFI and 2,400 heifer half-sibs measured for age at puberty and subsequent fertility.

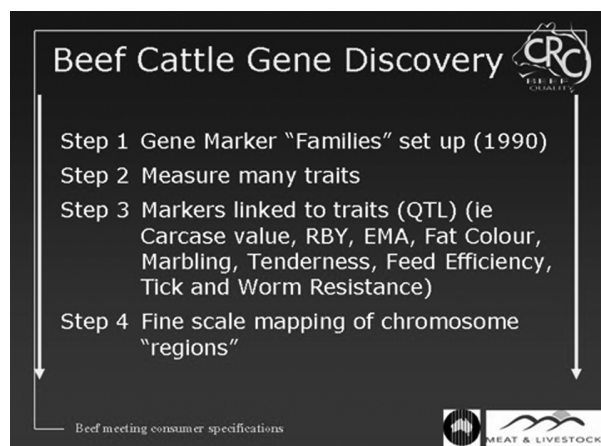
The Beef CRC and its partners have DNA on all the above cattle, ready to apply to whatever new opportunities arise from the Bovine Genome Project and related advances in technology.

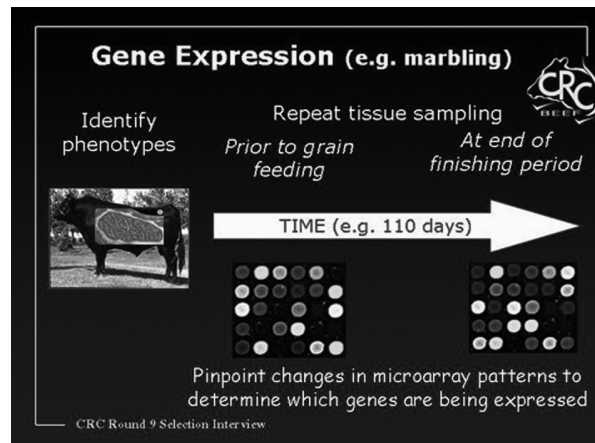
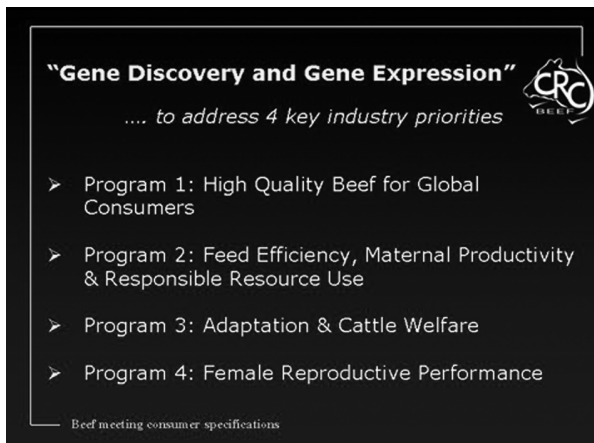
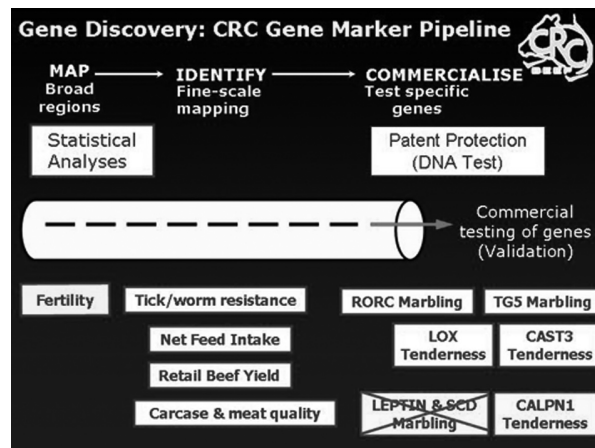
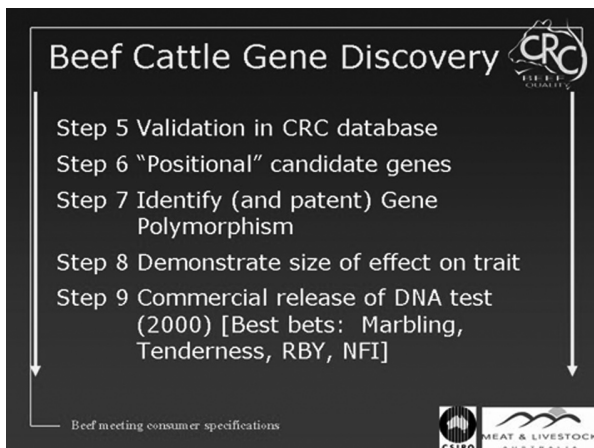
#### Recent Beef CRC Gene Marker Products

A major advantage for Australia is that the CRC, MLA and CSIRO formed a consortium in 2,000 to deliver the first Gene markers for beef production traits to the Australian industry. By that time, the consortium had already invested 10 years of background research in molecular genetics to begin the lengthy process of "Beef Cattle Gene Discovery".

The consortium has licensed an Australian commercial partner, Genetic Solutions Pty Ltd to turn the research results into commercial DNA tests for sale in Australia and overseas. The best known of these the "TG5" (Thyroglobulin gene variant) marketed as GeneSTAR Marbling and the "CAST 3" (Calpastatin gene variant) marketed as GeneSTAR Tenderness have been well publicised. These are directed at the seedstock sector primarily to increase the frequency of sires carrying the favourable genes for marbling and tenderness to bring about gradual improvement of these traits in the sectors of the breeding herds where the traits are considered important.

Other gene marker products developed by the consortium (shown below) are either being evaluated prior to commercial release or are already incorporated in other GeneSTAR tests.





#### New Opportunities in the new CRC for Beef Genetic Technologies

The new Beef CRC to commence on 1 July 2005 for a 7 year term will focus on "gene discovery and expression". The gene discovery part will deal with more of the gene marker research described above but with emphasis on some different cattle production traits, as shown in the right, centre diagram.

You can see that the CRC, following recommendations from industry, has directed its focus on the traits that are of highest economic importance but which are the most difficult to improve by traditional genetic improvement procedures. That applies particularly to feed efficiency (very expensive to measure), adaptation and disease resistance (expensive and complicated by disease control procedures) and cow reproductive performance (low heritability and takes a long time to evaluate individual females).

#### What do we mean by Gene Expression?

In beef production terms "Gene Expression" could refer to cattle which have the genes for (ie the genetic merit for or known genes which regulate) marbling, but which for some environmental reason (eg being fed on the wrong diet) are unable to display or express the marbling trait. This reflects the fact, already well known to cattlemen, that in some years (such as in droughts) cattle of known previous performance are not able to

produce because the unfavourable environment can suppress the genetic potential of these cattle.

So the study of "functional genomics" concentrates on genes and gene networks and how they are modulated over time or under different conditions such that the expected impact of the genes on the animal's biology (eg in cattle their productive performance) does not reflect the animal's genetic potential.

In the Beef CRC scientists have studied "functional genomics" in cattle with known propensity for marbling by sampling muscle and DNA during the feeding period to observe which genes in a network called a "microarray" are being switched on, or off (see below):

The potential of this research is that it may lead to new non-genetic methods to improve cattle performance. For example a specific diet or feed additive might be used at key times in the life of the animal because we know that intervention "switches on" a particular gene or suppresses some unfavourable gene affecting animal performance.


#### "Whole Genome Scanning" – a new opportunity arising from the Bovine Genome Project

As the science advances, new opportunities will arise to speed up the search for genes associated with important cattle traits. The "whole genome scan" is an example. This is based on the availability of many (eg 10,000) SNPs (ie "Single

**Planned industry outcomes**  
(Quality, Efficiency and Profit)

- More cattle meeting market specs for quality (more precise prediction of performance) → More Profit
- More efficient breeding cows and steers for grass & grain finishing → Reduced Costs
- Fewer sick cattle, welfare considerations & treatments → Reduced costs, greater market access
- Better turn-off rates → more profit (or reduced breeding herds ≅ ↓ costs)
- Beef industry better equipped to meet the (changed) global beef landscape by 2012

CRC for Beef Genetic Technologies



Nucleotide Polymorphisms”) spread evenly across all bovine chromosomes. These SNPs are spaced close enough to be in proximity with most chromosome regions likely to contain genes that cattle researchers are seeking.

Technology allows individual animals’ DNA to be rapidly tested (ie “genotyped”) against those 10,000 known SNPs. Evidently commercial genomics firms are able to do this at greatly reduced costs and with quick (one or two months) turn-around. Previously this might have taken many months or years to complete in-house in a CRC laboratory.

Australia’s competitive advantage here is that we have populations of measured, pedigree cattle as previously described. DNA from cattle of known divergence in a trait (eg Marbling, Tenderness or Feed Efficiency, measured as Net Feed Intake (NFI)) can therefore be sent to a commercial firm for “whole genome scan”. The results which come back to the CRC will enable our scientists to see if cattle of known performance for a trait have a different pattern of SNP frequencies, across the chromosomes than other cattle of known divergent performance. The procedure should thus show up the “HOT” regions of the genome where the genes responsible for the trait of interest are located.

The CRC has invested in just such a procedure, with two of our cattle populations in the last month.

*Incorporating Gene Marker Information into BREEDPLAN*

Advances in Genomics in future years can best be applied for cattle industry benefit by combining traditional genetic evaluation information (ie

Estimated Breeding Values, EBVs) with molecular genetic information (ie gene markers for various traits). Such combined information will provide the best estimate of a bull or cow’s genetic merit for delivery to industry via BREEDPLAN. This has not been possible yet because of the lack of sufficient results on cattle genotyped for existing commercialised gene markers. Scientists at UNE’s Animal Genetics and Breeding Unit (AGBU) and the Agricultural Business Research Institute (ABRI) are ready to do this when the data become available.

*What are our chances of success?*

The revolution in biology, including functional genomics will occur during the next 10 years whether we approve or not. For example, the USA Government is presently spending more on biology than all other science fields and research combined. Examples provided in this paper confirm that “Gene Discovery and Expression” actually works in the case of human health and to a small extent in cattle biology. The only question is how fast it will all occur.

In the Australian beef business we must be prepared to invest in genomics technology. Our success in domestic and export beef marketing depends, in large measure, on Australia’s ability to produce specific beef products with guaranteed quality for each of the 110 countries to which we export. To the extent that genetics is a major contributor to cattle productivity, unless we participate forcefully in beef genomics in the next 10 years we will fail to meet our goals of “Quality, Efficiency and Profit”. We have the resources and expertise to achieve these goals:

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