

Beef CRC Products

An update



2010

About Us



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Developed as a partnership between the Australian beef industry and prestigious national and international scientific institutions, the CRC for Beef Genetic Technologies aims to give cattle producers the knowledge they need to produce beef which consistently meets consumer expectations both domestically and in those 110 countries to which we export.

The Beef CRC focuses on world-class gene discovery and gene expression research to improve profitability, productivity (through improved reproductive performance and feed efficiency) and animal welfare.

Along with its partners in the United States of America, Canada, New Zealand and Korea and associate partners in Northern Ireland, the Irish Republic, France and South Africa, the Beef CRC aims to increase the value of the Australian beef industry by \$179 million each year from 2012.

Beef CRC Major Research Sites



Industry & Investment



SARDI



Established and supported under the Australian Government's Cooperative Research Centres Program

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Background

Beef is Australia's most valuable agricultural commodity, worth \$12.1 billion in 2008. By value, Australia is the world's largest beef trader, though Brazil overwhelms world trade by volume. With only 2.5% of world cattle numbers, but 23% of world beef trade, Australia can only retain leadership by producing to exacting specifications to satisfy consumers in extremely diverse markets. Greatly increased global demand for livestock products and availability of new genomics technologies provides significant opportunities for the beef industry and rural and regional economies throughout Australia.

The first phase of the Beef Cooperative Research Centre (**CRC for the Cattle and Beef Industry – Meat Quality**) was established in 1993 to identify the genetic and non-genetic factors affecting beef quality and related economically important production traits. In particular, we needed to answer the question: 'Can we guarantee beef eating quality from Australia's extremely diverse beef production environments?' In the early 1990s, the major emerging issue for the Australian beef industry was the liberalisation of the North Asian markets, leading to an increased demand for Australian beef. Consumers in North Asia and Australia were demanding a more consistent and predictable product and the beef industry needed to reverse declining beef consumption patterns across Australia, primarily driven by poor product consistency. Industry needed to move away from a beef commodity focus to one of producing quality-driven beef products.

Beef CRC's second phase (**CRC for Cattle and Beef Quality**) commenced in 1999 with the knowledge it was possible to guarantee beef eating quality across Australia's beef production environments. However a further question remained and was the

focus of the CRC's second term: 'Can we change carcass and beef quality attributes without unduly compromising key fitness traits like reproductive performance and adaptation to environmental stressors?' There was also a need to implement the results of the CRC's first term through development of the Meat Standards Australia scheme and enhancing BREEDPLAN to include new feed efficiency and carcass and beef quality attributes and to commence development of the CRC's DNA marker pipeline.

Outcomes from the CRC's first two phases of research are summarised briefly at the end of this document.

Beef CRC's third phase (**CRC for Beef Genetic Technologies**) commenced in July 2005, with funding to terminate in June 2012. The third-term CRC is aiming to increase the competitiveness of Australian beef businesses by targeting an additional 1.5% p.a. increase in gross revenue of the Australian beef industry, estimated at \$179 million per annum from 2012, with total expected benefits of the new CRC research being more than \$2 billion over 25 years. The centre is using emerging genetic technologies to:

- Improve capacity to deliver high quality beef to Australia's 110 global markets using cattle of known genetic merit for exacting specifications, without compromising animal welfare or the environment;
- Enhance beef yield and herd reproductive efficiency, improve efficiency of resource use, reduce production costs, minimise methane emissions and avoid chemical and antibiotic residues through precise application of knowledge about the genes controlling these attributes in cattle, their rumen microorganisms and in parasites affecting herd productivity; and

- Ensure Australia is the number one supplier of beef to meet the growing demand by neighbouring Asian countries to 2020.

Research outcomes will provide Australia with the ability to consistently produce beef products of exacting specifications to meet the needs of domestic consumers and those of the 110 countries to which we export, based on selection of cattle for specific markets using knowledge of the genes they carry, not through artificial modification of their genomes.

This document provides an update on progress towards products specifically being developed by the third-term CRC.



Benefits of the Beef CRC

Beef CRC's commercialisation strategy recognises different types of products and processes arising from CRC research and identifies appropriate pathways for their commercialisation (including IP and patent / trade secret protection where appropriate) and utilisation, with the specific aim of **maximising direct benefits to industry**.

The following sections outline the status (in May 2010) of each product targeted by the current Beef CRC, its likely status at June 2012, how industry will use the product and its economic impact once the product becomes available to industry.

Although the section below attempts to summarise the economic benefits of each product, in many respects it is not possible to calculate the true value of some CRC outcomes. For example, how can a realistic economic value be placed on outcomes such as 'reduced antibiotic usage' (by developing cattle that are productive in the absence of antibiotics) and 'improved animal welfare';

when the intrinsic value of such outcomes is based in the minds of consumers who demand that animals be treated with utmost care, almost regardless of cost, and that livestock remain 'clean and green', regardless of improvements in productivity and guarantees of food safety following use of medicinal drugs?

Similarly, the value of education to the Australian economy is not readily quantifiable, although clear evidence exists that ongoing improvements in productivity are affected by levels of basic education and levels of continuous employee development.

Non-economic benefits that will accrue to the Australian beef industry from Beef CRC investments include:

- Confidence by industry that Beef CRC products have been extensively developed and validated under Australian beef production systems and are therefore directly relevant for Australian beef enterprises. Particularly with regard to DNA technologies, it is important to

recognise it is not possible for the Australian beef industry to do nothing and simply assume that genomics companies will deliver products of value to industry. Such an approach would generate considerable risks to the beef industry, including the loss of influence over how the technologies are offered, access to the technologies on sub-standard terms and the potential to disrupt systems that currently operate in Australia (specifically BREEDPLAN and Meat Standards Australia).

- Beef CRC's new DNA marker commercialisation model required development of a National Database (of industry-relevant genotypes and phenotypes) that will be of direct ongoing use to the Australian beef industry, to services such as BREEDPLAN and Meat Standards Australia and to beef researchers well into the future.
- The new DNA marker commercialisation model was developed in conjunction with



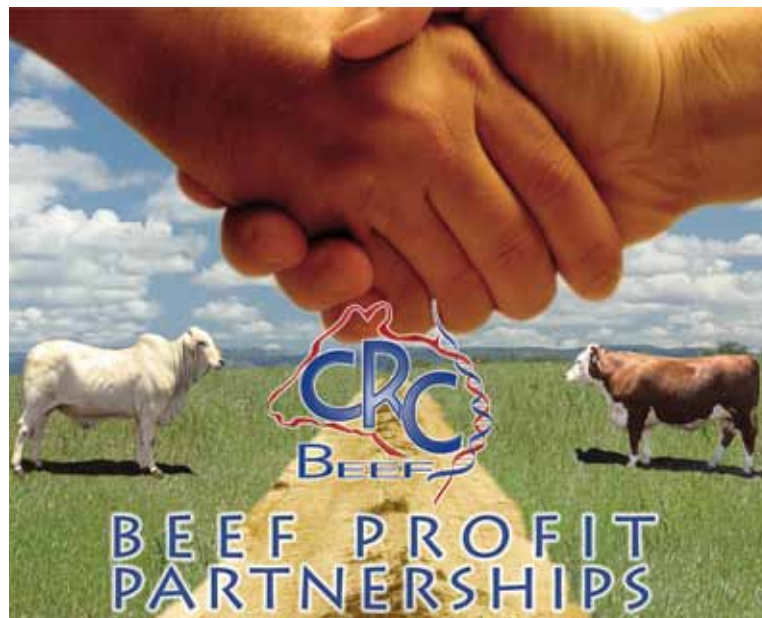
CRC's Products

the international genomics collaborators from USA and Canada, with agreement that they would use the same model. Once DNA markers are widely used in all three countries, producers will be able to make a direct comparison of the genetic merit (based on genomic breeding values) of animals across countries, thereby promoting the exchange of genetically superior germplasm and more rapid genetic improvement in all countries.

- Integration of DNA marker information into existing industry schemes (e.g. BREEDPLAN and Meat Standards Australia) to enable greater understanding by industry about how best to apply the new genomics technologies to achieve value in their own businesses.
- Improved environmental credentials for the Australian beef industry through reduced methane emissions, more effective feed-base resource use, improved cattle welfare

practices, reduced use of antibiotics and reduced use of chemicals to control parasites. This will lead to reduced chemical residues in beef that could potentially impact on beef market access.

- Enhanced technical and human capacity through formal training of post-graduate, under-graduate and vocational level audiences (including 39 PhD and MSc students in CRCIII).
- Enhanced beef industry capacity through a novel system of partnerships with beef businesses, value chains and the broader Australian beef industry, designed to achieve and accelerate improvements, innovations and adoption for sustainable impact on business profit and industry growth. The system relies on creative thinking using 'continuous improvement and innovation', action/experiential learning and a profitability framework to measure and record decisions and 'hard' and 'soft' measures of performance success.



DNA Markers

Markers for complex traits (growth, feed efficiency, resistance to parasites, carcass and meat quality, reproductive performance)

Predicted status at 30 June 2012:

Beef CRC markers for tenderness have been available now for several years. They are marketed by Pfizer and have been validated and included in BREEDPLAN EBVs. By June 2012, prediction equations for growth, feed efficiency, carcass and beef quality and female reproduction attributes based on Illumina's and/or Affymetrix's high density SNP panels (>500k SNPs) will be delivered to BREEDPLAN. These panels are expected to explain at least 15% of the genetic variation in each trait

Industry Use of the Product :

Once proven, DNA markers will provide beef producers with a simple and cost-effective method of identifying animals early in life that are best suited for breeding or to meet the exacting specifications of premium markets, thereby improving profitability and productivity of beef enterprises. Beef businesses will collect biological samples (e.g. hair,

blood, semen, skin) from their animals and send the samples to companies for DNA extraction and genotyping. Genotypes will be returned to the businesses and/or BREEDPLAN for data analysis and identification of animals that are genetically superior for the trait(s) of interest.

Industry Impact if Successful :

CRC economic analyses suggest that DNA markers accounting for either 15% or 50% of genetic variation for traits in a breeding objective will result in an economic benefit to the broader beef industry of \$1.108 billion (15%) or \$1.930 billion (50%) in net present value over the period 2006-2030. This represents a return of around \$10 or \$20 respectively for every \$1 of investment from all sources. In addition, a range of environmental benefits will accrue, including decreased methane emissions from more feed efficient cattle, reduced use of chemical control for parasites and improved animal welfare.

DNA markers in Meat Standards Australia (MSA)

Predicted status at 30 June

2012: Beef CRC has fulfilled its obligations. Further testing of

markers and the possible inclusion of them in MSA depends on outcomes from the next phase of an MLA Donor Company project between MLA and Pfizer and on decisions by the MSA Pathways Team about options for cost-effectively incorporating DNA marker information into MSA.

Industry use: CRC results show that DNA markers for tenderness are reliable indicators of beef palatability as assessed by untrained taste panels. If a cost-effective method of incorporating changing DNA marker panels into MSA can be identified, beef processors and retailers will be able to use that method to reliably grade beef based on existing MSA grades, potentially opening up MSA to new suppliers, particularly those in northern environments and those using Bos indicus-derived genetics. This may initially require vendor declarations about the sires used in their herds until widespread DNA testing in commercial herds becomes cost-effective in future.

Economic impact: In 2008-09, over-the-hooks premiums for MSA-graded yearling cattle ranged from \$0.05 to \$0.19 per kg

more than for non-MSA-graded yearling cattle. For a 240 kg carcass this translates to a premium from \$12.00 to \$45.60 per head. The average wholesale premium for MSA cuts was \$1.60 per kg and the average retail premium for MSA beef across all cuts was \$1.36 per kg. If DNA markers can be effectively incorporated into MSA, these premiums will become available to a large number of northern Australian beef producers for the first time.





Poll Gene Marker

Predicted status at 30 June 2012:

Beef CRC has identified a diagnostic DNA marker that accurately identifies homozygous polled bulls in >90% of cases in the breeds tested. The marker was licensed non-exclusively to the University of Queensland's Animal Genetics Laboratory in March 2010 for commercial development and inclusion in its DNA parentage testing panel of markers and further field testing in additional breeds of cattle. The aim is to have a low-cost commercial test available for industry use by mid 2010. Results will be published in 2010, allowing other genomics companies to include the test in their commercial products. Further research will be undertaken to determine whether additional marker(s) are associated with scurs and/or African horns to increase the accuracy of the existing diagnostic test. Should such additional marker(s) be identified, they will be commercialised by December 2011.

Industry use: The diagnostic test will be used by industry to differentiate polled individuals (bulls or cows to be used for breeding) that carry one (heterozygous) or two (homozygous) copies of the favourable polled marker. Breeders

will collect a biological sample (blood, tail hair, ear punch sample of muscle etc) for DNA extraction and assaying by a commercial laboratory. Homozygous polled bulls are expected to produce 100% polled calves when jointed to horned, scurred or polled females.

Economic impact: The cost of labour for de-horning calves is estimated at \$0.17 to \$0.33 per head. The value from reduced mortalities due to de-horning is estimated at \$1.70 per weaner. The total value to Queensland alone from not having to de-horn calves is estimated at \$3.5m per annum. Beef CRC economic analyses indicate the impacts of maintaining market access threatened by the combined effects of animal welfare concerns (including de-horning cattle) and chemical residues caused by inappropriate acaricide use in tick-endemic areas are ~\$27.5 million per annum.

Novel DNA markers for inclusion in high density marker panels

Predicted status at 30 June 2012:

In 2009, Beef CRC sequenced the genomes of Brahman, Africander and Tuli bulls to discover novel Single Nucleotide Polymorphisms (SNPs or DNA markers) for

inclusion in the high-density SNP panels to be released by Illumina and Affymetrix in mid-2010. This was the first time cattle adapted for tropical conditions had been sequenced. Inclusion of the new SNPs in the next-generation DNA panels will better enable discovery of markers associated with important production traits in tropically adapted cattle directly relevant to Australia. In future the sequence information will also be used by CRC scientists to develop new methods of identifying DNA markers associated with economically important traits (e.g. by imputing or inferring sequence data from high density SNP panels).

Industry use: See section on DNA markers for complex traits above.

Economic impact: See section on DNA markers for complex traits above.

Phenotypic Prediction Models

'BeefSpecs'

Predicted status at 30 June

2012: The calculator is freely available online at www.mla.com.au/beefspecs. The first validated model for predicting performance of groups of *Bos taurus* or *Bos indicus*-derived steers or heifers was commercialised in October 2008. Refinements are now being made to the model to allow prediction of performance of individual animals. The updated model is expected to be released for industry use by December 2011.

Industry use: The 'BeefSpecs' calculator helps cattle producers predict weight and fat specifications of animals destined for store and premium markets to increase carcase compliance rates for fatness and weight targets specific to various beef markets. The calculator is currently limited to predicting the performance of groups.

Economic impact: Up to 25% of Australian cattle fail to meet targets for hot standard carcase weight (HSCW) and fat specifications, at a cost of \$15 to \$30/head, depending on the target market. A recent study of feedlot cattle showed that in a 20,000 head sample of animals finished for short-fed markets, 28% missed HSCW specifications, foregoing \$31,000 (\$5.50/head) and 16% missed P8 fat specifications, forfeiting \$54,000 (\$17.50/head).

Feedlot Performance Model

Predicted status at 30 June 2012:

A model specifically designed to allow prediction of animal performance in feedlot finishing systems will be released to industry by June 2011.

Industry use: This model will offer further refinements to the 'BeefSpecs' model, but specifically aimed at feedlot finishing systems and their preferred markets.

Economic impact: See impact described in the 'BeefSpecs' model.

Optimisation Model

Predicted status at 30 June

2012: Development of the optimisation model is partially contingent on validation of laser scanning technology now being tested in a supply chain and its value proposition to industry. The optimisation model will include an economic prediction component as well as the animal prediction model, to allow supply chain partners to optimise animal performance (relative to premium market specifications) and profitability of the enterprise.

Industry use: This model will offer further refinements to the 'BeefSpecs' model, including an economic component designed to optimise feed and resource use relative to market specifications and return on investment by supply chain partners.

Economic impact: See impact described in the 'BeefSpecs' model.

Maternal Model

Predicted status at 30 June

2012: The maternal model is being designed to optimise maternal herd performance (defined as kilograms of calf weaned per mega-joule of energy per cow and calf unit), efficiency of feed utilisation and end-product traits such as carcase and beef quality attributes. It is the most scientifically challenging of the

CRC's prediction models and its development is still at an early stage. It will be based on the existing fat prediction model ('BeefSpecs') but will be enhanced to accommodate the much wider range of production / nutritional environments experienced by breeding herds. Data to support the model's development are available from the earlier CRCII Project 2.3 and CRCIII Maternal Productivity and Lifetime Fertility projects. Assuming development proceeds as currently planned, the model will be available for industry use by June 2012.

Industry use: This model will predict cow herd performance and the possible trade-offs that might be needed in steer performance to optimise profitability and productivity of cow-calf herds, initially in temperate production environments, but ultimately also in (sub) tropical production systems.

Economic benefit: Reproduction rate is a critical profit driver in cattle breeding herds across Australia. The impact of changed body composition on reproduction in breeding herds due to selection to improve steer traits also impacts on total herd profitability and productivity.



Genetic Parameters for use in Breedplan

Trial Marker-Assisted EBVs for Tenderness (EBV^M)

Predicted status at 30 June 2012:

Genetic parameters for traits associated with beef tenderness (shear force, MQ4 score, flight time, meat colour) and markers for tenderness were estimated and included in a new method to calculate EBV^M in BREEDPLAN for industry use in mid-2008. The new method will be adapted for use for additional traits (e.g. feed efficiency, carcass and meat quality, female reproduction) as soon as prediction equations accounting for sufficient variation for those traits become available.

Industry use: See section on DNA markers for complex traits.

Economic benefit: See section on DNA markers for complex traits.

CRCIII Female Reproductive Traits

Predicted status at 30 June 2012:

Genetic parameters for traits and indicator traits (e.g. age at puberty, post-partum re-conception interval, lifetime reproductive performance and early-life indicators of lifetime female reproductive performance) in northern Australian herds and the associations between those traits and steer traits (growth, feed efficiency and carcass and beef quality attributes) will be estimated and included in BREEDPLAN by August 2011.

Industry use: Estimates of genetic parameters (heritabilities, genetic correlations etc) are essential to underpin genetic evaluation schemes such as BREEDPLAN. Most industry practitioners of genetic improvement would not even be aware of these estimates, as they use only the BREEDPLAN EBVs and accuracies calculated from the parameters. The main users of such parameters are therefore the developers and commercialisers of BREEDPLAN (AGBU and ABRI), though the parameters will also be used by other researchers (e.g. the CRC's phenotypic prediction

project which use the parameters in their model development).

Economic benefit: Reproduction rate is a critical profit driver in cattle breeding herds. Sub-optimal reproduction rates in northern Australian Bos indicus-derived herds represent the major inefficiency of production in Australian beef herds. CRC economic analyses show the gross margin of beef cattle production in Queensland alone could increase (direct benefit to producers) by \$28 m annually by increasing branding rates by 5% in first- and second-calf heifers and 1% in mature cows. The impact of changed body composition on reproduction in breeding herds due to selection to improve steer traits also impacts on total herd profitability and productivity.

CRCIII Maternal Efficiency Traits

Predicted status at 30 June 2012:

Genetic parameters for traits and indicator traits such as conception and weaning rates and days-to-calving in first and second-calf heifers and their associations with body composition and feed efficiency in southern Australian breeding herds will be estimated and included in BREEDPLAN by June 2012.

Industry use: Estimates of genetic parameters (heritabilities, genetic correlations etc) are required to underpin BREEDPLAN, though most genetic improvement practitioners would not be aware of the estimates, as they simply use the BREEDPLAN EBVs and accuracies calculated from the parameters. The main users of the parameters are therefore the developers and commercialisers of BREEDPLAN, though the parameters are also used by other researchers (e.g. the CRC's phenotypic prediction project uses the parameters in their model development).

Economic benefit: Reproduction rate is a critical profit driver in cattle breeding herds. Associations between feed efficiency and

maternal performance are also important particularly in temperate areas of Australia where land costs are higher and supplementary feeding is more commonly practiced. The impact of changed body composition on reproduction in breeding herds due to selection to improve steer traits also impacts on total herd profitability and productivity.

Male Indicator Traits to Improve Reproduction

Predicted status at 30 June 2012:

Identification of male indicator traits for industry use depends on results of data analyses to commence after data collection is complete (December 2011). Early life predictors of fertility in the male will greatly improve the efficiency of selection of sires for reproductive performance. There are genetic and economic advantages in identifying new traits in sires used for breeding purposes to indirectly improve the fertility of both female and male relatives. Genetic parameters for such traits will be estimated and included in BREEDPLAN for northern Australian herds by April 2012.

Industry use: Estimates of genetic parameters (heritabilities, genetic correlations etc) are essential for BREEDPLAN, though most genetic improvement practitioners would use only the EBVs and accuracies calculated from the parameters. The main users of such parameters for male indicator traits will be the developers and commercialisers of BREEDPLAN (AGBU and ABRI).

Economic benefit: Identifying early life predictors of a bull's fertility will reduce the number of bulls required for breeding throughout northern Australia by up to 50%. Identifying new traits related to fertility of a bull's progeny will provide new opportunities to increase rates of genetic improvement for all traits and significantly increase the impact of using genetically superior bulls in commercial herds in northern Australia.

Objective Measures of Cattle Welfare

Predicted status at 30 June 2012: To enable beef enterprises and policy makers to counter criticisms of animal welfare concerns, they require robust, scientifically defensible measures and critical thresholds that define the welfare status of cattle when exposed to conditions that elicit a stress response. This project will develop those essential objective measures of cattle welfare and incorporate them in welfare assessment protocols and standards and guidelines by December 2010.

Industry use: Industry will use the CRC's objective measures of cattle welfare primarily through voluntary or

mandatory use of animal welfare protocols, standards and guidelines.

Economic benefit: Beef CRC economic analyses indicate the combined impacts of reduced market access arising from animal welfare concerns and chemical residues caused by inappropriate acaricide use in tick-endemic areas of northern Australia would cost ~\$27.5 m per annum.

Genetic and Management Tools

Growth Path Impact

Predicted status at 30 June 2012: Results with direct industry benefit were 'distilled' from specific CRCII projects and delivered as integrated packages of information during the early years of CRCIII. The CRC's 'growth path' results help beef producers in northern and southern Australia best target premium markets for high quality beef with better eating quality and/or marbling whilst maximising herd profitability.

Industry use: The 'growth path' package of information is used by beef producers and feedlotter to balance growth rates of animals against costs to maximise steer herd profitability and productivity.

Economic benefit: See impact of phenotypic prediction models above.

Regional Combinations of Genetics and Management Practices

Predicted status at 30 June 2012: Results with direct industry benefit were 'distilled' from specific CRCII projects and delivered as integrated packages of information during the early years of CRCIII. The CRC's 'Regional Combinations' results help southern Australian beef producers best target premium markets for high quality beef with better eating quality and/or marbling using different combinations of genetics for retail beef yield and marbling.

Industry use: The 'Regional Combinations' package of information including economic benefits and industry impact studies is used by beef producers and feedlotter in southern Australia to best match their genetics and premium market specifications.

Economic benefit: See impact of phenotypic prediction models above.

Reducing Methane Production by Cattle

Predicted status at 30 June 2012: The beef industry needs reliable and cost-effective methods to reduce methane production from cattle without compromising (or ideally enhancing) feed efficiency. To do so, the CRC is developing live microbial and/or bio-active products that either alone, or in combination, restrict the production of methane by rumen microbes and also maintain desirable levels of feed digestion. Candidate protein targets and microbes for live microbial and/or bioactive products will be identified by June 2011, though further development of the candidates into commercial products that have undergone full efficacy testing prior to registration will then require several more years of research and development and significant additional commercialisation funding.

Industry use: The products could be administered to cattle as a drench or a feed additive.

Economic benefit: There is a global focus on reducing greenhouse gas emissions and decreasing the environmental footprint of the beef industry. It is estimated that livestock contribute >12% of Australia's greenhouse gases in the form of methane. These emissions eliminate up to 10% of the energy consumed by an animal. Reducing enteric methane generation, while simultaneously increasing dietary energy capture, will provide significant financial benefits to the Australian cattle industries and the environment. Reducing greenhouse gas emissions from cattle will also assist Australia to meet its greenhouse gas emission reduction targets.



Non-genetic Control of Cattle Ticks

Tick Vaccine

Predicted status at 30 June 2012: Successful development of a vaccine to control cattle ticks is contingent on the successful outcome of an in vivo study and two animal trials to be conducted at the end of 2010. The high costs associated with controlling cattle ticks in Australia and internationally, together with the impact of the use of chemicals to control ticks on food safety and the environment, have meant the cattle industry and governments worldwide have identified the development of a tick vaccine with 12 month's immunity duration and 90% efficacy as a very high priority. Development of such a vaccine is the target of this project. Although the project is on track with all its milestones to date, the degree of difficulty in achieving viable vaccine candidate(s) is extremely high. Hence, the likelihood of success by June 2012 must still be regarded as low. If Beef CRC identifies effective vaccine targets through its animal trials it will still require very significant additional funds and several more years to develop the vaccine into a fully registered commercial product available (by way of example, it took 9 years for two vaccines developed in CRCI to pass through all national registration requirements and become commercially available).

Industry use: An effective tick vaccine will require an initial immunisation and possibly a booster vaccine within 4-8 weeks of the initial vaccination. It will also require that each animal is vaccinated annually thereafter to maintain ongoing immunity.

Economic benefit: The Australian cattle (beef and dairy) industry incurs losses of ~\$175m per annum due to the impact of ticks and tick-borne diseases and costs of treatment to ensure compliance with regulatory protocols for interstate and international livestock movement. The Queensland Government expends \$3.3m p.a. to maintain the tick line.

Test for Acaricide Resistance

Predicted status at 30 June 2012: A simple tool that can be used primarily by tick regulatory authorities to identify ticks that are resistant to synthetic pyrethroids was delivered to Queensland's tick control agencies in 2008, replacing the cumbersome and time-consuming larval packet test.

Industry use: Regulatory authorities now use this test in preference to the larval packet test to identify cattle ticks resistant to the synthetic pyrethroids used to control cattle ticks during interstate and international cattle movements.

Economic benefit: Synthetic pyrethroids are cheaper than alternatives, but are only effective if the ticks succumb to the chemicals. The CRC's test effectively identifies ticks that can be controlled with the cheaper acaricides.





Biomarkers associated with male and / or female reproduction

Predicted status at 30 June

2012: Industry requires access to reliable, easy-to-use, cost-effective biomarker technologies that are highly correlated with hard-to-measure but economically very important productive traits (e.g. a biomarker associated with feed efficiency or female reproduction). These biomarkers would be used in genetic evaluation schemes and to identify the most effective management practices for individual animals. Beef CRC's breeding projects are evaluating

a range of biomarkers for possible use in indirect selection programs to improve male and/or female reproductive performance. Several potential biomarkers have already been identified.

Industry use: Industry will collect samples (e.g. blood) for use in biomarker assays that would be undertaken by a commercial company. Assay results would be used as additional data in genetic evaluation schemes (BREEDPLAN) and phenotypic prediction models

to identify the best animals for breeding purposes and possibly for use in identifying management pathways to maximise productivity of beef herds.

Economic benefit: See description above relating to genetic parameters for male and female reproductive performance.

Training materials, resources and tools

More Beef from Breeding

Predicted status at 30 June 2012:

These course materials, resources and tools will be fully updated and new materials developed, accredited and delivered through existing and new education and training providers from June 2011. The resources will be targeted at undergraduate, vocational and industry audiences.

Industry use: These training resources will be made freely available to, or integrated with, training products developed by a number of educational institutions including universities, agricultural colleges, state departments of agriculture, MLA EDGENetwork and More Beef from Pastures, Northern Pastoral Group of Companies, consultants, breed societies, 'Beef Profit Partnership' networks and regulatory bodies and policy-makers.

Economic benefit: The 'More Beef from Breeding' courses will assist beef producers and supply chain partners to achieve balance in their breeding programs, aiming to maximise productivity and profitability of the different sectors of the beef industry (breeding, backgrounding, feedlotting, processing and retailing).

Breeder Herd Management Course

Predicted status at 30 June 2012:

These course materials, resources and tools will be fully updated and new materials developed, accredited and delivered through existing and new education and training providers from June 2011. The resources will be targeted at undergraduate, vocational and industry audiences.

Industry use: These training resources and materials will be made available to, or integrated with, training products developed by a number of educational institutions including universities, agricultural colleges, state departments of agriculture, MLA EDGENetwork and More Beef from Pastures, Northern Pastoral Group of Companies, beef industry consultants, breed societies, 'Beef Profit Partnerships' and regulatory bodies and policy-makers.

Economic benefit: The 'Breeder Herd Management' courses will assist beef producers and supply chain partners to implement best-practice processes to manage their breeding herds to maximise productivity and profitability of the different sectors of the beef industry (breeding, backgrounding, feedlotting, processing and retailing).

CI&I Resources

Predicted status at 30 June 2012:

These course materials, resources and tools will be fully updated and new materials developed, accredited and delivered through existing and new education and training providers from June 2011 and will be used to underpin a sustainable 'Beef Profit Partnerships' (BPP) business model across Australia and New Zealand beyond June 2012. The resources will be targeted at undergraduate, vocational and industry audiences.

Industry use: These training resources will be delivered by the 'Beef Profit Partnership' Hub, currently under development as a new business model to ensure sustainability of the BPP network across Australia and New Zealand beyond June 2012.

Economic impact: The BPP model shows direct impacts in beef businesses. For example 5 Qld BPPs comprise 26 individual beef businesses, with an average improvement due to CRC interventions to June 2009 being ~\$14/AE for breeding stock and ~\$43/AE for sale stock. The businesses control ~140,000 AE cattle. Their expected annual improvement in profit exceeds \$2.3 million. There are ~630,000 cattle in that region, so the potential regional impact is ~\$3.7 million per annum at conservative adoption rates.



Outcomes from the previous Beef CRCs

Outcomes from earlier phases of Beef CRC include:

- A compendium of genetic parameters (heritabilities and genetic correlations) to define the boundaries of genetic improvement of meat quality in beef cattle.
- Definitive carcase and meat quality measurements, based on 12,000 progeny test results, for incorporation into BREEDPLAN.
- A blueprint for straightbreeding and crossbreeding strategies to improve retail beef yield, intramuscular fat percentage, tenderness, eating quality and feed efficiency of Australian beef cattle.
- Identification of outstanding sires, in seven Australian beef breeds, to enable beef breeders to rapidly improve carcase and meat quality traits.
- The world's first EBVs for net feed efficiency of sires of steers finished on a standard feedlot diet.
- The world's first evidence to confirm a strong genetic correlation between cattle finished on grass versus grain diets. (Australia needs only ONE genetic improvement scheme, not TWO.)
- Identification of the relative contribution of genetics, growth path, meat processing and beef ageing to beef eating quality.
- Identification of sire breed effects on beef eating quality in crossbreeding programs for northern Australia based on Brahman females.
- Quantification of ossification score and correlated Meat Standards Australia eating quality scores of Brahman cross cattle finished on grain or grass in Queensland and northern NSW.
- Quantification of *Bos indicus* effects for inclusion in the Meat Standards Australia scheme.
- Mixing cattle in the days before slaughter results in increased bruising and poorer eating quality.
- The major contribution to the scientific platform underpinning the Meat Standards Australia grading scheme. An independent study by Insight Economics in 2006 indicated the realised net value of MSA to the Australian economy, from a zero base in 1999 when MSA commenced to June 2006, was \$244 million or a benefit: cost ratio of 8:1 relative to the total estimated Commonwealth Government funds contributed to Beef CRC between 1993 and 2012. That estimated value does not account for the considerable additional benefits that have accrued to the beef industry and the Australian economy since July 2006 or for the benefits that have accrued to the sheep-meat industry, through their subsequent use of the scientific platform to develop an MSA scheme for lamb.
- World's first direct DNA marker for tenderness in beef cattle.
- Development of electronic equipment to measure individual feed intake of groups of feedlot cattle.
- Definitive test of 'flight time'; as an indirect selection criterion to improve tenderness of tropical cattle.
- New knowledge of the relative contribution of genetics and nutritional manipulation to the achievement of Japanese B3 marbling scores in seven beef breeds.
- An understanding of pre- and post-weaning growth checks on ultimate fatness and eating quality of beef.
- New knowledge to prevent acidosis in grain-fed cattle.
- A new hormonal growth promotant technique to achieve prolonged growth increases in *Bos indicus*-derived cattle.
- Two new killed vaccines against *Pasteurella* and pestivirus which cause bovine respiratory disease (BRD), both firsts for Australia.
- A patented procedure to create a mutant version of *Pasteurella hemolytica*, essential for development of a novel live, sub-unit vaccine with worldwide sales potential.
- New knowledge to ensure responsible recycling of feedlot waste to achieve a sustainable feedlot sector.
- Definitive results to show the effects of hormonal growth promotants on beef eating quality.
- Education and training courses to create a more skilled beef industry workforce.
- Pre-boosting techniques to enhance performance of feedlot cattle.
- An explanation of the influence of marbling on eating quality of beef.

... More Outcomes

- New knowledge of the biochemical basis of why high *Bos indicus* content cattle do not undergo effective post-slaughter tenderisation.
- New knowledge of the trade-offs required in breeding herd performance and adaptation of cattle to their production environments to deliver guaranteed beef eating quality, particularly from harsh northern Australian environments.
- Restricted growth early in life does not compromise beef eating quality at slaughter age. However compensatory growth only partially compensates for the early-life restriction with respect to weight-for-age and retail beef yield measurements. Body composition and marbling are little affected by growth during early life.
- Use of BREEDPLAN EBVs to select sires results in carcasses that have the best compliance with premium markets. Sire selection using high accuracy EBVs for intramuscular fat (marbling) and retail beef yield for example, resulted in progeny differences of the magnitude predicted by the EBVs.
- Beef producers can select to improve more than one trait at a time, even when the traits are antagonistically related (e.g. retail beef yield and marbling).
- Responses to selection for BREEDPLAN EBVs are consistent across a wide range of environments and growth paths.
- A legacy of the first two phases of Beef CRC is the world's most comprehensive beef cattle databases based on fully pedigreed cattle recorded for hard-to-measure traits such as feed efficiency, carcass and beef quality, adaptation to stressors of tropical environments and female reproductive performance. Such databases are essential for bovine genomics research. They underpin Beef CRC's third term of gene discovery research. They were also the inducement that convinced the US and Canadian genomics researchers to collaborate with Beef CRC, in spite of their significantly greater funding for bovine genomics research. Those collaborations are now leading to significantly enhanced genomics outcomes for the beef industries of all three countries.



Further Information

DNA Markers

| | |
|--|-----------------------------|
| Professor Mike Goddard (DNA markers associated with growth and feed efficiency traits; international collaborations) | Mike.Goddard@dpi.vic.gov.au |
| Dr Bill Barendse (DNA markers associated with carcase and meat quality and adaptation) | Bill.Barendse@csiro.au |
| Dr Rachel Hawken (DNA markers associated with reproductive performance) | Rachel.Hawken@csiro.au |
| Dr John Henshall (Poll gene) | John.Henshall@csiro.au |
| Professor Dave Pethick (DNA markers in MSA) | D.Pethick@murdoch.edu.au |

Phenotypic Prediction Models

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Objective measures of cattle welfare

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Genetic parameters for use in BREEDPLAN

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| Ass. Prof. Wayne Pitchford (Maternal efficiency traits) | wayne.pitchford@adelaide.edu.au |
| Dr Richard Holroyd (Male indicator traits to improve female reproduction) | Richard.Holroyd@deedi.qld.gov.au |

Genetic and management tools

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| Dr Paul Greenwood (Growth path impact) | Paul.Greenwood@industry.nsw.gov.au |
| Mr Bill McKiernan (Regional combinations of genetics and management practices) | bill.mckiernan@industry.nsw.gov.au |

Non-genetic control of ticks

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| Dr Ala Lew-Tabor (Tick vaccine) | Ala.Lew@deedi.qld.gov.au |
| Dr Drewe Ferguson (Test for acaricide resistance) | Drewe.Ferguson@csiro.au |

Products to reduce methane production

| | |
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Biomarkers associated with reproduction and feed efficiency

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| Dr Richard Holroyd (male reproduction) | Richard.Holroyd@deedi.qld.gov.au |

Training materials, resources and tools

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Economic impact assessment

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