Discovery! 150 new DNA markers
How to boost beef business profit by at least 5%!
Fine tuning the beef supply chain
Creating a global beef language with MSA
Research: Breeding sires of the future
I look forward to working with you all in 2007.

I hope all of you have a very happy, safe and wet festive season and New Year and Beef CRC.

A message from the CEO

It is now 2 years since the successful renewal of Beef CRC was announced and 18 months since CRCIII officially commenced - and what a hectic period those past 2 years has turned out to be! It is with genuine pleasure that we are able to reflect on a very successful and relatively smooth transition from CRCII to CRCIII and look forward to what promises to be a very exciting future.

I would like to most sincerely thank the CRC Board and Management Committee, and CRC staff at CRC headquarters and throughout the CRC network for all their input, assistance and particularly their commitment and dedication to the CRC over that period. I would also like to gratefully acknowledge the ongoing support, input, encouragement and generous funding of our beef industry partners, particularly Meat and Livestock Australia, Australian Lot Feeders’ Association, Cattle Council of Australia, Meat and Wool New Zealand, the Northern Pastoral Group of Companies and individual seedstock and commercial breeders in northern and southern Australia who continue to contribute so effectively to the success of this Beef CRC.

I hope all of you have a very happy, safe and wet festive season and New Year and look forward to working with you all in 2007.

Editor's Note

Welcome to the second edition of the Beef Bulletin.

The new Beef CRC is now 18 months old and well and truly hitting its straps. Over the past year several research milestones have been achieved and exceeded. There is no better an example than the number of new DNA markers that have been discovered. Beef CRC scientists have located more than 150 markers and while not all of them will be commercialised, this number is a far cry from the initial prediction of 10 per year.

As the world of genetic technologies continues to evolve the Beef CRC’s research thread of gene discovery and gene expression will become effortless, as will the integration of emerging genetic technologies into beef production. Forecasts like Professor John Gibson’s on page 7 which predicts that by 2010 cattle breeders might be able to generate an accurate assessment of a bull or dam’s future performance within months of its birth, has the beef industry optimistic about the future ahead.

In another Beef Bulletin story, the woman behind Australia’s highest marbling herd reiterates the growing importance of understanding genetics and urges “a high level of genetic literacy is absolutely necessary for a stud breeder these days.”

In this edition of the Beef Bulletin we have also highlighted our strong relationship with industry. Working with Australia’s largest pastoral company to lift the market potential and thus income of its Bos indicus herd, creating reliable supply chain strategies to deliver feedback to producers from Australia’s largest processors and tailoring individual production systems to capitalise on regional market specifications are just a few of the stories highlighting the Beef CRC’s research at work, work which is value adding Australia’s beef industry.

Enjoy the Beef Bulletin and the festive season.
In retrospect, Mr Mackay says, AAco may ultimately not have gone down the highly successful path it took, had not the Beef CRC - which the company has heavily invested in from the outset - given it a scientific basis on which to make the transformation.

“High quality beef production in a northern environment then looked problematic,” Mr Mackay says. “It’s less likely that we would have gone ahead, or we would have at least taken things more quietly, if the Beef CRC’s work hadn’t been there to verify what we thought was right when it came to producing composite cattle in northern Australia.”

Where AAco once used the traditional northern strategy of an annual muster across its seven million hectares, pulling off fats and culls that were sold mostly into commodity-grade beef markets, the company today runs a highly sophisticated operation that spans the market range, from premium branded beef to value-added and commodity products.

AAco has developed two composite breeds, the Barkly and the Gulf, which each have 25 per cent Charolais and 25 per cent Senepol genetics. (Senepol is a tropically-adapted Caribbean bos taurus breed). The remainder of the Barkly genetics is made up of Santa Gertrudis; the remainder of the Gulf, which comprises the bulk of AAco’s composites, is Brahman.

In the company’s feedlots, composite cattle can return a gross margin premium of $52 per adult area (AE) over their Brahman counterparts. AAco figures show that 60 per cent of lot-fed composites deliver a $5/AE premium on marbling, and overall, composite growth rate and feed efficiency is worth $38/AE over the Brahman. Off grass, composites deliver on average an extra 5 cents per kilogram premium on tenderness payments alone.

“AAco may ultimately not have gone down the highly successful path it took, had it not been for the Beef CRC.”

In the mid 1990s, when the Australian Agricultural Company began a program of lifting the genetic and market potential of its bos indicus herd, it had to base its breeding decisions largely on traditional subjective values.

AAco’s Barkly Composite

AAco chief executive Don Mackay recalls a time of “easy steps” as the company worked to lift the eating quality and performance of its Brahman and Santa Gertrudis cattle by creating its own terminal cross and composite animals.

But the hesitancy progressively disappeared as results from the Beef CRC began shining light on formerly hidden regions of the beef cattle genome, and on the factors affecting eating quality.

Beef CRC research has underpinned a decade of evolution by Australia’s largest pastoral company, which has moved its 500,000-head operation from being a traditional commodity-meat pastoral operation to a sophisticated player across all facets of the beef market.

In the company’s feedlots, composite cattle can return a gross margin premium of $52 per adult area (AE) over their Brahman counterparts. AAco figures show that 60 per cent of lot-fed composites deliver a $9/AE premium on tenderness, 15 per cent of composites have a $5/AE premium on marbling, and overall, composite growth rate and feed efficiency is worth $38/AE over the Brahman. Off grass, composites deliver on average an extra 5 cents per kilogram premium on tenderness payments alone.

AAco contributed its own genetics to the ground-breaking work of the first two Beef CRC programs, Mr Mackay said, and the exercise proved the capacity of those genetics to thrive in a northern environment.

Beef CRC research that contributed to the Meat Standards Australia (MSA) grading system then enabled AAco to extend its program into the meat quality area.

Meat quality, along with herd health, is for Mr Mackay increasingly defining Australia’s position in the competitive global beef market.

When AAco started down the high-quality path, he says, only about 40-50 per cent of its carcasses complied with MSA standards. Now it consistently gets compliance “in the high 90s”. “If we were trying to rely on a breed, or days on feed, to give us a consistent standard, we would have many failures,” he says.
**Fine tuning the beef supply chain**

It’s been talked about for years, and small beef brands have often tried and nearly as often failed - to make it work: a system that builds profitable self-correcting alliances between beef producers and processors.

That should begin to change this year (2007), as Beef CRC research, MSA and NLIS data are used to build information bridges between producers and processors. The aim is to boost the number of cattle meeting market specifications by 20 per cent over the next few years.

The project has two aspects that will eventually feed off each other with information to ensure ever-increasingly accuracy.

One project which is being supported by Meat and Livestock Australia (MLA) is to lever information already collected by the beef industry. By early 2007, all the information from three million MSA-graded carcasses will be compiled in a database that enables the data to be analysed by various categories, including region and grading outcomes.

This database will be central to a benchmarking and feedback system that will tell beef producers how their animals perform against those from other producers, and in relation to previous shipments from the same property.

Providing gross margin tools which producers customise to their specific production system to see whether different pathways can earn them a better return."

Working from the other direction, the Beef CRC is also developing a means of predicting how an animal will slaughter well before it reaches the abattoir.

"At the moment, our ability to predict the performance and therefore value of an animal through the supply chain is pretty woeful," Prof. Thompson says.

The predictive model will roll together existing knowledge about breed differences, growth patterns and environmental effects - later adding EBVs and gene markers - into a tool that producers will be able to use to better target market specifications.

With the project’s two-pronged approach, the depth of its science, and the industry backing it has via the Beef CRC and MLA, there are high hopes that it will finally forge a mutually profitable link between Australia’s beef producer and processing sectors.

In the past, supply chain reform concepts have either involved a single template stamped on the industry, leaving little room for individual choice; or conversely, been actively tackled by small operations that have kept their practices to themselves, or not had the critical mass to succeed.

“This is the first time we’ve had everyone participating,” says Professor Thompson. “Before NLIS, we didn’t have the data necessary to do this, and so through necessity we always took on relatively small chunks of the supply chain.”

This time, the major processors have engaged with the process in the knowledge that they can customise the system to their own advantage.

There are 5 supply chains participating in the project across Australia involving a total of about 5,000,000 cattle per year.

“Each supply chain will work independently allowing each chain to have their own emphasis on what they consider important for their market. However despite these differences the principles between the supply chain will be similar” Prof. Thompson says.

But with accelerated adoption of the technology a core goal of the project, it is hoped that a constant loop of information will be rolling between committed processors and producers well before the end of 2007.

Queensland processor John Dee is looking forward to a new era in supply chain evolution. John Dee is no stranger to supply chain relationships. It forms the processor half of the Banksia Beef joint venture, targeting the south-east Asian supermarket trade.

But Warren Stiff, John Dee’s Warwick plant manager, says the Beef CRC-supported grainfed supply chain model now being developed may enhance John Dee’s core business, the middle-fed Japanese and Korean beef markets.

Early in 2007, the company will implement its offal feedback system (supported by MLA) that will inform processors not only about offal recovery, but will also provide information on the state of their animals.

Later in the year, as part of the CRC program, feedback “to preferred suppliers” will be ramped up, utilising NLIS, chiller assessment and quantification of the effects of gene markers - ultimately offering producers even more data to inform their decisions.

Via improved communication and the uptake of new technology it is expected that participating producers will be able to improve compliance to carcass specification, especially in the areas of marbling and yield.

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**ACC Supply Chain, Bill McKiernan (Beef CRC), Brian McIntyre (Beef CRC), Paul Gibson (ACC), John O’Kane (ACC), Des Rinehart (MLA), Blair Brice (MLA).**
Australiapassdevelopedan international reputation for the scale and quality of its beef exports; now steps are being taken to export our world-class grading system as well.

Meat Standards Australia (MSA) has been thoroughly tested in the abattoir and retail sector across millions of carcasses, but there is further value yet to be exploited in the system’s potential as the basis for an international meat trading language.

Beef CRC research leader John Thompson notes that persuading other countries to adopt the MSA system of predicting beef palatability will not be an easy task, or a quick one.

“There is a lot of interest around the world in how MSA predicts palatability for different consumer groups,” Professor Thompson says. “As supermarkets become more dominant in countries around the world, there is growing interest in programs that deliver consistently palatable meat.”

“But it would be naive to assume that MSA can be simply used overseas in its present form without some modifications. It’s to our benefit to assist experiments to tune the system for other cultures and production systems, and to make sure the work is done correctly.”

At present, initial testing has been undertaken in Korea, Ireland and France, Japan and the US.

Testing has been undertaken in Korea, Ireland and France, Japan and the US.

For Australia, the real value in exporting MSA will be the opportunity to establish a language of international palatability that will overcome cultural barriers and allow Australian exporters to target the preferences of overseas consumers.

A first step is to use the MSA system to quantify differences in how Australian and international consumers view palatability of beef. A far bigger job ahead is to match Korean and Irish eating preferences with a palatability-based grading language that is useful not only in Korea and Ireland, but to Australian exporters looking to accurately target certain markets in these countries. The Koreans currently have a grading system similar to the United States, but with a high emphasis on marbling, which is what their consumer values.

Building the first bridges between the two industries, Beef CRC researchers are contributing to a project aimed at understanding what critical control points impact on beef palatability in the Korea production system. This will help local researchers evaluate the potential impact of an MSA like grading scheme in Korea.

France, which has its own meat quality assurance system, has also emerged as an interest in evaluating the MSA technology.

Associate Professor Dave Pethick, a Perth-based Beef CRC research leader, has presented an outline of the Australian beef industry and MSA to the French meat industry, and as a result the first steps toward collaboration are underway.

Dr Pethick said that while Australia can offer the French its MSA technology to enhance France’s existing meat quality assurance system, the French have amassed considerable information on meat biology that could be used to explain some of the differences between MSA meat cuts.

Information about enzymes, fast twitch and slow twitch muscle fibres and connective tissue “will help us get in behind the biology of MSA”, Dr Pethick said.

That particular bridge will start being built in 2007, when the French will send a post-doctoral researcher to Australia to work with the Beef CRC, using both the MSA and the French databases to “validate and determine the international applications for MSA”.

...testing has been undertaken in Korea, Ireland and France, Japan and the US.
A project involving cattle producers, feedlotters and processors from across Australia and New Zealand aimed at increasing beef industry uptake and implementation of new research and technology is expected to improve beef business profits by at least five percent in just two years.

Undertaken by the Beef CRC, the national project involves 50 teams consisting of cattle producers, feedlotters and processors and CRC extension specialists using innovative delivery processes and regular benchmarking to quantify the impact that groundbreaking new research and technologies are making on their profits.

Known as “Beef Profit Partnerships” (BPPs), the teams will work in partnerships on their own beef businesses to measure, monitor and evaluate current practices and set new goals and objectives to improve profitability.

“In the past, the adoption of new technologies in the beef industry has been slow relative to other livestock industries. But this strategy to bring researchers and producers together will bridge the gap and deliver definite results,” said Dr Peter Parnell, Project Leader of the CRC’s “Adoption” project.

Victoria has already made a start on its BPP Program, with four groups established and underway with meetings and benchmarking of their current operations, using the Victorian DPI Farm Monitor Project model and the MLA Cost of Production Calculator. Fodder conservation and early weaning will be two of the major issues examined by Victorian BPP groups during their first year.

Tim Cooke, a beef producer from south western Victoria is a member of the Ballarat BPP group.

“The BPP model is an efficient way for me to access ideas and the latest information and technology available within the beef industry to improve the bottom line of my farming operation,” Mr Cooke said.

According to Mr Cooke, information learnt from his BPP group is particularly useful during dry times, especially like the current season. “In these groups we can learn from each other, whilst also finding out the latest ways to make the best of the situation,” he said.

“The partnership provides a really great support network and source of information during droughts such as these and gives farmers the encouragement to start implementing new technologies and practices in our own farming operations,” Mr Cooke said.

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The nuts and bolts of Beef Profit Partnerships

The project involves the development of an adoption system focused on achieving measurable outcomes across a network of 50 Beef Profit Partnership teams (BPPs) located across Australia. The outcomes of BPPs will underpin the achievement of commercialisation outcomes of the Beef CRC.

Each BPP will follow an improved performance method called Continuous Improvement and Innovation, involving an ongoing cycle of focus, action, measurement & evaluation. Key performance indicators and performance targets will be set by individual groups and then profitability framework will be used to assess the potential impact of new technology.

This process of measurement, monitoring and evaluation will be undertaken at regular intervals and progress monitored using cost of production calculators and gross margin tools.

BPPs will each meet at scheduled intervals for action tracking & support (0, 90, 180 & 270 days). The teams will determine their own adoption focus, objectives & activities and will establish focused partnership agreements with the Beef CRC.
By 2010 the Beef CRC anticipates cattle breeders may be able to get an accurate assessment of a bull or a dam’s future performance within a few months of its birth.

The technology to bring this revolution to life has already been developed and Beef CRC scientists will now test whether it can become a commercial tool for the Australian beef industry.

Professor John Gibson, leader of the Beef CRC’s Research Program 3: Adaptation and Cattle Welfare, said existing microarray technology allowed researchers to measure gene expression (how strongly a gene functions within an animal) on thousands of genes simultaneously.

In fact, the technology means that the entire 23,000-odd separate genes of the bovine genome can now be printed on one microarray plate the size of a microscope slide.

The process allows all the genes of two animals to be quickly compared, so that scientists can swiftly determine genetic differences. Over numerous microassays, a picture can be readily established of where the genes of different animals vary from the species norm.

All this is a radical leap from the process that Beef CRC researchers have been using to date, which involves teasing out the value of genes one-by-one, within herds that are carefully structured to highlight potential differences in gene expression.

Professor Gibson believes that microarray technology potentially offers twofold benefits to beef producers.

The first is the prospect that it will speed up the Beef CRC’s genetic work to previously undreamed-of levels.

“Much of the Beef CRC’s work involves looking at the inheritance of different genes using molecular markers,” Prof. Gibson said. “We’ve operated on the premise that how well an animal expresses a gene, for example how well that gene functions, depends largely on what version of the gene the animal inherits.”

“We can predict that if an animal inherits a certain copy of a gene, it will perform better or worse. But using traditional methods to get to this point is a long and tedious process.”

“With microarray technology, we think that it may not be necessary to establish which copy of a gene an animal has.”

“Because we have an overview of gene expression across the entire genome, and can see which genes are important for changing certain traits, we can instead just look at how an animal’s genes are functioning without being concerned about tracking down the individual gene type.”

This ability to get a full genetic overview of an animal could eventually lead to the grassroots application of microarray technology, Prof. Gibson says.

Work done overseas indicates that how an animal expresses its genes in early life provides an accurate picture of its gene expression at breeding age. This leads to the prospect that microarrays could be produced that carry genes of commercial interest, which could then be used to predict the breeding performance of young animals well before they reach breeding age.

Prof. Gibson observes that this would help breeders quickly eliminate genetically inferior bulls and cows without the costs of feeding and progeny testing now required to determine the duds.

It could also encourage the industry to join bulls at a younger age, speeding up genetic progress.

“If the cost of the technology becomes cheap enough - and there’s every possibility that it could - it would even be possible to test animals before they went into a feedlot, to see whether genetically, they were worth feeding and would deliver a return on investment.”

The catch?

“At the moment, it’s all blue sky stuff,” Prof. Gibson says.

“But the Beef CRC will be doing a small, low-cost pilot study on the technology in mid-2007, and that should give us a proof of principle. If that looks promising, we’ll immediately follow up with some wider testing.”

“We would hope that by the end of the current Beef CRC, we’ll know whether we have a product that is useful for the commercial beef industry.”
New technologies have advanced the Beef CRC’s discovery of new gene markers from a trickle to a flood—and that introduces a whole new set of questions for researchers.

Now it is being asked whether BREEDPLAN can be the vehicle for the wealth of new information emerging from a rapidly accelerating gene discovery process.

For much of the CRC’s existence, just identifying a single gene marker with potential commercial relevance to the beef industry was a milestone, usually reached after a long and rigorous research process.

But technologies introduced in the past 18 months have ramped up the process of gene marker discovery, to the point that Beef CRC researchers have identified nearly 150 markers in the last 12 months alone.

By comparison, it took about five years for CSIRO and Beef CRC researchers back in the 90’s to produce TG5 and then CAST3, the first and second commercialised gene markers for marbling (commercialised in July 2000) and tenderness (commercialised in November 2002) respectively. But as the new markers roll in, the focus is shifting from gene discovery to what happens next.

The Beef CRC has a definite goal for its gene marker discovery program: to obtain enough markers for key traits to explain at least 50 per cent of the genetic variation between cattle.

For instance, the TG5 marbling gene was found to only explain about six per cent of the variation in marbling. Other genes, some since identified by the Beef CRC, also influence how an animal marbles. Finding enough genes to explain at least 50 per cent of the genetic variation means a DNA test using several genes that gives a far more accurate assessment of an animal’s ability than a single gene alone.

Traits being fleshed out by the gene discovery program include meat quality, fertility, Net Feed Intake (NFI) and tick resistance. The CRC databases will also be exploited to look at new commercially significant traits, such as fat distribution (intramuscular vs. carcass) and total carcass fatness.

Professor Mike Goddard, program manager for the Beef CRC’s Underpinning Sciences program, says that the CRC hopes to identify at least 10 markers for each of the six significant traits, and by 2012 to have about 100 commercially significant gene markers available or in the commercialisation pipeline.

But at this point, the Beef CRC enters new and interesting territory. How to make all this information available to the beef producers who need it, given that Beef CRC is only one of several research organisations worldwide undertaking gene discovery for the beef industry?

“The last thing we want is for cattle breeders having to send DNA samples to half a dozen different labs to get a picture of the potential of their animal,” Professor Goddard said.

“It all has to be bundled into a single tool, and we’ll be pressing hard for that tool to be BREEDPLAN.”

DNA data can be used on its own as a predictive tool, Professor Goddard says, but that leaves cattlemen caught between two rival systems, gene markers and BREEDPLAN Estimated Breeding Values (EBVs).

“If you’re a breeder and you’ve got access to an EBV for marbling, and a DNA marker, what do you choose?” Professor Goddard says. “If we don’t develop this properly, we face the possibility that we’ll be confusing the cattle industry, not helping it.”

For successful uptake of the gene discovery work, choosing the right method of presentation will also be vital.

“I think DNA markers are best rolled into current EBVs, where those EBVs exist,” Professor Goddard says. “Again, for a gene like marbling, it’s not helpful to cattlemen to have a traditional EBV, and a marker-derived EBV.”

He points out that traits that can only be assessed on the carcass pose challenges for stud breeders, as do traits like NFI - which is very expensive to test for - and female fertility.

“If there is already an EBV for days to calving, then it would be crazy to throw it away. But we can enhance it with genetic markers for fertility.”

But there is some work ahead before this puzzle needs to be solved.

First, there are the technical and political hurdles to be negotiated before DNA markers can be integrated into BREEDPLAN; not least, the DNA testing and analysis needed to ease the integration of molecular information into conventional breed evaluation.
The rapid progress made by the Beef CRC’s gene discovery team is being watched with keen interest by beef producer and seedstock breeder Lucinda Corrigan, an independent director on the Beef CRC Board.

Mrs Corrigan and husband Bryan have been early adopters of breeding technologies on their Bowna, NSW, Angus stud Rennylea. But as a hands-on producer, Mrs Corrigan is also highly aware of the need to make technology relevant.

“How do we make it work?” says Mrs Corrigan of the gene marker program. “How do we make it add value down the supply chain? At the moment, that’s not clear.”

“While the process of pinpointing genes and their function in trait expression is maturing fast, neither we’re going to be bombarded with random genes from snake-oil salesmen.”

Her view is that the best possible course is a system that firmly integrates gene marker technology into the existing - and well-used - BREEDPLAN Estimated Breeding Value (EBV) system.

An early indication of the possibilities have emerged in Holland, where Holland Genetics is offering scans of 2000-3000 genes for about $400 a head, and then transferring the DNA information straight into the industry’s predictive breeding system, Holland’s version of BREEDPLAN.

But before this can happen, the Beef CRC needs to fully assess the value of each gene marker in expressing a trait, so that a gene’s role can be properly weighted within an EBV.

“While the process of pinpointing genes and their function in trait expression is maturing fast, neither the majority of beef producers or the commercial delivery system for gene markers are currently capable of properly handling the information,” Mrs Corrigan says.

“These markers may be used for marketing purposes at the moment, but I am talking about using this information to inform our genetic improvement system.”

“On the one hand, I’ve had breeders tell me that they’re not going to use BREEDPLAN, and instead they’re going to use gene markers to direct their breeding program. This overlooks the fact that we still don’t really know how much variation of a trait these markers describe.”

“And then there is the possibility that if we don’t properly co-ordinate the commercial use of these markers, accuracy in the EBV,” Mrs Corrigan says.

Rennylea has been an active participant in the NFI EBV program for several years.

“I think a high level of genetic literacy is absolutely necessary for a stud breeder these days. And if you’re going to produce genetics for the supply chain, you need to be well connected to the people you’re supplying.”

Mrs Corrigan lists as one of her favourite quotes a comment by an Argentinian agribusiness leader, who said his business changed when he began to “understand our business from its destination rather than its origin”.

While Rennylea is now starting to see some of the results of its breeding strategy filter down through the supply chain, Mrs Corrigan wants progress on formalising the process of producer-processor interaction - the subject of another Beef CRC program.

“We as producers of genetics need to capture some of the really innovative supply chains, the ones that are really making changes and tracking their progress,” she says. “They have the information to actually predict where they need to go, and that’s what we want to inform us at the breeding end.”
On the smell of an oily rag - cattle using less fuel and giving off fewer gases

The old adage, “what’s good for the environment is good for us” takes on a new twist when it comes to methane-producing cattle.

Livestock are estimated to produce more than 12 per cent of Australia’s greenhouse gas emissions in the form of methane. Produced by a suite of rumen microbes during the digestive process, methane is regarded as a potent contributor to the greenhouse effect.

For the beef cattle industry, these methane gas emissions also represent the loss of up to 10 per cent of digestible energy - lost productivity that the Beef CRC researchers are now set on capturing.

By 2012, the Beef CRC aims to cut methane emissions per animal by 20 per cent, and increase the dietic energy available for beef production by up to 10 per cent. If the targets are met, the research will give a substantial boost to the beef industry’s productivity, while addressing increasingly urgent political and environmental challenges.

However, Mark Morrison, Beef CRC methane research leader and Professor at The Ohio State University and CSIRO Science Leader in Brisbane, doesn’t underestimate the size of the task ahead. He believes the answer will ultimately involve a range of strategies, including genetics, feeding and direct intervention in the rumen with bioactive compounds.

A decade of work by the New South Wales Department of Primary Industries shows that some animals produce significantly more methane than the norm, and some significantly less, indicating a genetic factor in methane production that is possibly associated with genetic values for net feed efficiency.

Feed is another important factor: for instance, animals fed a grain-rich diet often produce less methane per unit of digestive energy than when the same animal is fed a grass-based diet.

But the research that could have the biggest effect on the beef industry is investigating what goes on in the bovine rumen, home to the methane-producing microbes at the heart of the issue.

Professor Morrison says that researchers figuring out how to slow methane production in the rumen must approach the issue like building a platform; stable alterations will only be achieved if multiple challenges are met and overcome. For these reasons, they need to:

• determine the range of factors that influence how much methane an animal produces, and the links between methane production, rumen microbiology and net feed efficiency. The whole animal methane measurements by NSW DPI scientists are proving to be very helpful in this regard.
• identify the range of methane-producing microbes and work out how to selectively suppress all of them
• find new pathways for the waste products normally handled by methane-producing microbes, in particular hydrogen, which is normally bound up in the methane molecule and expelled.
• stimulate or introduce other non-methane-producing strains to compensate for the lost activity of the suppressed bacteria;

“Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.” Prof Morrison says. “Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.” Prof Morrison says. “Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.” Prof Morrison says. “Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.” Prof Morrison says. “Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.”

“Another key aspect to it all is finding a way to recycle the hydrogen released during feed digestion in the rumen without producing methane.” Prof Morrison says.

Researchers at the Queensland Department of Primary Industries and Fisheries are now working on identifying families of methane-producing microbes using genetic screening techniques, so that all of them are targeted.

“There are very likely to be related families of methane-producing bacteria, which makes the job especially challenging,” Prof. Morrison says. “If we develop a strategy that suppresses one type of organism, but not its cousins and other related families, it’s very likely that another group of methane producers will step up to take the place of the one we have suppressed.”

Overall, the techniques being used are not dissimilar to those used by other Beef CRC researchers to isolate eating quality and productivity traits. Ideally, Prof. Morrison says, the project will result in a range of inoculants, bioactive agents or supplements that can be easily used by the feedlot and grazing industries to suppress methane production in cattle and at the same time capture more of the digestible energy that would be otherwise lost, into profit.
There’s a recipe for good beef that begins well before the char grill.

The basic ingredients are genetics, nutrition and management, but the Beef CRC’s Regional Combinations Project has found that like any recipe, the outcome depends on how the ingredients are used.

While there is still some distance to go in analysing the results from about 4000 steers assessed in the exercise, project leader Bill McKiernan of NSW DPI says that early findings are already delivering clear messages.

“For instance, we’ve done an analysis of different growth paths which so far show that there is little or no effect on final eating quality between animals that grow fast and those that grow slow,” Mr McKiernan said.

“That means the difference between growth paths comes back to an economic argument. When we looked at the economics, the fast grown animals are vastly better economically than slow grown.”

With earlier Beef CRC research showing that breed differences are also largely irrelevant to eating quality, such findings help narrow down the key traits that beef producers need to focus on, while widening the gene pool in which they can locate those traits.

The MLA-supported project has assessed steer progeny from six herds in NSW, Victoria, South Australia and Western Australia. A Queensland herd dropped out because of drought.

As well as genetic and growth path factors, the project MSA-graded 560 carcases and then had them taste-tested, to look at predicted eating quality and actual eating quality. (A preliminary estimate is that the MSA model is conservative in ranking eating differences compared to real tasters.)

A primary aim of the project is to establish the effect of different treatments - including sire selection, calving and weaning time, and feeding regimes - on the steers’ ability to meet market specifications.

“We’ve been saying that the industry has to meet market specifications for 20 years, but no-one really knows what that means,” says Mr McKiernan.

One of the project’s analyses is looking at the effect of different approaches on payments according to the abattoir grid.

But the project has also gone deeper, Mr McKiernan says, and is also investigating what the effects of tightening up the grid specifications might be, and as a result delivering more finely graduated payments.

“Processors and the industry want finer specifications,” he says. “While the grid provides for 7-37 millimetres of fat, they ideally want 10-17 mm.”

“We’re looking at how well the animals in the project meet a refined grid, and what would happen if it allowed more gradual discounts.

One of the problems of the standard grid is that there are big jumps in discounts. We’ve experimented with setting the top of the grid to a perfect animal, and then grading down to a heavily discounted animal.”

The project has also examined what might happen if the beef market shifted direction, for instance discounting according to yield instead of fat.

“The database quickly shows what genotypes and treatments will fit into what markets, so producers can slice and dice the information to suit their own purposes,” Mr McKiernan said.

The number-crunching is expected to be complete by the end of 2006; a report will be delivered to MLA in the first quarter of 2007, and the project’s messages for producers will be available soon after, sometime in the first half of 2007.

For northern NSW cattleman Peter Rose, the results of the Regional Combinations Project will initially be an opportunity for benchmarking, to see how his shift away from Herefords into fast-growing, high-yielding crosses stacks up against the alternatives.

Mr Rose runs a Santa-Angus cross breeding herd on his Blackville property “St Helena”, over which he puts Angus bulls. The female progeny of this joining are then put to Charolais in a terminal cross.

Fat isn’t much of an issue for Mr Rose’s European Union-targeted operation. “They only want 7 mm, and that’s a piece of cake,” he says.

Instead, he’s been chasing yield, and successfully: his steers regularly hit 350 kilograms at 20 months, and his dressing percentages now average close to 60 per cent.

So far, Mr Rose says, the project has confirmed his direction. But he’s still keen to see the results in their entirety.

“I can’t see how any producer wouldn’t get something out of this,” he said. “It’s going to really help know what to do, when.”
Beef CRC HQ draws international interest

Beef producers and Government officials from Chile, New Zealand, Kazakhstan, Thailand, America, Italy and from all over Australia have visited the headquarters of the Beef CRC during 2006.

Groups including an international agriculture delegation from Chile and representatives of the World Trade Organisation have stopped in to hear the latest in beef research developments.

In June the next generation of the United States livestock industry, more than 30 third and fourth year students from Colorado State University visited to learn about the Centre’s research which aims to maintain Australia’s status as the world’s number one beef trader.

Students heard from the Centre’s research staff including Bob Gaden, John Thompson, Robert Herd and David Johnston addressing a range of topics including genetic research, overseas markets and meat grading.

The Beef CRC was recognised as a leading example for the world’s beef industry according to the Chilean Minister for Agriculture, Dr Alvaro Rojas during his recent visit to the Beef CRC.

“Australia is not just a model for Chile, but also the world,” said Mr Rojas, “and we hope this trip can help us learn more about the industry as well as establishing trade and agency contacts.”

According to the Minister, the beef industry is the latest agricultural boom in Chile.

“The 70s were forestry, in the 80s it was fruit, wine in the 90s and now Chilean agriculture has turned its focus to the beef industry,” Mr Rojas said. But unlike neighbouring South American beef industries, Mr Rojas said Chile would like to follow in Australia’s footsteps and create a beef industry recognised for producing good quality beef rather than volume.

“We really acknowledge Australia’s beef industry and we aim to adopt the same high level in our emerging cattle industry,” said Dr Rojas.

Accompanied by the Australian Department of Agriculture, Fisheries and Forestry the delegation toured the Beef CRC research facility, ‘Tullimba’ west of Armidale, after attending the recent Cairns Group meeting.

Colorado State University students, Amanda Stansky, Cheyenne Dixon, Katie Johnson, Caitlan Antle, Krista Schiffers and Jessica Heath.

Chilean Minister for Agriculture, Dr Alvaro Rojas and Chilean Ambassador, Mr Jose Luis Balmaceda with Beef Cooperative Research Centre CEO Dr Heather Burrow.

L to R: Kairat Sabitov, Aitugan Mukashev and Assemgul Khassenova.
The beef industry’s biggest players will speak at a unique feedlot workshop delivering the latest Beef Cooperative Research Centre (Beef CRC) research and practical skills to help improve the paddock to plate supply chain.

Representatives from Australia’s largest cattle producer, the Australian Agricultural Company, Australia’s largest processor, Australian Meat Holdings and one of the countries largest feedlots, Rangers Valley will speak at the Armidale Feeder Steer School in January.

The popular workshop last year drew a capacity crowd with participants from New Zealand, Korea, New South Wales, Tasmania, Victoria and Queensland, representing all levels of the beef industry.

Held from January 30th to February 1st, 2007, workshop organiser, Angus Australia’s Bob Dent says the residential school offers cattle producers and backgrounders the chance to learn how to maximise the opportunities when selecting and preparing cattle destined for the feedlot trade.

“Using a mix of practical and theory sessions the school shows producers and backgrounders how they can apply the latest breeding, nutrition and marketing research to generate a more productive and profitable herd.”

“The School covers three main issues: tailoring production to meet different market specifications; applying new research to improve production; and using genetics for herd improvement. It is regarded by industry as the best place in Australia to learn the skills needed to tailor production to meet precise feedlot and markets specifications.”

The 2007 Armidale Feeder Steer School will feature speakers from industry, government and research covering the latest trends and the future direction of the feedlot industry, meat quality and grading, sire selection and breeding programs as well as a tour of Rangers Valley, a 24 thousand head feedlot supplying the long fed Japanese and Korean market.

Regarded a must for those involved in the cattle and feedlot industry, the school is a joint initiative between the New South Wales Department of Primary Industries, Angus Australia and the Beef CRC.

Registration for the 2007 Armidale Feeder Steer School closes on January 18.
More than 100 new articles written specifically for beef producers have been added to the Livestock Library database, a free information resource for beef and sheep producers.

Currently there are almost 16,000 journal articles, conference papers, extension documents and web pages available on www.livestocklibrary.com.au with new information constantly being added, ensuring the site is a comprehensive ‘first port of call’ for livestock production information.

Livestock Library is a one stop site for the beef and sheep industries – including producers, students, researchers and service providers and now with new software upgrades you no longer need a password to access the site, it’s as simple as visiting www.livestocklibrary.com.au. When you have arrived at the site you can use the Brief Search screen, likened to Google or click on the Advanced Screen search for a more detailed browse.

The great advantage of the Livestock Library is that every link is to a full text article or a web page. Currently conference papers and extension articles accessed via the Livestock Library are free to all users, while publishers may impose charges prior to downloading journal articles.

More than 16,000 research articles FOR FREE!

A new report has highlighted the economic impact Cooperative Research Centres are making on the Australian economy.

Released by the Minister for Education, Science and Training, the Hon Julie Bishop MP, the report found CRCs have boosted the economy by an estimated $2.7 billion.

The economic impact study measured net economic benefits for the economy for the period 1991 to 2010. It only considered benefits that could be quantified by industry and occurred as a direct result of the CRC Programme’s research, training and commercialisation activities.

Minister Bishop said that the CRC Programme has played a key role in supporting the success of Australian industry in global markets.

“The value of the CRC Programme is well known by industry, however this study measures the benefits in a tangible and significant way.”

“The report shows the net benefits of the CRC Programme are at least twice the level calculated previously. The return to Gross Domestic Product (GDP) for each dollar invested in the CRC Programme is $2.16, a return of more than 2.1.”

The Beef CRC contribution to the Meat Standards Australia Scheme and development of vaccines to control bovine respiratory disease in feedlot cattle were highlighted in the report, which is available from http://www.crc.gov.au/
Beef CRC drafts next generation of livestock experts

The Beef CRC Scholarship Program is finding the next generation of experts to help keep Australia at the top of the international beef industry, well into the 21st Century.

The 2007 Beef CRC Scholarship Program has now closed with strong interest for the scholarships worth up to $28,000 a year, tax-free.

Beef CRC Scholarship Program Coordinator, Dr Graham Gardner says with more than 20 applications received, interest has been as strong as ever.

“The strong interest is due to a number of factors,” Dr Gardner said, “first and foremost it’s the money on offer. Valued at $28,000 tax free per annum, the scholarships are no longer just attracting school leavers, but salary earners as well.”

“This stipend represents not near as much of a pay cut for salary earners as it was in the past and this has been evident in the number of applications we have received from experienced people in the workforce.”

“The reputation of the Beef CRC and it’s post graduate education popularity and notoriety has also boosted interest for the 2007 intake.” Dr Gardner said.

Scholarships holders will have the opportunity to work alongside some of Australia’s leading scientists on Beef CRC research projects aimed at increasing the returns to the beef industry by $179 million per annum.

“Potential students have identified an issue of particular importance to the Australian beef industry and if they are successful a research project will be created to investigate and deliver research outcomes to benefit the Australian industry,” Dr Gardner said.

“The Beef CRC scholarship program presents a real opportunity for the next generation to become involved in shaping the future of the Australian beef industry and it will provide significant benefits for the Australian beef industry well into the future,” Dr Gardner said.

Currently the Beef CRC has fourteen scholarship projects underway, researching issues including gene marker technology focused on marbling in Bos Indicus cattle to the uptake of new technologies in the beef industry.
Australia’s largest integrated beef research program
**Who are we?**

**Beef CRC Board Profile**

The Beef CRC Board comprises an independent beef industry Chairman, the CEO and seven non-executive Directors appointed on the basis of their skills and elected by the CRC’s industry and research Participants. At least two Directors are highly experienced in R&D management, at least two Directors are highly experienced in beef industry issues and the remaining three have specialist skills in areas such as finance, legal, commercialisation management and knowledge and experience of collaborative research. Currently, five of the nine Directors are independent of the Participants. Six Directors are from the private sector.

**Mr Guy Fitzhardinge** (Chairman) is a commercial cattle producer from NSW and a past member of the Boards of Meat Research Corporation and Meat and Livestock Australia. He has postgraduate training in extension and agricultural economics and is committed to R&D and commercialisation of results.

**Mr Rob Backus** brings northern beef sector and feedlot expertise and knowledge of the industry relevance of genomics to the Board. Mr Backus has had a close personal involvement in the Beef CRC since 1992, was a member of the Beef CRC Advisory Committee since 1999 and a member of the third term Renewal Committee 2003-2005.

**Mrs Lucinda Corrigan** is a southern beef sector expert and seedstock business operator that was a cooperating herd in CRCI from 1992. She is also a Director of the CRC for Plant Based Management of Dryland Salinity. She brings beef industry communication skills to the new CRC Board.

**Dr Jay Hetzel** has worked for more than 25 years in cattle genetics and genomics research and commercialisation. He combines expertise in R&D and Intellectual Property (IP) management and commercialisation with knowledge of CRCs.

**Mr Greg Robbins** is General Manager of Animal Science for the Queensland Department of Primary Industries and Fisheries (QDPI&F) and former Director of the Queensland Beef Industry Institute. With more than 20 years of experience Greg has a strong understanding of the northern beef industry.

**Professor David Siddle** is Pro-Vice Chancellor (Research) at University of Queensland. He is a highly experienced R&D manager with extensive knowledge of CRCs and corporate governance and financial skills from diverse Boards and budgetary responsibilities through the University of Queensland.

**Dr Keith Steele** is a business advisor with beef R&D management experience, genomics knowledge and corporate governance and finance skills. He has IP commercialisation experience in Australia and New Zealand and is a current or former Director of 16 technology companies.

**Professor Grant Sutherland AC** is an acknowledged genetics expert, with experience of CRC management and extensive experience in commercialisation of intellectual property resulting from Australian R&D. He is a co-founder of Bionomics Ltd and an Executive Director of Biolipids Pty Ltd and of New World Bio Ltd.

**Dr Heather Burrow** (Chief Executive Officer) has 28 years quantitative genetics R&D experience, specializing in genetic improvement of tropically adapted beef cattle. She has 12 years management experience in the Beef CRC with 5 years as Deputy CEO. She is committed to delivery of results to industry.
Swans Lagoon Research Station fills an important role for the Beef CRCs northern research managing a proportion of the Brahman cows and progeny required in Beef CRC Research Program 4 – Female Reproductive Performance, the largest project of its kind in Australia.

Nearly 400 cows donated to the Beef CRC from the Consolidated Pastoral Company, McDonald Holdings, Belmont Research Station, Cona Creek and Tartrus call the 36,000 hectares that make up Swans home. Situated on the banks of the Burdekin River, south west of Ayr, the station has a carrying capacity of approximately 3500 head. Despite a worrying start for 2006, late but good wet season rain has helped feed quality hold up and kept conception rates solid.

Manager Stephen O’Connor isn’t only working the cattle yards on a daily basis, but as the contributor of these photos he is also at home behind the lens.
More than fifty Brahman bulls sourced from some of Australia’s leading seedstock producers as well as overseas have been evaluated as part of a large research project to help pinpoint the best ways of breeding productive and profitable progeny in northern Australian environments.

The Beef Cooperative Research Centre (CRC) research project is using purebred Brahman bulls from a number of seedstock herds identified in conjunction with the Australian Brahman Breeders’ Association as being representative of the range of Brahman genetics available in Australia over the past decade.

The project used leading bloodlines from Australia, South America, Brazil and the United States and were joined in industry herds to Brahman cows contributed by Belmont Research Station, Cona Creek, Consolidated Pastoral Company, McDonald Holdings, Stanbroke Pastoral Company and Tartrus.

The bulls, including well known sires like Lancefield Ambition and Mr International, were joined over four years (shown in figure 1 as Generation 0) and their progeny (Generation 1) have since been involved in an intense evaluation program spanning the past seven years.

During this time the progeny have been data recorded over diverse environments for a wide range of productive and adaptive traits, including complete carcase and beef quality, feed efficiency, resistance to stressors such as ticks, worms, buffalo flies, heat and seasonally poor nutrition, age at puberty in heifers, days to calving in breeding females and scrotal size in male offspring.

To further value add the research the Generation 1 female progeny are now also being recorded for traits associated with lifetime reproductive performance, taking into account environmental stressors and

Table 1. Highest and lowest EBVs for project Brahman sires for a range of traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>Lowest EBV</th>
<th>Highest EBV</th>
<th>Range</th>
<th>Estimated diff. in progeny</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcase Weight</td>
<td>-8</td>
<td>+44</td>
<td>52kg at 650 days of age</td>
<td>26kg carcase weight</td>
</tr>
<tr>
<td>Retail Beef yield %</td>
<td>-1.2</td>
<td>+3.6</td>
<td>4.8% at 300kg carcase</td>
<td>2.4% saleable meat yield at a 300kg carcase = 7.2kg saleable yield</td>
</tr>
<tr>
<td>Days to Calving</td>
<td>+16.6</td>
<td>-12.9</td>
<td>30 days</td>
<td>15 days</td>
</tr>
<tr>
<td>Jap Ox $ Index</td>
<td>-23</td>
<td>+54</td>
<td>$77 per cow joined/yr</td>
<td>$38.50 per cow joined/yr</td>
</tr>
</tbody>
</table>

The full results from this Beef CRC research project detailing performance of each of the 50 sires and their progeny will be publicly released early next year.

Beef CRC Generation 1 Stanbroke heifers at Belmont Research Station
lactation. Their male offspring (Generation 2) are being evaluated for male reproductive traits to identify traits in males that will improve the reproductive performance of their daughters and other female relatives.

Early results are already showing large differences between the sires in the project, indicating there are significant economic gains for breeders willing to base joinings on genetics and producers purchasing bulls proven to be genetically superior based on measured performance.

Estimated Breeding Values (EBVs) of the Generation 0 sires evaluated in the project have been calculated for some of the project traits. Table 1 shows the range of Brahman BREEDPLAN EBVs between the best and worst Brahman sires for a number of different attributes.

Using current market prices, the results show that basing selection of breeding cattle on measured performance will generate increased economic returns. For example, research found one sire is able to breed progeny with the ability to add an extra 26 kilograms in carcase weight. Using recently quoted figures from the Queensland Country Life (31/8/2006) of 345 cents a kilo, this equates to an extra $90 dollars a head, achieved simply by carrying out some genetic homework.

Another trait identified from Beef CRC research as having a major impact on productivity in the research project is days to calving.

One bull in the research project is able to reduce the days to calving of his daughters by nearly 15 days. This equates to more than a 15 percent difference in calving rate with the added benefit of steers that are born early in the calving period and all at the same time of the year provides a significant advantage when preparing and managing sale progeny.

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Similarly significant economic gains have also been identified in regard to saleable meat yield. The bull with the best EBVs for the saleable meat yield trait was able to increase meat yield in his progeny by an extra 7.4 kilograms. Multiply this by the average of $10 per kg and an extra $74 a head is achievable.

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Table 1. Trait means and ranges of performance for Brahman sire EBVs

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<th>Max</th>
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<tr>
<td>Age at puberty* (days)</td>
<td>751</td>
<td>394</td>
<td>1211</td>
</tr>
<tr>
<td>Weight at puberty (kg)</td>
<td>334</td>
<td>196</td>
<td>485</td>
</tr>
<tr>
<td>P8 Rump fat depth at puberty* (mm)</td>
<td>4.5</td>
<td>1.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Heifers achieving puberty* by commencement of first joining at 2 years (%)</td>
<td>0.51</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Days to calving following first joining (days)</td>
<td>346</td>
<td>279</td>
<td>423</td>
</tr>
<tr>
<td>Calving success following first joining (%)</td>
<td>0.71</td>
<td>0.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*First observed/scanned CL

Table 2. Trait means and ranges of performance for Brahman heifer progeny

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*First observed/scanned CL
that a first corpus luteum (CL) was detected on the ovary during regular ovarian ultrasound scanning was slightly more than two years of age in the CRC environments (Toorak, Swans Lagoon and Belmont Research Stations near Julia Creek, Ayr and Rockhampton respectively), some heifers achieved puberty at about 13 months, whilst others did not achieve puberty until >39 months.

Weight and fat depth at the time the heifers achieved puberty varied enormously. One aim of the CRC study is to identify those sire lines which reached puberty early and determine whether they are also the same sire lines that have best lifetime fertility. Another aim is to identify indicator traits of lifetime fertility (e.g. growth rate and body composition traits) that could be modified using non-genetic approaches, to determine the economic feasibility of managerial interventions to improve reproductive performance.

Age at first CL was strongly genetically correlated with days to calving and calving success following first joining in Brahmans, indicating that females that were younger at puberty had genetically shorter days to calving and increased calving success when mated for the first time at approximately 25 months.

All data collected from the Beef CRC project goes into BREEDPLAN and EBVs are readily available on the web at http://breedplan.une.edu.au/

To date the research project has yielded two significant findings: the first that the difference in the age of puberty for the bulls’ daughters could vary by as much as six months, and secondly there is an overall difference of 25 percent in the calving rate between the daughters of the project, a trait which is estimated to have an 18 percent heritability.

In Brahmans, age of first CL could be used as an indirect selection criterion to improve subsequent reproductive performance, provided it can be measured cost effectively in industry and providing the associations with lifetime reproductive performance indicate the approach would be economically important for industry.

Full results from this Beef CRC research project detailing performance of each of the 50 sires and their progeny will be publicly released early in 2007.

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Full results from this Beef CRC research project detailing performance of each of the 50 sires and their progeny will be publicly released early in 2007 after the sponsors of the project have been informed.

MORE INFORMATION
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Phone: 02 6773 2658
Email: djohnsto@une.edu.au

One of the world’s leading Brahman sires, Mr International has been involved in Beef CRC research.

Australia’s largest integrated beef research program
Marbling Biology: What do we know about getting fat into muscle?

Key findings of research

- Intramuscular fat content (% fat) or marbling score is late maturing.
- The expression of marbling is due to maintained fat synthesis combined with declining muscle growth as animals grow older.
- A growth curve for the development of marbling found (i) a period up to approx. 200kg where intramuscular fat does not increase (ii) a period of linear development as carcass weight increases from 200-450kg and (iii) the suggestion that intramuscular fat content reaches a maximum at mature body size (approx 500kg carcass weight depending on breed).
- Expression of intramuscular fat after extended grain finishing is driven by three primary genes (i) overall fatness (ii) the degree of muscle development which also interacts with mature body size and (iii) the extent of fat distribution bias toward the intramuscular site. Further interaction of these genes will help in the final understanding of how they affect final marble score.
- The level of intramuscular fat at the start of finishing is a key determinant of the final level of intramuscular fat after finishing supporting the use of ultrasound estimates as a means of selecting superior marbling animals.
- Recent results from Beef CRC research in collaboration with International partners using modern biochemical and genomic tools suggest that (i) intramuscular fat cells are different to other fat depots (i.e. subcutaneous) and (ii) intramuscular fat cell development is determined relatively early in life (3-8 months of age).
- The major nutritional and/or management tool for increasing the development of marbling is to maximise the availability of net energy (and glucose) for fat synthesis during finishing.
- Net energy available for fattening is the most likely reason why grain feeding (compared to grass) results in a higher marbling score at equal carcass weights.
- In heavier ‘British’ type cattle (Live Weight ≥540kg, P8=12mm) it is difficult to increase the net energy for fattening by reducing protein supply (that is these cattle have a low protein requirement) and this is clearly an avenue for reducing feed costs.
- Increased processing of the ration (i.e. steam flaking versus dry rolling) will increase the net energy intake and glucose supply and increase marbling.

The role of intramuscular fat in meat palatability

Despite all the hype, world literature suggests that marbling only explains 10 to 15% of the variance in palatability. Meat Standards Australia (MSA) research basically agrees and shows that the contribution of marbling to palatability was significant and important, but just one of many factors determining final palatability. However it has been suggested that as variations in tenderness are controlled by schemes such as MSA, marbling will become a more important determinant of palatability due to its specific contribution to juiciness and flavour.

There is concern that very low levels of intramuscular fat will lead to meat that is dry and less tasty. Such a situation has been found in young highly muscled lean cattle (e.g. double-muscled cattle genotypes, young bulls from Belgian Blue or Blonde d’Aquitaine) and in many cuts from modern pig genotypes. The minimum requirement for intramuscular fat in order to achieve acceptable consumer satisfaction for grilling ‘red meat’ cuts (beef and lamb) is quoted at 3-4% on a fresh uncooked basis.

Development of intramuscular fat - Growth and development

Adipose tissue is deposited in specific depots primarily in the abdominal cavity (perirenal, mesenteric and omental) and intermuscular, subcutaneous and intramuscular sites. However the proportions differ between the species and are influenced by age. Intramuscular fat represents about 5-10% of the total fat in the live animal and so it is of a moderate to small size.

The development of intramuscular fat in beef cattle is shown in Figure 1. Based on this data the Beef CRC can hypothesise four drivers of intramuscular fat development (i) the potential for total carcass fat deposition (ii) the potential for muscle growth (iii) mature body size and finally (iv) the extent of fat distribution bias for intramuscular fat versus other carcase depots. Importantly these principles suggest that genetic selection (via traditional quantitative genetics or via gene marker assisted selection) for increased intramuscular fat alone could come about via alterations in any of the drivers described above.

Selection for high levels of muscularity is known to reduce both total carcase fatness and intramuscular fat at a given carcase weight. Recent work in sheep has shown that lambs produced from sires with a high estimated eye muscle depth (using the Sheep Genetics Australia system) produce substantially leaner carcasses with reduced intramuscular fat when compared to lambs from sires with an elevated estimated breeding value for post weaning eye muscle depth. Therefore the Beef CRC propose that the developmental curve for intramuscular fat will be shifted to the right in animals with a high propensity to grow muscle or with a greater mature body size (and in these cases with the same propensity
to marble at maturity, Figure 2). This ‘right shift’ would also occur in response to metabolic modifiers such as hormonal growth promotants, β agonists and organic chromium supplementation, all of which can increase muscle growth.

In very highly muscled animals it might be that intramuscular fat does not reach the ‘linear accumulation’ phase discussed in Figure 1 within normal commercial slaughter weights (that is the right shift described in Figure 2 is profound). This would appear to be the case for the modern pig genotypes where intramuscular fat % does not increase over a wide range of commercial carcass weights.

The initial or ‘starting’ intramuscular fat content at ≤ 200kg carcass weight is likely driven by the genetic predisposition for development of fat cells at the intramuscular site relative to other depots. Importantly there is a proportional developmental difference that is maintained when the American or Australian cattle are compared to the Japanese Black cross cattle such that the starting (2 vs. 4%) and final (13 vs. 27%) intramuscular fat contents are proportionally different at about 2 fold (Figure 1).

This suggests that the potential for development of fat cells is fixed relatively early in life and there after changes in either size and/or number of cells occurs in proportion to the initial cell number. This would clearly indicate that a measure of intramuscular fat content (perhaps by non invasive methods such as ultrasound) would be a good predictor of subsequent marbling performance.

**Development of intramuscular fat - Metabolic Understanding**

Recently some gene expression work has been undertaken by the Beef CRC using both Japanese and Australian cattle and the results confirm that developmental changes related to marbling occur quite early in life. Thus by 11 months of age Japanese Black cattle had a significantly greater expression of genes associated with intramuscular fat compared to other beef breeds and the key time of maximal difference in gene expression was between three and eight months of age (before the end of weaning).

Related work has established that marbling adipocytes show a preference for glucose carbon while subcutaneous adipose tissue uses mainly acetate as a source of acetyl units for lipogenesis. This may offer an opportunity to study the role of specific nutritional and hormonal intervention work in young (pre-weaning) cattle to ‘set up marbling’ for the finishing phase.

Another feature associated with the development of intramuscular fat is the muscle fibre type or metabolic pattern of energy use expressed by the muscle tissue. Within the one animal genotype the ‘fast twitch’ or white muscle types (e.g. eye round) marble less strongly. Across genotypes a similar response can be found.

In a Beef CRC study in collaboration with French scientists where two muscle types were contrasted across three breeds of cattle with disparate propensity to accumulate intramuscular fat, there was a strong correlation between intramuscular fat and ‘slow twitch’ or red muscle fibres.

**Nutritional modulation of intramuscular fat - Manipulating protein and energy**

Nutritional manipulation of intramuscular fat levels in pork via altering the dietary protein:energy ratio has been clearly shown in a number of studies. Of course the basic premise is that by restricting muscle development through a subtle protein deficiency, total carcass fatness will be increased sufficiently to elevate intramuscular fat.

The results of manipulating the protein:energy ratio in beef cattle diets is less conclusive. The conclusions from two studies Beef CRC were that diets which contain more or less protein than recommended amounts for feedlot animals do not lead to significant differences in marbling or intramuscular fat. However, there was a trend for high protein diets to produce less and low protein diets more marbling than control diets in both experiments. Certainly the data suggests that a simple diet based on cereal grain and hay (=10-11% crude protein, with no additional protein source in the form of grain legumes or urea) fed to Angus steers at a starting
live weight of 540 kg (P8 back fat = 12 mm) produced equal performance to more traditionally formulated rations containing additional protein sources at an extra cost.

Nutritional modulation of intramuscular fat - Fermentation pattern in ruminants

It has been assumed for sometime that diets which promote both: (i) maximal fermentation in the rumen to produce glucose precursors (propionate), and (ii) which maximise starch digestion in the small intestine (to produce free glucose) might increase intramuscular fat deposition. Such diets are usually associated with high levels of processing which increase the accessibility of the dietary starch granule to both microbial and animal amylases and so maximise the availability of glucose to the fattening animal.

The logic behind this hypothesis was that (i) such diets would promote increased levels of anabolic hormones (insulin) which are known to stimulate lipogenesis; (ii) the logic parallels the observation in humans that diets with a high glycaemic index (i.e. diets that allow rapid glucose absorption and concomitant high insulin levels) promote obesity; (iii) Such diets will also deliver increased levels of net energy for lipogenesis (the reason why grain feeding promotes more intramuscular fat development compared with grass finishing and (iv) there is evidence that marbling adipocytes show a preference for glucose/lactate carbon while subcutaneous adipose tissue uses mainly acetate as a source of acetyl units for lipogenesis (see above).

Conclusions

Intramuscular fat is clearly an important but not exclusive determinant of consumer response to beef. A major determinant of intramuscular fat content is the potential for mature size and muscle growth. Thus animals which display high muscle growth either have reduced expression or show no development of intramuscular during the so called fattening phase. In this scenario genetic approaches for increasing intramuscular fat will need to focus on changing fat distribution (toward intramuscular fat) if the potential for muscle growth is to be maintained.

Our knowledge of fat development at the intramuscular site is now being underpinned by new metabolic and genomic characterization of pathways for adipogenesis and lipogenesis and the hope is that this might allow for some nutritional management of marbling.

Nutritional manipulation of intramuscular fat independently from total carcase or whole body fat depots has proved difficult to achieve. However there is now a growing body of evidence that intramuscular adipocytes are metabolically different to at other depots (subcutaneous fat) and further research is needed to see if this offers the possibility for targeted stimulation of fat development within muscle.

MORE INFORMATION

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Australia is battling for the title of the world’s largest beef exporter, but to maintain or increase share of the world beef trade, it must continue to produce high quality beef tailored to Australia’s sometime harsh environment.

Research underway by the Beef Cooperative Research Centre, Australia’s largest beef research program is helping maximising beef production by enabling cattle producers to match the genotype (breed) to a particular environment and certain markets - precision breeding to increase productivity and profitability.

Some genotypes have attributes making them better suited to particular environments. However, in every environment, there are factors that limit beef production, which basically means that no one breed is going to be “best” in all environments. But by crossbreeding, picking and choosing desired traits from a range of breeds producers are able to tailor their herds, specifically.

Crossbreeding allows the best features of different breeds to be combined. This is known as complementarity. Complementarity is defined as crossing breeds to combine direct and maternal breed and heterosis effects to optimise performance. Complementarity also helps match genetic potential for growth rate, mature size, reproduction and maternal ability and carcase and meat quality attributes with climatic environment, feed resources and market requirements.

Aiding the development of crossbreeding, over the past decade there has been an increasing emphasis on development of molecular genetic tools such as genetic markers, to improve beef production and quality through marker-assisted selection.

Australian beef breeders are faced with the challenge of using vastly diverse production environments and systems to produce cattle that are both productive and profitable and beef products that satisfy consumer requirements. To do this, they need knowledge of genetic and non-genetic influences on beef production and quality.

One of the most powerful tools available to them is the use of crossbreeding and composite populations. Results from extensive research programs from crossbred and composite populations, have been able to define specific benefits for Australian beef producers embarking on a composite breeding program. These studies have focussed on a range of attributes including growth, carcase and beef quality and female fertility attributes, because improvement of these traits has the greatest economic impact on beef enterprises.

Breeds and breed types

No single cattle breed has all attributes that are needed to produce beef efficiently in all environments and to meet the requirements of all markets. Great variation exists between breeds in performance for both productive and adaptive traits. Hence, appropriate use of systematic crossbreeding programs provide significant benefits to beef producers, particularly through improved growth and female fertility, in both temperate and tropical environments.

Breeds can be categorised into several general groupings according to mature size and rate of maturing. Although in temperate areas there may be substantial differences between some of the breeds
within the general groupings, in tropical and subtropical areas, differences in performance tend to be masked because of the stressors of the environment. Hence, in tropical areas, the broad groupings are reduced to the following:

1. Bos taurus: In general, these breeds have good growth and reproductive rates and good carcase characteristics when reared in the absence of environmental stressors. However, they are poorly adapted to tropical environments, and thus their productive attributes cannot be expressed in harsh environments. These breeds can be subdivided into:
   - British breeds such as Hereford, Shorthorn, Angus, Murray Grey, Wagyu;
   - Large European breeds such as Charolais, Simmental, Saler, Limousin, Romagnola.

2. Bos indicus: These are breeds derived from the Indian subcontinent (e.g. Brahman, Sahiwal, Sindhi, Indu-Brazil). They are the breeds best adapted to tropical environments, but this is at the expense of productive traits (growth, fertility, carcase attributes), except when animals are reared in the most severe tropical environments.

3. Sanga: These are Bos taurus breeds that evolved in the harsher regions of southern Africa, so whilst they retain the productive attributes of the Bos taurus breeds, they are also relatively well adapted to tropical and subtropical environments, although their resistance to environmental stressors is generally below that of pure Bos indicus breeds. Sanga breeds currently available in Australia are the Africander, Tuli and Mashona.

4. Synthetic tropical breeds: These synthetic (or composite) breeds can be based on either the Bos indicus or the Sanga breeds, and can therefore be subdivided into:
   - Brahman x British: e.g. Droughtmaster, Santa Gertrudis, Braford, Brangus
   - Brahman x Large European: e.g. Charbray, Simbrah, Braler
   - Sanga x British: e.g. Belmont Red, Bonsmara and Barzona, all of which are regarded in Australia as lines of the Belmont Red breed, though the Bonsmara was developed in South Africa and the Barzona in North America. All are based on the Africander breed.
   - Boran: a unique stabilised breed derived from Eastern Africa, founded from Bos indicus x Bos taurus crosses. Based on limited data, this breed performs differently to other Bos indicus x Bos taurus crosses such as Brahman x British or Brahman x Large European breeds.

Crossbreeding systems and composite populations

Options for genetic improvement of beef cattle include within-breed selection, systematic crossbreeding and the use of composite populations. Within-breed selection is a very effective tool over the medium-long term for improvement of traits that are moderately to highly heritable (e.g. growth, carcase attributes, resistance to ticks, worms and heat stress.) However breeders must remember that although the benefits of selection are cumulative across generations, the process is slow, and hence the best way to optimise use of within-
breed selection is, in the first instance, to combine the breeds and breed types that are most appropriate for the target markets and production systems. It will be a lot quicker and more effective for breeders to increase growth of an Angus herd for instance, by the use of Charolais sires, rather than relying on within-breed selection!

Systematic crossbreeding systems can be planned to optimise the use of different breeds and breed types. There are infinite numbers of combinations of crossbreeding systems that producers could use, and like breeds, none is perfect for all markets and production systems and no one system is suitable for all herds.

When breeders design a crossbreeding system, they need to consider the size of the herd (generally, herds that use fewer than 4 sires will not achieve satisfactory gains from use of systematic crossbreeding), the facilities available for handling the various groups of crossbred cattle, the amount and skill of labour available and the breeds that suit the markets, feed available and other resources. The most essential requirement of an effective crossbreeding system (or formation of a composite breed) is that the system must be properly planned. Crossbreeding generates hybrid vigour or heterosis. Heterosis is defined as the difference between the average of reciprocal first crosses (for example, F1 A x B and B x A) and the average of the two parental breeds (A and B) mated to produce the reciprocal crosses. Heterosis can be both favourable (e.g. increased calving rates of F1 Brahman x British breed cows relative to the average calving rates of Brahman and British parental breeds) and unfavourable (e.g. increased calf mortalities that result directly from increased birth weights of F1 Brahman x British calves out of British breed dams, compared to the average calf mortalities experienced by straightbred Brahman or British breed cows).

In general, heterosis and heritability (the degree to which a trait is under genetic control) are inversely related. Hence, greatest heterosis is achieved for traits that are the least heritable (e.g. female fertility, survival, longevity and for combinations of traits, such as weight of calf weaned per cow joined.) Crossbreeding should be used in conjunction with selection in the parental breeds to achieve long-term genetic improvement. This is demonstrated by studies showing that maximum genetic gains are achieved by a combination of selection of superior animals within a breed and crossbreeding, as shown in Figure 2.

The Composite checklist

There are a number of general considerations that producers should remember when making decisions on different crossbreeding systems. These include:

- In general, rotational systems generally make more effective use of heterosis than development of composite populations, but they are much more difficult to manage. Over a number of generations, about 68% of the F1 heterosis is maintained in 2-breed rotations, 86% in 3-breed rotations, 50% in 2-breed composites and 75% in 4-breed composite populations.
- Terminal crossbreeding systems work well in livestock species with high reproductive rates (e.g. poultry and pigs) but less well in species with lower reproductive rates such as cattle.
- Composite populations maintain significant levels of heterosis, though less than rotational crossing. However, they have the ease of management of straightbreeding systems.
- Heterosis retained in composites increases as the number of breeds in the composite increases. This can be calculated as (number of breeds in the cross – 1) / number of breeds in the cross. For example, if there are 5 breeds in the cross then the amount of heterosis retained in the composite population is 5-1/5 = 4/5 or 80%.
- At Clay Centre (Nebraska), 50:50 Continental and British crosses had a much better chance of hitting profitable targets for retail product percentage, marbling and carcass weight than other crosses.
- In northern Australian environments, 25% - 75% adapted genes are required. These genes can be derived by the use of both Bos indicus or Sanga breeds, with greater levels of adaptation required in the harsher environments.
- Alternative crossbreeding systems use genetic differences among breeds, heterosis and complementarity with differing degrees of effectiveness.
- Responses to crossbreeding and formation of composite breeds are greatest for lowly heritable traits such as female fertility, survival and longevity, and to a lesser extent, in growth. In studies from the USA and northern Australia, there is little or no response (3% or less) to crossbreeding in carcase and beef quality attributes, independent of the effects of heterosis on growth (i.e. at the same carcase weight, heterosis has little or no effect on carcase and beef quality attributes.)
- Although heterosis effects do not significantly improve carcass composition or beef quality, crossbreeding can potentially benefit these traits through increased growth rates and also through complementary blending of breed characteristics to reduce problems associated with genetic antagonisms between traits such as retail beef yield and marbling.
- Genetic progress will be maximised through simultaneous selection of parental breeds for the traits of interest. However, breeders must remember the genetic antagonisms that exist both within and between breeds when they are implementing their breeding programs, to ensure that correlated responses do not retard genetic progress.
- Regardless of what option or options are used to genetically improve beef cattle, accurate recording for the traits of interest is essential.
The animal welfare debate is often characterised by emotion over fact, because facts on the matter tend to be hard to come by - an issue that the Beef CRC is working to overcome.

The Beef CRC cattle welfare project is working on developing objective measures of cattle welfare and it is hoped that this will form part of a larger Australian and New Zealand research initiative that aims to develop objective, scientifically defensible measures of animal welfare for our respective cattle and sheep industries.

Beef CRC research scientist Drewe Ferguson notes that it is a field “burdened by controversy”, and as such has to be investigated carefully and thoroughly.

“It’s unlikely that there is going to be a single measurement that applies to all situations, so we have to recognise and assess a range of measurement responses that represent both the emotional and physiological states of the animal,” Dr Ferguson says.

Research on the issue will cover a range of fields, from behaviour and emotions to physiology, health and productivity. In the short-term, the aim is to find a set of measures that provide “scientifically defensible” indicators of animal welfare under different conditions.

The Beef CRC is working on a more strategic aspect of this research. The Centre hopes to contribute its expertise in molecular biology and stress physiology to the wider research initiative by examining whether changes in gene expression in white blood cells can be an effective objective measurement of stress.

“Gene expression changes in specific white blood cells have been reported in response to a whole range of stressors,” Dr Ferguson said.

“Our primary focus is on the relationship between stress and the immune system, and the specific changes in lymphocyte gene expression in response to stress.”

“We need to follow through the gene expression changes in cattle after they have been subjected to psychologically and physically demanding challenges and identify specific genes or changes that are indicative of some failure to adapt to these challenges.

“The fact that there is a change in the response to a challenge is not as important as how long the change lasts. Sustained levels of change may indicate a failure to adapt to the challenge and this potentially is more informative from an animal welfare perspective.

Breeding polled cattle is a cost effective alternative to the practice of dehorning, which is increasingly being viewed as an animal welfare issue.

Figure 1. Naturally polled cows from Kenilworth Station
The plan is to conduct microarray experiments and targeted gene expression studies on tissue samples collected from cattle that have been exposed to specific challenges (e.g., chronic fear, fatigue) to identify the more informative markers.

While this research is more long-term, the end result may eventually be a quick, cost-effective on-site test that augments existing welfare measures to provide a more complete assessment of the welfare status of animals.

The new understanding gained from this research will also yield new leads with regard to the well-documented yet poorly understood association between stress and immune function in livestock.

One particular aspect of the welfare project already underway aims to identify DNA tests for the poll, African horn and scur genes in tropically adapted cattle. This strategy is being led by Dr Kishore Prayaga of CSIRO, Rockhampton.

Breeding polled cattle is a cost-effective alternative to the practice of dehorning, which is increasingly being viewed as an animal welfare issue. Inheritance of the poll / horn / scur condition is presumed to be influenced by three separate genes. Because of the complex pattern of inheritance and the sex-influenced nature of the genes, DNA markers are needed to help introgress polled genes into cattle breeding populations. This is particularly important in northern Australia, as the frequency of polled genes is lower and the presence of African horn gene is far higher in tropically adapted cattle. Due to the complex nature of inheritance of the genes in these breeds, knowledge of any one of the genes (e.g., the poll / horn gene common in Bos taurus breeds) is not always useful. Hence development of DNA tests for poll / African horn / scur genes is essential in northern Australia for animal welfare reasons.

A project largely funded by Meat and Livestock Australia is now underway in the Beef CRC to develop DNA tests for poll, African horn and scur genes in Bos indicus and Sanga-derived breeds. The project aims to exploit new genetic technologies such as gene expression and a systematic search of the entire bovine genome using single nucleotide polymorphisms (SNPs) to identify gene markers associated with these genes in cattle.

**Gene expression study**

Differential gene expression at the horn region of new-born calves can be a vital source of information in the search for genes affecting inheritance of horns. The CRC’s gene expression study is therefore collecting tissue samples from the horn region of specifically selected new-born calves at weekly intervals over a 2-3 month period after birth.

For this study, 20 pregnant Brahman cows with a known potential to produce scurred and polled calves were identified by collaborating industry partners and transferred to Belmont Research Station near Rockhampton. As the cows calve, each calf is identified and repeated tissue biopsy samples are collected at weekly intervals from around 1-2 days to around 8-10 weeks of age. Six horned calves from the Beef CRC Program 4 population at Belmont Research Station were also sampled in the study to allow examination of differential gene expression among polled, horned and scurred calves.

Cows and calves for this gene expression study were contributed by Kelvin & Margaret Maloney of Kenilworth Brahmans, Mount...
Coolon and Eddie & Debbie Streeter of Fairy Springs, Monto. After sampling, the cows and calves will be returned to the owners in January 2007 and will continue to be monitored on their owners’ properties to ascertain subsequent horn status.

**Gene discovery Study**

Concurrently, efforts are now underway to breed calves that can be accurately phenotyped for their horn status, by way of developing a resource population for a whole genome scan approach of gene discovery and / or validation of DNA markers for the poll / African horn and scur genes.

A long-term supporter of the Beef CRC (and beef research generally), Mr Tom Mann of Hillgrove Pastoral Company has opened up his Brahman herd at Charters Towers to Beef CRC scientists to conduct a breeding program on his property and access the data generated from it. Around 400 Brahman heifers (polled, horned and scurred) have been identified for an AI breeding program to be undertaken in February 2007. The breeding program will be conducted in conjunction with an unrelated research project managed by Professor Mike McGowan at the University of Queensland to minimize costs and optimize the use of the cattle resource. The design of the breeding program is now being finalized.

**MORE INFORMATION**

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**Aim**

Discover clusters of genes that control key meat science traits such as tenderness, Meat Standards Australia eating quality score, marbling and retail beef yield. In addition the control of the commercial expression of the genes into the final outcome will be tested and understood.

The technologies are moving fast in this area such that soon we will be able to map some 35,000 genes (or more) in one single assay. These newer, faster and more powerful technologies are now showing that clusters of genes (10-100) will be associated with the genetic variance of the meat science traits.

Recent achievements are the further testing of new genes associated with marbling (an extra four) and the first high resolution genomic scan for MSA tenderness has produced 131 candidate genes. The research team is currently finding out which genes account for most of the genetic variation with our target being 50%.

A detailed experiment to test three tenderness gene markers in Bos indicus cattle is underway in Western Australia and New South Wales. Cattle in the research herd have been genotyped as ‘tough’ or ‘tender’ for these genes and are currently undergoing backgrounding before entering the feedlots at Vasse Research Station (WA) or Tullimba (NSW).

The research herd will be extensively measured for all meat science traits to understand how the markers effect tenderness and how they interact with processing (pH decline, tenderstretch, meat aging). The ultimate aim is to include these marker effects in the MSA model if they prove robust.

Another key project underway has been the establishment of collaborative relationships with beef supply chains (typically processors). These relationships will enable the testing of gene markers, traditional estimated breeding values (EBVs) and phenotypic prediction models in a commercial scenario. This will help develop adoption strategies and proof of profit. To date supply chain projects have already begun with Australian Country Choice, John Dee and Rockdale with more expected to come online in the next twelve months.

In addition, samples have been collected for student projects from 2004 drop Angus Progeny Test cattle at Trangie Research Centre. These projects have identified differences in the activity of specific enzymes and level of proteins between steers with high versus low NFI.

In December a final application for patenting of novel panels of SNPs for efficiency was lodged with a view to commercialisation in 2007. The Program team will continue to refine the SNP panels, and is seeking to identify the biological basis of their effects and measure the associations with other production traits so that the marker information can eventually be used in BREEDPLAN.

The 2005 born calves at Trangie were from high or low NFI bulls, representing a third generation of selection. The heifers from this group were sent for feed intake testing at Vasse Research Centre in Western Australia. Vasse have also purchased heifers from industry with high or low fat depth. Both groups (NFI and fat) will form the basis of the Maternal Productivity trial which will be run at Struan in South Australia as well as Vasse. The NFI heifers for Struan have been born at Trangie and will be sent soon.

The 2005-drop bull calves at Trangie were left entire and have been through the feed efficiency test at Tullimba, near Armidale. The extreme bulls are being used as sires of the next generation of NFI calves at Trangie born in 2007. The bulls are also being measured for methane production. Rumen samples from extreme (high or low) methane producers and extreme feed efficiency bulls have been sent to Brisbane and are currently being characterised by Queensland Department of Primary Industries & Fisheries microbiologists. Their preliminary results show there are some differences in the types of methane-producing microbes between the high and low emitters.

Mark Morrison, the Project Leader of this work has also relocated to Australia now, and is collaborating with CSIRO scientists in a project to identify bacteria that can maintain hydrogen balance in the rumen when methane producers are slowed down or eliminated. Research has now also begun on finding ways to inhibit methane producing microbes. Researchers on this work have made significant progress isolating some of the methane producing microbes of interest, now proteomic and genomic approaches will be used to seek and identify candidate targets for the development of novel classes of methanogen inhibitors.
**Beef CRC Research Program 3 - Adaptation and cattle welfare**

**Aim**

Improve disease control and welfare of cattle, with a focus on northern production systems. Various projects are working to develop genetic and non-genetic tests for tick resistance, to develop genetic tests for lack of horns in northern cattle, to develop an effective vaccine against ticks and to develop objective measures of the welfare of cattle.

Reanalyses of old experiments using new statistical methods are being combined with recent gene mapping experiments in dairy cattle to identify the gene regions in cattle that control resistance to ticks. This information will be used to design a new gene mapping experiment in tropical cattle in 2007 which will confirm which genetic regions are most important in the control of ticks. If successful this will lead to development of genetic markers for use by breeders to improve resistance in tropically adapted purebred and cross bred cattle.

Late dehorning is costly, unpleasant and an animal welfare concern. The CRC obtained new funding from Meat and Livestock Australia (MLA) and the Queensland Government to start a new project to identify the gene in tropically adapted cattle that overrides the polled gene. If this gene can be identified it will speed up the conversion of northern cattle to be genetically hornless, which will remove the need for late dehorning.

Another Program 3 research project to receive new funding from the Queensland Government was the work underway to identify a new vaccine against ticks. $1.4 million from the Queensland Government will accelerate and broaden the scope of research. This project is accessing the latest tick genome information from collaborators around the world, and using the latest techniques in bioinformatics to search this information for potential targets for a new vaccine. These targets will then be tested under laboratory conditions and those that are most promising used for development of commercial trials.

The industry commitment to enhancing animal welfare is currently being hampered by a lack of objective measures of animal welfare status. The CRC has worked closely with MLA, Australian Wool Innovation (AWI) and other agencies over the past year to design coordinated research programs that will develop objective measures of animal welfare. These programs will be in 2007.

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**Beef CRC Research Program 4 - Female reproductive performance**

**Aim**

Improve the reproductive performance of northern Australia’s breeding herd by reducing the days between calving and re-conceiving, lifetime reproductive performance, age at puberty and male indicator traits. It is anticipated this improvement will be achieved without impacting on breeder herd mortalities due to younger age of joining and with cows rearing their calves to normal weaning age of 6-9 months.

Improving the number of cattle turned off in northern Australia has economic consequences for the beef industry and impacts on the live export trade, cattle for the expanding feedlot sector and the domestic and international beef markets.

The research strategies being utilised in Program 4 include gene discovery (or identifying DNA markers), gene expression which involves finding interventions such as nutrition which promote expression of “favourable” genes which enable cows to re-conceive quickly after the birth of their calf and perhaps suppressing or “switching off” unfavorable genes.

The Beef CRC has access to in excess of 2,000 breeding cows and their progeny at research facilities in Queensland. The records of the growth, reproduction and carcass attributes of cattle supplied to the CRC by the Northern Pastoral Group and some private cattle breeders are a resource unique in the world. This pedigree information and the phenotypes enable us to gauge the size of the effect a genetic marker (or suite of markers) may have.

Furthermore the genetic parameter estimates obtained underpins and makes our internationally acclaimed genetic evaluation scheme BREEDPLAN much more comprehensive and profit focused.

Last autumn genetic material from 600 Brahman females was sent to the USA for a whole genome scan. Genotype information has been received and results from duplicate samples for some animals indicate very high (greater than 99.7%) agreement on genotype, which means the test is very accurate. An independent analysis of the data is being undertaken by scientists at CSIRO Livestock Industries in Brisbane and Animal Genetics and Breeding Unit (AGBU) in Armidale.

Field collection of measurements on young bulls run on Bragalow Research Station in Central Queensland and laboratory assessments of semen have been completed for first cohort (Feb 2006) and partially (to 14 months) for the second group. A major literature review identified pre-pubertal non-traditional male reproductive traits like luternising hormone, inhibin, leptin etc and seminal proteins etc which are potentially predictive of both male and female reproduction traits. Semen, seminal fluid and blood have been collected and stored pending decisions on which predictive characters will be pursued.

Currently, experimental populations of ~2006 cows are located at five different sites across Queensland to study their lifetime reproductive performance. During 2005/06, decisions regarding the nature and frequency of reproduction measurements to be undertaken were made. Preliminary results of the genetic analyses undertaken supported our measurement protocols and scientific papers on the results presented at a conference in Brazil and to the owners who control 12% of cattle in the north. The briefings of owners concentrated on implications of the results for their breeding programs.

Breeding and calving records were collected at all the research stations and early analysis shows age at presence of first corpus lutemum (CL) is moderate to highly heritable in Brahmans (0.57) and Tropical Composites (0.52) and genetically correlated with calving success and days to calving. These genetic estimates are important in their own right but also suggest our chances of finding DNA markers for traits related to lifetime reproduction rate are good.

Team members have also developed “Pathways to Adoption” for genetic markers and for incorporation of genetic parameters for existing and new traits into new BREEDPLAN and BREEDOBJECT. Staff have also been involved in numerous presentations to industry forums such as the recent MLA Meat for Profit Day in Alice Springs and to over 900 beef producers in New Zealand.
If you would like to know more about the Beef CRC, why not check out our website? www.beefcrc.com.au We also have four publications available to anyone interested in learning more about the Beef CRC and its science.

**Producing Quality Beef**

If you produce beef, this booklet has been written for you. Whether you are a seedstock breeder, commercial breeder, backgrounder, finisher, processor or chef, you have an influence on the consumer’s eating experience. The Beef CRC has given us new knowledge on how to play your part, and tune your production system to delivering the quality and consistency our customers expect.

“Producing Quality Beef” is free and to order your copy please fill out this order form.

**Genetics CD**

This CD is a summary of GENETICS findings of the Beef CRC. The CD contains a variety of documents, from simple summaries, to scientific papers and slides. Most of the slide sets have speaker’s notes to assist their use in presentations.

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**Australian Beef - the Leader! Conference Proceedings**

In March 2006 over 200 delegates attended the Beef CRC conference where the results of two phases of Beef CRC research was showcased. Papers included in these Proceedings are from well-respected overseas speakers as well as leading Australian scientists in the fields of quantitative genetics, molecular genetics, meat science and management and nutrition.

To order your copy, please fill out this order form and one will be posted to you.

**Nutrition, Meat Science & Health CD**

This CD contains the findings of the Beef CRC. It is a summary of nutrition, meat science and health & welfare outcomes. This CD contains a variety of documents, from simple summaries, to scientific papers and slides. Most of the slide sets have speaker’s notes to assist their use in presentations.

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**World class science, creating first class beef**
## 2007 Calendar of Events (cont)

### AUGUST
- 20-22, Farm Fantastic Field Days, Caboolture, Qld
- 23, Getting the most from Breedplan workshop, Launceston, Tas
- 25, Getting the most from Breedplan workshop, Warragul, Vic
- 25-1, Grazing for Profit School, Rockhampton, Qld
- 26-28, Royal Darwin Show, Darwin, NT
- 27, Getting the most from Breedplan workshop, Shepparton, Vic
- 27-29, Dalby Cattle Assessment School, Dalby, Qld
- 30, Getting the most from Breedplan workshop, Albury, NSW

### TBC, South and Central Qld Beef Weeks

#### OCTOBER
- 1-3, Brahman Week, Gracemere, Qld
- 3-5, Elmore Field Days, Elmore, Vic
- 3-10, Grazing for Profit School, Geraldton, WA
- 6-7, Pro-Ag Field Days, Macksville, NSW
- 12-13, Wandin Silvan Field Days, Wandin East, Vic
- 13-14, Murrumbateman Field Days, Murrumbateman, NSW
- 16-18, Australian National Field Days, Orange, NSW
- 21-22, Symposium: Adaptation & Fitness in Animal Populations, Armidale, NSW
- 22-25, Applied Grazing Course, Roma, Qld
- 24-26, Assoc. for Advancement of Animal Breeding & Genetics Conf, Armidale NSW
- 24-27, Royal Hobart Show, Hobart, Tas
- 26, Feeding for Profit, Roma, Qld
- 28-29, Bega Field Days, Bega, NSW
- 29-6, Royal Perth Show, Perth, WA
- 31, LiveCorp AGM, Melbourne, Vic

### SEPTEMBER
- 28, Getting the most from Breedplan workshop, Northam, WA
- 29-31, American Angus Assoc. National Conferene & Tour, USA
- 30, Getting the most from Breedplan workshop, Kojonup, WA

#### TBC, MLA Beefed Up Forum, Injune, Qld
#### TBC, MLA Beefed Up Forum, Emerald, Qld

### NOVEMBER
- 2, Hereford/Poll Hereford Group Breedplan cut-off
- 3, Windellama Field Days, Taragai, NSW
- 9, Angus Group Breedplan cut-off
- 9-10, Farming Small Areas, Hawkesbury, NSW
- 16, Murray Grey Group Breedplan cut-off
- 21-28, Grazing for Profit School, Townsville, Qld
- 23, Beef CRC AGM, Venue TBA
- 23, Beef CRC Forum, Venue TBA
- 30, Limousin Group Breedplan cut-off
- TBC, Meat and Livestock Australia AGM, Qld
- TBC, Cattle Council of Australia AGM, Qld

### DECEMBER
- 7, Shorthorn Group Breedplan cut-off
- 14, Angus Argentino Group Breedplan cut-off

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**Beef CRC**

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Calendar of Events 2007

JANUARY
2-6, South Australian Beef Week
11-14, Andel Young National Roundup, Armidale, NSW
24, Beef CRC Field Day, Vasse Research Station, WA
19, WA Angus Society AGM, Claremont, WA
29-5 Feb, Victoria and Riverina Beef Week
30-1 Feb, Armidale Feeder Steer School

FEBRUARY
2, Simmental Group Breedplan cut-off
2-6, South Australian Beef Week
5-9, Shorthorn Beef Industry Symposia, Holbrook, Launceston and Naracoorte
7-14, Grazing for Profit School, Toowoomba, Qld
8, Green Triangle Beef Expo Field Day, Hamilton, Vic
9, Angus Group Breedplan cut-off
13, Seymour Cattle Research and Development Workshop, Sydney, NSW
16, Seymour Alternative Farming Expo, Seymour, Vic
19-20, Cattle Council of Australia Meeting, Canberra, ACT
19-20, MLA Genetics Focus Group meeting - Breed Society Executives
21, Beef and Dairy Field Day, Busselton, WA
21-23, Sungold Field Days, Allansford, Vic
21-28, Grazing for Profit School, Longreach, Qld
23, Hereford/Poll Hereford Group Breedplan cut-off
23, Devon Group Breedplan cut-off
23-25, Royal Canberra Show
27-2, Applied Grazing Course, Dubbo, NSW
TBC, MLA Beefed Up Forum, Greenvale, Qld
TBC, MLA Beefed Up Forum, Bowen, Qld
TBC, MLA Beefed Up Forum, Biolea, Qld

MARCH
2, Charolais Group Breedplan cut-off
2, Shorthorn Group Breedplan cut-off
2, Feeding for Profit Workshop, Dubbo, NSW
3-4, Small Farming, Lang Lang, Vic
6-7, ABARE Outlook Conference, Canberra, ACT
6-8, Wimmera Field Days, Horsham, Vic
7-8, Angus National Expo, Wodonga, Vic
7-10, NSW Beef Spectacular, Dubbo, NSW
9, Gelbvieh Group Breedplan cut-off
10, National Droughtmaster Female Sale, Gympie Qld
13, Winnamale Field Days, Wimbalm, Tas
14-21, Grazing for Profit School, Alice Springs, NT
16-17, South East Field Days, Lucindale, Vic
19-25, Southern NSW Beef Week
20, Getting the most from Breedplan workshop, Miles, Qld
20-22, Northern Beef Research Update Conference, Townsville
20-22, NSW DPI Beef Industry Conf, Tea Gardens, NSW
21, Getting the most from Breedplan workshop, Kingaroy, Qld
21-28, Grazing for Profit School, Katherine, NT
24-25, Beef Assessment Field Day, UQ Gatton, Qld
25-29, NZ Angus Conference
27, Getting the most from Breedplan workshop, Tamworth, NSW
28-29, East Gippsland Field Days, Bairnsdale, Vic
28, Getting the most from Breedplan workshop, Singleton, NSW
29, National Store Droughtmaster Cattle Show & Sale, Emerald, Qld
29-1 Apr, Gippsland Field Days, Warragul, Vic
29-30, National Meat Industry Training Advisory Council AGM, Adelaide, SA
30, Devon Group Breedplan cut-off
30, Getting the most from Breedplan workshop, Glen Innes, NSW
30, NT Cattlemen’s Ass. AGM & Annual Conf., Katherine, NT
TBC, MLA Beefed Up Forum, Katherine, NT
TBC, BeefLeader Course, Victoria

APRIL
5, Red Poll Group Breedplan cut-off
5-18, Royal Easter Show, Sydney, NSW
20, Blondes Group Breedplan cut-off

MAY
1-2, Beef CRC Scientific and Industry Review, Armidale, NSW
2-3, Western Australian Beef genetics Expo
3-5, Agfest, Launceston, Tas
3-5, Small Farming, Lang Lang, Vic
4, Hereford/Poll Hereford Group Breedplan cut-off
4-6, Tocal Field Days, Paterson, NSW
4-6, Victorian Cattle Assessment School, Melbourne, Vic
8-9, Murray Downs Field Days, Swan Hill, Vic
9, Hereford Society National Junior Judging Competition
9-10, Hereford National Show and Sale, Werodonga, Vic
10-12, Agro-Trend Field Days, Bundaberg, Qld
11, Salers Group Breedplan cut-off
11, Angus Group Breedplan cut-off
11-12, Murrumbidgee Farm Fair, Yanco, NSW
11-12, Riverina Field Days, Griffith, NSW
18-19, National Beef Week, Bendigo, Vic
16-23, Grazing for Profit School, Armidale, NSW
21-22, Cattle Council of Australia Meeting, Canberra, ACT
21-27, Casino Beef Week, Casino, NSW
25, Murray Grey Group Breedplan cut-off
25, Santa Gertrudis Group Breedplan cut-off
TBC, MLA Beefed Up Forum, Tennant Creek, NT

JUNE
3, Poll Hereford Society AGM, Dubbo, NSW
4-5, Poll Hereford National Show and Sale, Dubbo
5-7, Farmlist, Kingsthorpe, Qld
6-13, Grazing for Profit School, Cowra, NSW
8, Limousin Group Breedplan cut-off
8, Droughtmaster Group Breedplan cut-off
13-16, NZ National Ag Field Days, Hamilton, NZ
14-16, PRIMEX, Casino, NSW
15, Brangus Group Breedplan cut-off
15, Charolais Group Breedplan cut-off
18-25, Northern NSW Beef Week
19, Beef CRC Forum, Venue TBA
20-27, Grazing for Profit School, Mount Gambier, SA
22, Belmont Red Group Breedplan cut-off
27-4, Grazing for Profit School, Mackay, Qld
29, Shorthorn Group Breedplan cut-off
29, Beef CRC Forum, Charleville, Qld
30-1, Beach Group Breedplan cut-off

JULY
2-5, Tocal Cattle Assessment School, Paterson, NSW
6, Brahman Group Breedplan cut-off
6-7, New England Hereford Youth Group Junior Show, Tamworth, NSW
9, Getting the most from Breedplan workshop, Cler, SA
9-11, Recent Advances in Animal Nutrition in Australia, Armidale, NSW
10-12, WA Cattle Assessment School, Harvey, WA
11, Getting the most from Breedplan workshop, Keith, SA
11, Red Angus National Show and Sale, Dubbo, NSW
12-14, Ag Grow Field Days, Emerald, Qld
13, Getting the most from Breedplan workshop, Ballarat, Vic
13, Tenant Creek Show, Tenant Creek, NT
13-14, Mudgee Small Farm Field Days, Mudgee, NSW
16-17, Droughtmaster Youth Development Course, Emerald, Qld
TBC, MLA Beefed Up Forum, Tennant Creek, Qld
TBC, MLA Beefed Up Forum, Charleville, Qld

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