Opportunities for Beef Producers from the CRC for Cattle and Beef Quality
Producing Quality Beef

2004 Cooperative Research Centre for Cattle and Beef Quality

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ISBN: 1863898751
A message to readers

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 deliver the quality and consistency our customers expect.

The significant implications – and opportunities - for you are highlighted on pages 3-6. We have sifted these out of the first ten years of the CRC’s ground-breaking research.

So far, the commonwealth, the core partners, industry bodies, agribusiness, pastoral companies and individual producers have invested more than $100 million in this cooperative research program.

We trust you can reflect on the changes it has brought to the industry and how you can capitalise on some of them.

Finally, may I thank Brian Sundstrom, Sharon Pettiford, Peter Dunlon and John Bertram for their help in selecting and presenting the stories from this huge research program.

Bob Gaden, Editor
What is the Beef Quality CRC?

Centred at the University of New England, Armidale, NSW, the CRC for Cattle and Beef Quality was established in 1993 with a team of geneticists, ruminant nutritionists, meat scientists and economists drawn from CSIRO, UNE, NSW Agriculture and Queensland Department of Primary Industries. As part of the largest integrated beef research project in Australia’s history, the scientists are contracted to work together to identify the key genetic and non-genetic factors influencing beef eating quality.

Supporting participants come from institutions in Victoria, South Australia and Western Australia and a large number of valued industry sponsors are involved.

The CRC is governed by a board of people representing the core parties, pastoral companies, producers, processors, feedlots and commercial beef producers. They ensure the research is relevant and important.

The Beef CRC’s charter

The Centre’s initial charter was to develop Australia’s ability to meet the specifications of the emerging markets for high quality beef, particularly in Japan. As reported in this publication, substantial progress has been made, and we are in a much better position now to capitalise on these growing markets. Consumers in Australia have been demanding more consistent quality too. The CRC was instrumental in defining the critical factors determining beef eating quality under Australian conditions, enabling Meat Standards Australia to develop the world’s most advanced consumer grading system for beef.

Sire evaluation

Using state-of-the-art molecular and quantitative genetic technologies, researchers have conducted a large meat quality sire evaluation program.

The 12,000 progeny were drawn from pedigree seedstock herds of Hereford, Angus, Shorthorn, Murray Grey, Brahman, Belmont Red and Santa Gertrudis breeds and crossbred progeny of 1,000 Brahman cows donated by industry.

The cattle breeding program has identified sires that will produce cattle which:

- Eat less to produce more;
- Excel in the traits which directly affect profitability: growth, carcase quality, boning room yield and beef quality;
- Perform in specific environments (north and south) under different production systems (pasture or feedlot) for specialist markets (Domestic, Japanese or Korean); and
- Achieve eating quality excellence.

All breeds now benefit from more accurate and complete genetic evaluation of growth, carcase and meat quality traits by BREEDPLAN, which has been greatly extended and strengthened by the knowledge gained. This publication outlines some of this ground-breaking work.

New phase

A new phase of the CRC began in 1999, with broader involvement across the beef producing regions around Australia, including network sites in Queensland, South Australia, Western Australia, Victoria and NSW. This work is now in progress. Studies to be completed by 2006 include:

- How muscle cell growth and development affects eating quality;
- How the deposition and expression of marbling is regulated;
- Studies of how genes are influenced by nutrition to produce different beef quality results;
- Identification of new gene markers for beef quality;
- Improving efficiency of feed utilisation;
- How genetic selection for better beef quality (marbling and carcase yield) might affect breeding herd productivity in northern Australia;
- How to manage pre-slaughter stress to improve beef quality;
- On-farm strategies to reduce the risk of pathogens entering our food;
- Broadening the understanding and adoption of best practice, to improve eating quality of beef;
- Further strengthen the meat quality practices in the Meat Standards Australia grading scheme; and
- Regional strategies to optimise genetics, nutrition and management to achieve high market compliance and guarantee beef eating quality across Australia.

The CRC is active in delivering its findings to the industry through a range of seminars, education and training packages.

After 2006?

The present CRC is a contractual arrangement between the parties, which will conclude in June 2006. A group led by the Cattle Council of Australia will present a case to the Commonwealth in 2004 for a new CRC for the cattle and beef industry after 2006, with a new set of objectives.
The major achievements of the Beef CRC for the Australian beef industry are listed in the box opposite, but what do they mean for individual producers and small businesses?

There are many pieces of information from the work of the Beef CRC which individuals can use to improve their enterprise. Some of them can make a substantial difference.

Here is a summary of the main points – with the page number where you can read more detail.

**Opportunities for marketing groups and alliances**

It is now much more feasible to develop and manage integrated enterprises such as branded product alliances. New knowledge about how all the production processes from “paddock to plate” impact on the final product has enabled the industry to develop systems such as Meat Standards Australia (MSA) to ensure product quality and consistency. Now, entrepreneurs are developing new business systems to manage integrated supply chains, opening up many opportunities. Here are a few:

- Use MSA grading to underpin the quality of your product, because it is a package of “new generation” knowledge on meat quality. Its quality assurance of the critical factors, makes it possible for branded beef products to work. Key factors helping to guarantee meat quality in MSA grading (page 7-12) include:
  - Ensure adequate growth prior to slaughter
  - Ensure cattle exceed minimum fat cover requirements
  - Minimise pre-slaughter handling and stress, especially mixing with strange cattle
  - Minimise time between farm and slaughter
  - Ensure pH/temperature meet MSA guidelines after slaughter
  - Use tenderstretch hanging, and/or ageing of chilled product to enhance quality
  - Be aware of the impact of HGPs (page 41-42) and breed effects
  - Develop new branded products and

- Use knowledge on how to use genetics to improve returns to participants by boosting meat quality and carcase yield. For example, help them to:
  - Select suitable breeds for the task (page 15)
  - Use BREDPLAN to improve growth, carcase yield and marbling (page 15)
  - Use Gene markers to improve marbling, and tenderness in tropical breeds (page 22)
  - Measure Flight Time and use it to improve temperament and feedlot performance in all breeds, and tenderness in tropical breeds (page 26)

Set standards for pre-weaning and post-weaning growth to meet customer specifications for quality, and to optimise carcase yield and/or marbling. This helps maximise profit along the production chain (page 38)

Adopt yard weaning and vaccination to ensure optimal finishing performance, especially if cattle are finished in feedlots (page 32)

If marbling is important to your market, manage growth to ensure it will be expressed to its greatest effect (page 40)

Make a careful decision about the use of hormonal growth promotants (HGPs) for your situation, recognising that they enhance live cattle performance (which you usually get paid for) but may have detrimental effects on meat quality (which you may or may not get paid for, and may have a negative effect on your customers) (page 41)

Look at the potential to develop more advanced profit-sharing payment systems which encourage everyone to focus on improving the product to the customer

Use information and feedback systems which allow cattle suppliers to identify strengths and weaknesses in their production, and target improvement

Follow your nearest CRC “Regional Combinations” experiment to

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**Benefits from the Beef CRC across the industry**

- A greater understanding of how to improve marbling, tenderness and carcase yield, allowing us to produce better beef products for all our high quality markets
- Underpinning and assisting the design of the grading system (MSA). Best practice technology is packaged into a practical industry supply system
- Understanding of how growth at various stages of life can impact subsequent growth, carcase yield and meat quality
- Genetic knowledge of how breeds and sires perform, under grass and grain finishing systems, and for purebreeding and crossbreeding
- A more powerful BREDPLAN evaluation which has stimulated significant gains in the carcase area for several breeds, allowing producers of all types to select the most appropriate genetics for quality and carcase yield, to suit their markets
- New gene marker technology which adds to our ability to improve meat quality, and in future will give us the tools for rapid improvement of other production characteristics
- The world’s first EBVs for Net Feed Intake (NFI, a measure of feed efficiency)
- Knowledge of recycling of feedlot nutrients which will help make the feedlot industry sustainable
- New vaccines against major feedlot diseases
- An extensive education and technology transfer program that helps distribute and apply the vast amount of new knowledge throughout the industry.

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**Implications and opportunities for beef producers**

Bob Gaden
get relevant performance data on combinations of genetics and growth paths for your environment (page 25).

- Ask the Beef CRC or your local State Department about information and training for your cattle supplier group (page 43).

Opportunities for seedstock producers

CRC Genetic studies have helped define the role of major breeds in meeting the needs of our various markets, and greatly enhanced the selection tools for carcase traits available to each breed. There are new opportunities for seedstock breeders:

- Have greater confidence in BREEDPLAN EBVs for whole herd performance, carcase yield and meat quality. CRC has generated detailed knowledge on these traits, and the underlying genetic parameters, for seven major breeds (including hundreds of sires) and incorporated them into BREEDPLAN (page 15).
- BREEDPLAN EBVs are more accurate and meaningful than before, because CRC research has greatly enhanced our knowledge about the correlations among traits (eg antagonisms between carcase yield and marbling). This means when you select for one trait, it adjusts EBVs for the impact on other important traits (page 16).
- Use $ Index values calculated by Breed Object Selection Indexes to assist you with balanced multi-trait breeding decisions.
- Use live cattle ultrasound scanning to produce better EBVs for carcase traits (page 17).
- Use EBVs for Net Feed Intake (NFI) when buying new genetics, to improve feed efficiency in your herd.
- CRC and NSW Agriculture research has shown that low NFI (more efficient) cattle may be slightly leaner, but there are no other significant positive or negative correlations with the important productive traits (page 18).
- Consider the merits of testing your bulls for NFI, to produce more accurate figures on your own cattle for your own selection or for sale (page 18).
- Watch for results of the new IGF-1 blood test. It looks promising for screening bulls for NFI testing, making it cheaper to get accurate EBVs for NFI (page 19).
- Look at new gene markers for marbling and tenderness, and others in the pipeline, they will assist in identifying animals carrying superior genes. Be aware that BREEDPLAN EBVs are still the best guide, and the best use of gene markers in the long-term will be to have them incorporated into BREEDPLAN (page 23).
- Use flight time to measure temperament in tropical breeds (and docility scoring in temperate breeds), and use it to improve both...
temperament and tenderness (pages 26 and 28).

- Follow the results of the Northern CRC project studying what happens to female fertility traits when you select for marbling, meat yield or NFI. The results will answer many industry concerns, and the genetic relationships will be used to strengthen BREEDPLAN EBVs (page 24).

- Producers of crossbred and composite bulls should record and keep the basic data (birth date, pedigree and weight performance etc), even if they are not members of BREEDPLAN. The mechanism for BREEDPLAN analysis for these cattle is being developed, and past records will be valuable (page 21).

- Obtain feedback on the feedlot and carcase performance of commercial progeny of your seedstock, either from your own commercial cattle or from your clients. Use it to benchmark the performance of your genetics.

- Help your clients improve the performance of their cattle both by genetics and by implementing recommendations on growth, health, management and handling.

- Participate in learning about meat quality and encourage your clients to do the same (page 7).

**Opportunities for commercial breeders**

In addition to tapping into the wider industry benefits (such as the availability of better documented genetics, and better market opportunities for suitable stock), there are significant benefits which commercial breeders can reap by applying the principles identified by CRC research:

- Look for access to higher priced markets for suitable stock (eg feedlots supplying specialised markets, branded products, MSA graded products etc.)

- Ensure adequate pre-weaning growth for calves - this is critical to ensure their future ability to grow efficiently, produce high yielding carcasses and express marbling. For example:
  - Calves should grow at more than 0.6kg/day until they reach 250kg (12 months).
  - Otherwise they may suffer significant stunting which will reduce their potential to grow out, and eventually result in fatter, lower yielding carcasses.
  - Any periods of growth below 0.6kg/day could have permanent detrimental effects.
  - A weaning weight of 180kg at 9 months should be the minimum target (page 42).
  - Yard wean your calves, and check the merits of vaccinating them at weaning to enhance their potential feedlot performance (page 36).

- Connect to a market which provides feedback, and use the feedback to fine-tune your production. The main points here are:
  - Benchmark your production against target market specifications, and if possible, against other suppliers to the same market.
  - When looking to adjust your production, decide carefully whether changes need to be made to nutrition/management (short term) or genetics (long term).

**Key MSA producer requirements – good practices for all producers serious about producing good meat quality for their customers:**

- Cattle dispatched for slaughter must meet with the following requirements:
  - Be continually grazed or fed rations to a level that is adequate for growth for a minimum period of one month prior to dispatch.
  - Be handled and mustered quietly to reduce stress.
  - Have free access to water until dispatch.
  - Have free access to feed until dispatch, other than a minimum period required for preparation through cattle yards.
  - Do not consign any cattle of poor temperament or with signs of severe stress.
  - Do not consign sick cattle or cattle within a withholding period for any treatment.
  - Do not mix cattle from different mobs or pens on the property within two weeks of dispatch.
  - Do not dispatch cattle purchased or moved from another property/sale yard within one month or arrival.
  - Load cattle quietly, preferably with no use of goads or electric prodders.
  - Load cattle at the recommended densities set out in the trucking industry code of practice.

*Source: Meat Standards Australia*

- USE BREEDPLAN along with your physical assessment to guide your selection of bulls, because BREEDPLAN is now a more powerful and complete evaluation of the important traits they are likely to breed.

- Follow MSA guidelines for pre-slaughter management of cattle (see box), even if the cattle are not to be graded, as these steps will help maximise meat quality.

- Ensure cattle are well-fed in the period leading up to slaughter. This will ensure good reserves of muscle glycogen and protect against dark cutting (page 11).

**Opportunities for backgrounders**

Producers who grow cattle out for feedlot entry can do a number of things to ensure their good performance both during backgrounding and finishing.

- Look for higher-priced markets for your feeder cattle if you are adding value to them (for example, by improving their potential for growth, carcase yield or marbling).

- If marbling is important to your feedlot client:
  - Select the appropriate genetics.
  - Some breeds are more likely to produce marbling (page 40).
  - Some individual breeders are using technology to improve marbling genetics.
  - Develop a knowledge of sire lines and their performance.

- Ensure calves have been grown adequately without a major pre-weaning setback (page 38).

- Avoid stunted weaners, as they are likely to perform poorly in the feedlot, depositing more subcutaneous fat, less muscle and less marbling than well-grown weaners with the same genetics (page 38).

- Calves that are backgrounded at slower growth rates will perform better in the feedlot (i.e. show compensatory gain). You may get better returns for them by retaining ownership in the feedlot. (page 38)

- Yard weaned calves, will perform better in the feedlot. If you buy calves which have not been yard weaned, train them by feeding them in yards for about 7 days yourself (page 33).

- Get as much feedback as you can on feedlot performance, carcase yield and quality. Use it to identify key factors which drive profit, and fine-tune your livestock purchase decisions.
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- Use new vaccines for feedlot performance at weaning to enhance their feedlot performance – especially if you retain ownership through the feedlot (page 34)
- If you have used the new vaccines, they will improve the reputation of your feeder cattle so don’t forget to tell the feedlot
- Avoid cattle with poor temperament, as they are likely to perform worse for the finisher (page 28)
- Consider buying cattle which are the progeny of bulls of superior NFI. There are benefits to you, and it may be a useful selling point

Opportunities for finishers

Below are some general hints for producers who finish cattle in the paddock, with or without supplements. The CRC has studied all facets of feedlot production, but full detail on grain finishing is beyond the scope of this publication.

- Look for access to higher-priced markets if you are value-adding to your cattle
- Seek carcase feedback and use it to identify better markets and fine-tune production to increase compliance
- Follow MSA protocols for pre-slaughter management of stock, as this helps minimise stress and maximise meat quality (page 8)
- Ensure cattle are well fed in the period leading up to slaughter, to ensure good reserves of glycogen, this protects them against dark cutting (page 11)
- Beware of buying stunted weaners (i.e. calves which have had a major growth check before weaning) to finish – they will grow slower, finish lighter and fatter, and produce less marbling (page 38)
- Calves that have had a good start to weaning will retain their growth and carcase yield potential, even if they have been backgrounded after weaning at a slower growth rate (page 38)
- Slow growth during backgrounding is an advantage to the finisher, except where marbling is a major requirement. These cattle grow faster and more efficiently on finishing feed (compensatory gain), and produce leaner, higher-yielding carcasses (page 38)
- Yard-weaned calves for feedlot finishing are preferred as they adapt quicker and suffer less stress-induced disease (page 32)
- Avoid cattle with temperament problems, as they are likely to perform poorly, suffer more disease problems and show pre-slaughter stress (page 26)
- If you are finishing cattle in your own feedlot, check the merits of vaccinating cattle against Pestivirus (Pestigard) and IBR (Rhinogard), to reduce disease. (page 34)
Ten years ago, we knew what factors affected meat quality, but we didn’t know how important each of them really were to consumers. For example, we knew marbling was associated with good eating quality, but no-one could tell us how much marbling was needed, and if it really did allow the chef to get away with overcooking the steak.

We suspected that beef from Bos indicus cattle was often tougher than beef from British breeds, but how much was genetics, and how much due to the cattle being raised in a harsher environment?

The CRC Meat Science Program has helped provide the answers. We now have a much deeper understanding of how the animal, production systems, slaughter and post-slaughter processing all affect meat quality under Australian conditions.

CRC’s teamwork with the industry-funded Meat Standards Australia (MSA) grading program has been a vital part of this process. To achieve their goal of guaranteeing tenderness to consumers, MSA needed much more specific answers about all the known factors – which cuts does it affect and by how much?

The CRC responded with specific projects designed to tease out our knowledge of the important issues.

As a result we can now set the specifications for producing and processing beef which will satisfy our customers for quality beef products, here and around the world. We now have the systems like MSA, which implement the technology and are being used by the industry to guarantee consistent tenderness in branded beef products.

**Measuring meat quality**

The Meat Science program of the Beef Quality CRC was originally set up as a “service program” to measure the meat quality and carcase yield effects resulting from the various experiments covering genetics, growth paths and behaviour. Although the whole focus of the CRC was to understand meat quality, it was thought that the animals would provide most of the important answers – their genetics, growth paths, nutrition – while the Meat Science team was there merely to measure and report on the resulting meat quality.

There were early clues that it was not going to be quite so easy:

- The CRC set up a simple set of guidelines for slaughtering operations, to eliminate many of the causes of poor meat quality which could interfere with the experimental measures (see box). Why was the beef consistently better than the equivalent commercial product, even though the animals and their production were typical of commercial practices?

- When the CRC’s cooperating abattoir closed in 1996, the move to a different abattoir brought significant changes to tenderness. If the meat quality results could be so different from different abattoirs, what was this doing to the experimental conclusions? And what was happening in the industry at large? Further investigation was required.

Meat Standards Australia (MSA) found a similar problem when their industry-funded project began consumer testing of beef samples. They too identified big effects on tenderness from pre-slaughter and processing practices. They needed to know more about these and all the factors affecting meat quality, in order to develop a system to guarantee tenderness to consumers.

The MSA project was driven by a “Pathways Team”, which included CRC meat scientists. As the consumer taste panel results raised questions, the research team looked for answers. In many cases, experiments were set up by the CRC to understand the underlying causes and develop ways to manage their effects.

**Early lessons on the importance of pre-slaughter management**

When the CRC began slaughtering its experimental animals in the mid 1990’s, researchers insisted on minimum pre-slaughter handling of cattle, to ensure that factors like stress, poor livestock handling or processing did not affect meat quality and interfere with their other studies.

Their ‘best practice’ procedures were extremely successful in virtually eliminating the harmful effects of stress and it was obvious to those who ate the meat it that it was consistently more tender than the equivalent commercially-produced product.

Well before MSA existed, the CRC protocol included these basic, well-known good management practices. Most of them have been adopted as MSA requirements:

- cattle that are familiar with yarding and handling
- quiet and firm handling - no dogs or electric prodders
- all necessary live cattle handling, measurement and drafting completed a few days before slaughter
- yarding and trucking within 2 hours
- use of professional livestock carriers with a proven record
- a short trip to the abattoir (2-3 hrs max) the day before slaughter
- keeping the mob together and not boxed with other cattle before slaughter
- effective electrical stimulation of the carcase after slaughter
- careful control of carcase chilling conditions.

Even before the first research was analysed, the CRC demonstrated that the industry could lift its meat quality game by getting the basics right.
Processing - Temperature/pH decline

For example, electrical stimulation has been an accepted practice at abattoirs for some time, to eliminate cold shortening – a toughening of the beef caused by rapid chilling.

Taste testing by MSA revealed inconsistent results from electrical stimulation. It appeared that even where it was being applied according to the recommendations at the time, the results varied.

A series of experiments by the CRC meat science team has sorted out the reasons, and MSA has adopted the new “best practice” temperature/pH specifications as requirements to grade beef carcases.

Since 1999, most abattoirs have had their chilling and stimulation systems checked and set to MSA specifications. All carcases receive the benefit from this technology, not just those graded by MSA. Consumers are receiving the benefit - this has been a major contribution to meat quality in Australia.

Tenderstretch

Hanging the carcase from the aitch bone (pelvis) instead of the traditional achilles tendon (hock) was documented by CSIRO more than 30 years ago to improve the tenderness of many of the major high-priced grilling cuts.

The technology was simple and cheap, but despite its overwhelming positive effect, it was never adopted by the industry. The visible, practical problems of handling the carcases and cutting slightly different shaped primals seemed more important than the invisible improvement in tenderness.

Fortunately, consumers in the MSA tasting program provided new evidence of substantial improvement to the major grilling cuts. As part of this study, CRC has looked in detail at the eating quality impact of two different tenderstretch techniques and an alternative known as Tendercut (see box).

These options for improving eating quality have now been studied in detail, and the improved eating quality to each cut of beef is now available through the MSA cut-based grading prediction model. Retailers and restaurateurs who understand the MSA system can now recoup the value for the extra eating quality imparted.

MSA - Integrating knowledge on eating quality

There are many factors affecting eating quality, and most of these have been known for a long time (see page 11). Some of these come from the animal itself (breed, age, nutrition etc), some from the way it is handled (pre-slaughter stress) and some after slaughter (chilling and ageing, and of course, cooking).

The challenge for MSA was to know enough about all these factors so they could adjust accurately for them, to guarantee the eating quality outcome for any particular piece of meat.

MSA used the combined knowledge of many leading scientists and the practical experience of people in the industry to develop their integrated system of cut-based grading.

Tenderstretch and Tendercut

Tenderstretch or aitch bone hanging works by preventing some muscles from over contracting while rigor mortis takes place. Advantages over conventional achilles tendon hanging include:

- More tender high-quality and middle value cuts, including striploin, topside and round
- Less time required to age meat to its potential tenderness

Tenderstretch has not been widely adopted because:

- Extra handling is required to change the suspension point at the end of the slaughter chain
- Chillers are harder to load, and hold less tenderstretch carcases
- The shape of some hindquarter cuts is changed, requiring different cutting techniques and retaining of boning room staff and retailers.

Tendercut is an alternative hanging technique developed in Virginia USA, which gives similar improvement to tenderstretch, but avoids some of the disadvantages. The carcase is suspended from the achilles tendon at slaughter, and the pelvic and back bones are cut through, allowing the muscles to stretch as they take the weight of the carcase.

The MSA grading software is an amazing outcome of this combined research effort. It effectively packages all our knowledge of meat quality together, and for each cut of beef on any particular carcase, it answers the question: given the sum total of all our knowledge of meat quality, for this particular carcase, what will be the eating quality result if I cook this particular cut of meat in this particular way?

MSA has evolved rapidly since 1999 and new knowledge is now regularly built in to the grading software. For example, new CRC information on the impact of hormonal growth promotants on eating quality is a new factor, planned to be included in commercial grading from 2004.

To be eligible for MSA grading, each participant, from producer to retail, must meet requirements based on minimising stress and applying best practice. Variable factors are then used to determine the predicted level of eating quality (grade) of individual cuts. These factors include Bos indicus content, marbling, hanging method, weight for maturity and ageing.

MSA has had an unprecedented impact on the industry’s pre-slaughter handling practices, with processors, saleyard operators and livestock transporters showing far greater recognition of the importance of pre-slaughter stress in meat quality.

To find out more about the producer requirements for MSA, see page 5 or visit the MSA web site www.msagrading.com and look for the Tips and Tools series.
Pre-slaughter stress

The success of the CRC pre-slaughter handling protocol (see page 11) in virtually eliminating dark cutting is a fair indication that pre-slaughter stress is a significant problem in the commercial industry, where levels of 5-10% dark cutting in some consignments are quite common.

Dark cutting (see box) is usually the result of accumulated poor nutrition and stress over several days leading up to slaughter. It occurs when the animal has exhausted its muscle energy reserves before slaughter. But are there less obvious effects of stress on meat quality?

The CRC health and welfare program has been studying a number of aspects of stress in a range of projects. Some are reported in the health & welfare section of this booklet, others are relevant to meat quality.

It’s not easy to measure stress in live cattle. The standard test is by measuring blood levels of the hormone cortisol, but with commercial cattle, the process of yarding, confining and bleeding the animal is itself a cause of major stress.

The CRC has developed a number of behavioural tests to describe temperament and measure stress. For example, a radio transmitter strapped to a beast can transmit heart rate, respiration rate and temperature remotely to the researcher, allowing an indication of stress during studies on handling, transport and management practices.

Mixing before slaughter

The CRC conducted an experiment at Tullimba feedlot near Armidale NSW, in which two groups of cattle on feed were mixed in feedlot pens four, two or one week before slaughter. Mixing did not affect their weight gains, but the group mixed one week before slaughter produced slightly tougher beef. There was no difference in pH or dark cutting. This suggests that even in an accustomed environment, the stress of adjusting to new peers is significant in the psychology of the cattle for at least a week.

This implies that the mixing of cattle in the days before slaughter, which occurs commonly throughout the industry, is having detrimental effects on meat quality. These effects are probably more significant if mixing occurs in a strange environment, under closer confinement and closer to the time of slaughter (e.g. saleyards, transport and abattoir).

Acute pre-slaughter stress

Finished British breed yearling steers were used in a CRC experiment to assess the effect of acute stress 15 minutes before slaughter. At the abattoir, half of the cattle were taken out of earshot and subjected to electric prodders, 6-8 times over about 10 minutes. The remainder were handled quietly, and all were then slaughtered in the usual way.

The acute stress was not enough to cause dark cutting (it would take longer to use up their muscle energy reserves) but caused significant toughening of the meat. There was no visible difference in the colour or appearance of the meat.

The industry commonly regards dark cutting as the outcome from high levels of pre-slaughter stress, but this work suggests that even with no sign of dark cutting, pre-slaughter stress could be significantly toughening our beef.

Time in lairage

It is normal for cattle to be held at least overnight in lairage (yards) at the abattoir before slaughter. While this may be important for cattle exhausted after a very long journey, it could be an unnecessary additional stress for the vast majority of high quality slaughter cattle, which travel much shorter distances to the abattoir.

Processors prefer having cattle overnight for practical reasons – they can be assured of having a full day’s kill, and emptier paunches are easier to handle on the slaughter floor, with less likelihood of spillage and contamination.
The CRC conducted two experiments at different abattoirs with grain-fed yearling steers, comparing slaughter 3 hours after arrival at the abattoir, with slaughter the next day, 18 hours after arrival.

At the time of writing, preliminary results indicate that the quality of beef from the short lairage groups were slightly more tender. The abattoirs did not report any extra problems with processing them.

Further work is under way to understand the muscle biology involved, but this is another example of the CRC questioning industry practices, which could be changed to improve meat quality.

Future work in Meat Science

Work planned for the period to June 2006 covers two main areas – understanding and managing stress, and fine-tuning of processing and animal factors affecting meat quality. Projects include:

- Finding better ways to measure stress in cattle
- Understanding the physiological basis for the genetic correlation between temperament and beef tenderness in Bos indicus cattle
- Developing better pre-slaughter management practices
- Optimising the processing conditions, especially pH decline and electrical stimulation, to suit individual carcases
- Estimating muscle glycogen in live cattle, to enable management of dark cutting (high pH) beef
- Determining the effect of hormonal growth implants on the palatability of beef
- Determining the effects of growth checks on carcase yield and meat quality
- Incorporating relevant findings on pre-slaughter management into MSA best practice requirements for grading

Measuring the pH of samples of meat

Ultrasound scanning for intramuscular fat
There are many factors which combine to produce the meat quality eating experience. The combined resources of CRC science and MSA consumer testing have shown:

**Live animal:**
- There is little difference between breeds, but Bos indicus content produces tougher beef, mainly in the grilling cuts
- Other factors equal, heifers have slightly lower eating quality than steers
- Younger animals produce more tender meat, but faster growth to any particular age adds only slightly to tenderness
- Hormonal growth promotants may cause significant toughening, mainly in the high quality grilling cuts
- Milk fed vealers have better eating quality than their weaned counterparts

**Pre-slaughter handling:**
- Cattle are susceptible to stress and this can result in dark cutting (high pH) beef
- Stresses are cumulative – e.g. time off feed, weather, mixing
- Pre-slaughter stress causes tougher beef, even when its colour and pH is normal
- Mixing cattle with strangers one week before slaughter results in tougher meat
- Normal saleyard handling usually results in tougher meat than direct to abattoir consignment

**Processing:**
- Correct management of chilling after slaughter is vital – chilling too fast or too slow can toughen meat and reduce its eating quality
- Rate of chilling of carcases must be coordinated with electrical stimulation to avoid cold shortening or heat toughening
- Tenderstretch hanging substantially improves the eating quality of the main grilling cuts, and reduces the need for ageing
- Fatter carcases need less electrical stimulation, and are less prone to cold shortening
- Ageing after slaughter improves tenderness, particularly grilling and roasting cuts. The improvement is greater for achilles hung carcases and for Bos indicus genotypes
- Bos indicus carcases are more responsive to electrical stimulation and ageing

**Meal preparation:**
- Different cuts of beef have different levels of eating quality
- Each cut has an optimum cooking method
- Marbling improves eating quality of grilling and roasting cuts

Not only have these factors been identified as significant, but in most cases they have been quantified. Their importance has been recognised by the industry since they have been promoted as requirements for MSA grading, or have become inputs which determine the grade of cuts in the MSA grading prediction model.

Dark cutting beef (also called dark, firm and dry, or DFD) is a serious cause of downgrading of table beef across the industry. It occurs when the energy store in muscle (glycogen) is depleted at slaughter and there is not enough left to convert to lactic acid, to produce normal pH (acidity) in meat of around 5.5.

- Pre-slaughter stress and poor nutrition are the main causes of “dark cutting” beef
- Pre-slaughter stress can be physical (exhaustion), environmental (extreme heat or cold) or psychological (confinement with strange cattle, humans, dogs etc.)
- The effects of these are cumulative over the days before slaughter, in depleting glycogen
- Better fed cattle (for example, grain-fed) have higher reserves of glycogen, and are less susceptible to dark cutting
- Electrolyte supplements in lairage (abattoir yards) are unlikely to make up for poor nutrition and stress because:
  - They require several days to produce results
  - Animals take several days to settle in a new environment anyway
  - Feeding in lairage is not usually practical
- The industry is adopting better pre-slaughter management to reduce dark cutting beef, e.g.
  - MSA requirements for direct to slaughter with no mixing etc.
  - Direct farm to abattoir purchase by processors
  - Focus on design of transport and handling facilities
  - New low-stress saleyard practices for MSA
  - Protocols for branded products and marketing alliances
  - Minimising use of electric prodders at abattoirs

Further information from state departments or Graham Gardner 02 6773 3257
Producers like to chill carcases quickly, to ensure maximum shelf life of the meat, and reduce the food safety risk from bacterial growth. Unfortunately, very fast chilling can cause tough meat, even from potentially tender young animals.

The Beef CRC has used their findings about early post mortem changes in the carcase to develop better guidelines for managing the chilling process. Their findings have already been implemented in many abattoirs across Australia, and improved the tenderness of our beef.

Cold shortening

After slaughter, the glycogen reserves in the muscles convert to lactic acid as the muscles “set” (that is, undergo rigor mortis). Normally this results in a decline in pH (acidity) from about 7.0 to about 5.5 over a number of hours, as rigor takes place.

If chilling is very fast, it can cause “cold shortening”, when the muscles react to the cold and tighten, before rigor is complete. This results in tougher beef.

Cold shortened carcases don’t look any different, even to an experienced butcher, so it’s not easy to stop affected carcases passing through the trading channels and giving consumers unnecessarily tough meat.

Electrical stimulation of carcases was developed many years ago to counteract cold shortening. Applied immediately after slaughter, it speeds up the pH drop, accelerates the onset of rigor and enables faster chilling, without toughening of the meat.

Most abattoirs installed stimulation equipment in the 1980’s and used it on carcases for the domestic market. Unfortunately, as both the CRC and MSA discovered, its effectiveness was not well monitored.

Electrical stimulation questioned

It was only recently that the simple practice of electrical stimulation has been questioned. In one experiment, a group of meat samples which had been stimulated at slaughter and chilled slowly, unexpectedly had poorer eating quality than their rapidly chilled counterparts.

This problem was identified as “heat toughening”, which is a consequence of over-stimulation. The Meat Science group then investigated the phenomenon further, and this has resulted in a better understanding of the post-mortem changes, and new recommendations for stimulation and chilling in abattoirs.

New abattoir recommendations for the

• in some abattoirs, carcases already receive plenty of electrical pulses on the slaughter floor, with equipment such as immobilisers and the rigidity probes used with hide pullers;
• for optimum eating quality, electrical stimulation needs to be adjusted to the chilling rate of carcases, and type of cattle.

Industry benefits

The recommendations from this research are benefiting consumers already – Meat Standards Australia has adopted the optimum pH/temperature recommendation as a license requirement for grading at abattoirs. Their graders regularly monitor abattoirs for compliance.

Future CRC experiments will study the biological basis of heat toughening, and examine the effect on eating quality of the pH/chilling treatments on a range of other cuts (current knowledge is mainly based on effects on the striploin).

For example, cold shortening is unlikely if the pH has dropped below 6.0 by the time the muscle has cooled to 12°C.

Other findings

Some other findings of the research include:
• lighter and leaner carcases, domestic carcases, are the most susceptible to cold shortening;
• heavier, fatter carcases destined for export tend to cool more slowly, and therefore require less electrical stimulation (or even none at all);
• cattle with high reserves of glycogen, such as lot fed cattle, also require less stimulation;

A low voltage electrical stimulation system in a domestic abattoir. Stimulation allows carcases to be chilled faster without toughening the meat.
Producing Quality Beef

Sharon Pettiford

Tallawanta Tender gets it right!

Bruce Picone is proud of the growing reputation of Tallawanta Tender. And so he should be – the Moree-based family business supplies top quality meat that customers agree is tender to eat, every single time.

Bruce, who is Managing Director of Tallawanta, says the secrets to their success are their customer focus, their innovative approach to value adding, their use of Meat Standards Australia (MSA) grading system and a consistent supply from their own long-established cattle breeding and finishing operation.

“Our customers demand tender beef today, tomorrow and the next day”, Bruce said. “We have to be able to deliver high quality product 365 days a year, not just when the season permits grass to grow”.

“It’s important to use the right type of animal and grow it out and finish it properly,” he said, “but the real opportunity for us has been to apply new research, improve eating quality and add value past the farm gate.”

Guaranteeing tenderness

The Picone family has full control over every step including the breeding, growing, finishing and finally the retailing of Tallawanta beef products.

Their 5,000-head feedlot north-west of Moree plays a crucial role in guaranteeing their ability to supply well-finished beef to customers 12 months of the year.

They use the Meat Standards Australia (MSA) system to underpin the integrity and eating quality of their beef. This ensures the highest meat quality from their carefully produced animals.

MSA does this with a QA system to minimise pre-slaughter stress and ensure that abattoir stimulation and chilling equipment is set to optimise meat quality.

MSA gives every cut of beef an eating quality grade and a recommended cooking method. It even grades some individual muscles. This enables the butcher to make sure the customer gets exactly the result they are looking for.

“Meal friendly is what the MSA grading system is all about – identifying product by eating quality, not the traditional primal cuts”, Bruce said.

Tallawanta prefers to hang their beef by tenderstretch to further increase tenderness of the main grilling cuts.

Applying research

Bruce believes consistent growth through the feeding period, along with age and weight of animals, sets the pattern for consistent eating quality.

“We’ve taken notice of CRC results that show that growth of cattle prior to feedlot entry is equally important as the finishing and processing stages”, Bruce said.

He also commented that “Selecting the correct genetics using BREEDPLAN, and the right type of animal, will deliver the carcase we need.”

More accurate EBVs are a product of CRC research, particularly for carcase traits.

Adding value

The Picone family has been feeding cattle at Tallawanta since 1984 and over the last 19 years has seen many changes in markets and in feedlot operation.

They have been a regular supplier of finished cattle to Woolworths for many years, and have produced some high quality Japanese export beef more recently.

The feedlot adds value to the cropping program, which grows most of the feed for the feedlot.

One key factor has been extending the value-adding philosophy to their beef system. Tallawanta is focusing on full utilisation of the carcase. “This is very important in maximising returns from each animal,” Bruce added.

Heavier carcasses

“The CRC and MSA have both taught us a lot about the eating quality of individual cuts and muscles. For example, we now know that heavier carcases give a better eating quality performance if they are the same age,” he said.

A few years ago, it was a problem for Bruce if some cattle were too heavy for his regular Woolworths market. Taking the heavier cattle out to increase their compliance with Woolworths specifications became the opportunity which started “Tallawanta Tender”.

Bruce Picone says CRC research has helped his integrated business supply his customers with consistently tender beef.

(Photo : Australian Farm Journal)
Producing Quality Beef

A large amount of research and consumer tasting has shown that on average, other things equal, Bos indicus content means tougher beef.

This is a significant issue for Australia, where almost half the national herd lives in tropical and sub-tropical areas, where these cattle are much better adapted.

The CRC has made a major commitment to understanding the problem and has come up with some outstanding solutions.

**Processing**

Bos indicus cattle are more sensitive to processing:
- They respond better than British breeds to effective electrical stimulation
- They respond even better than British breed types to tenderstretch hanging
- Their beef improves more with ageing after slaughter
- They are more susceptible to pre-slaughter stress, which leads to tougher beef

**Long term answers**

CRC studies have shown that some strains of Brahman cattle are genetically more tender than others. This means it is possible to improve them by selection – but how do you identify those carrying the tender genes?

In CRC experiments, when processing has been carefully managed to achieve “best practice”, there has been very little problem with tough Bos indicus beef.

This suggests that processors can do a lot to improve their Bos indicus product by managing their procedures to best practice standards.

New work has given us two clear and practical options to improve the genetics. The first is to measure and select on Flight time (see page 26) as this will effectively improve both temperament and tenderness.

The second is a new gene marker test (GeneStar® Tenderness) which will further help in selecting stud animals with tender genes (see page 22).

Apart from these major breakthroughs, the CRC also has on-going research aimed at improving the management of pre-slaughter stress, behaviour and handling systems across the industry (see page 10).
Key CRC genetics findings and their application

Brian Sundstrom

Australia's beef genetic evaluation system BREEDPLAN is very highly regarded and is widely used around the world. Research from the Beef CRC has provided the foundation for many of its new capabilities, especially in carcase and meat quality traits.

For the first seven years, much of the CRC was built around two core breeding experiments. One followed the progeny of hundreds of sires in seven major breeds (see straight breeding program design) and the other used the same sires in a crossbreeding experiment in northern Australia. All the progeny were measured for growth and carcase characteristics, providing a full analysis of the performance of their sires, and new information about the genetics of carcase traits. Different growth and finishing treatments were applied, to determine the important genetic and non-genetic effects.

Apart from strengthening BREEDPLAN, the CRC genetics program has opened the door into DNA technologies, a new era of applied genetics. Data from CRC experiments has helped find the first gene markers for commercial traits, and will continue to be used to find new gene markers into the future. Our animal selection will be assisted by an increasing number of commercially available gene tests, which identify cattle carrying favourable individual genes.

Straight breeding program

From 1993-2000, seven breeds were involved in a major 'progeny test'. This provided some 8,000 head for the genetic studies described below and also much of the CRC Meat Science and Nutrition work documented elsewhere in this booklet.

All breeds were offered participation, but had to be in BREEDPLAN and able to provide large lines of commercial purebred steers. Angus, Belmont Red, Brahman, Hereford, Murray Grey, Santa Gertrudis and Shorthorn were selected.

Known sires of these breeds were mated in the cooperating Seedstock and Commercial herds. Steer progeny from commercial herds were purchased by the CRC as weaners. They were backgrounded in a variety of situations where growth rate and other studies were carried out, and then finished at Domestic, Korean and Japanese market weights.

Half the cattle were finished on grain and half on grass and the carcase and meat quality of all cattle were studied in detail, including consumer tasting on the majority.

DNA samples from the cattle have been stored for future use.

Key findings included:

- BREEDPLAN EBVs of sires predicted the growth and carcase performance of steer progeny with very acceptable accuracy, further demonstrating that BREEDPLAN really does work.
- Data from the experiment allowed the introduction of EBVs for IMF% (marbling) to BREEDPLAN and

![CRC1 Straightbreeding project design](image)

The CRC core breeding project enabled scientist to separate the genetic and non-genetic effects which control growth, carcase yield and meat quality.
made available for these breeds. This means it is possible to predict the specifications of steers which will be produced under various market/production systems by sires of known EBVs.

**Multibreed EBVs**

Although all Australian breeds currently use the same BREEDPLAN genetic evaluation, each breed has its own database. As EBV figures are relative to their own breed base, they cannot currently be compared across breeds. The industry has a long-term aim for all breeds to have the option to move to a common base and CRC has provided some data to help with this process.

- Data from the CRC has been combined with the MLA Southern Multibreed experiment to provide Australia’s first Multibreed EBV adjustment table (see Multibreed EBVs p 21). This is initially for Hereford, Poll Hereford, Angus, Simmental and Limousin, and includes EBV adjustments for birth weight, growth and carcase weight. Other breeds and traits will be added progressively to this table, but the long-term aim is joint analyses across breeds.

**DNA technologies**

The CRC has a large and continuing molecular genetics program, which aims to find the individual genes that affect commercial production traits, and determine how important they are. CRC researchers have been closely involved in the commercialisation of the world’s first two of these discoveries, now available from Genetic Solutions Pty Ltd, as GeneSTAR® Marbling and Tenderness.

Current CRC work includes searching for other genes controlling marbling, tenderness, other meat quality traits, feed efficiency and tick resistance. (see article on DNA technologies page 22)

**Feed efficiency research**

The CRC has a major research program on the genetics of feed efficiency, following earlier research by NSW Agriculture, which showed that some cattle are genetically better than others at converting their feed into liveweight gain. This work is now linked to many other projects such as breed society progeny tests and gene marker research.

The CRC is continuing and expanding this research. This has allowed the inclusion of the efficiency measure “Net Feed Intake” (NFI) in the BREEDPLAN genetic evaluation program in Australia. NFI is the feed consumed by cattle, under (-) or over (+) the amount of feed expected for their weight and their rate of gain. This means efficient cattle of any size can be selected. NFI EBVs are now available for bull breeders doing the required testing.

The trait has similar heritability to growth, so good selection progress is possible, once practical testing options are widely available. Current research is aiming to assist this. (See separate article p 18)

**Northern crossbreeding work**

From 1993 to 2000, the CRC had a large experiment in central Queensland. Brahman cows donated to the CRC were joined to Angus, Brahman, Belmont Red, Charolais, Charbray, Hereford, Limousin, Santa Gertrudis and Shorthorn sire breeds. The crossbred progeny were grown out and finished in Northern and Southern locations.

These cattle contributed to understanding breed effects for carcase traits, the North versus South and Multibreed outcomes discussed above, along with growth path and transport/stress findings discussed in other papers in these notes. Further detail on this work can be obtained from the researcher in charge Dr Heather Burrow CSIRO Rockhampton. 07 4923 8139 heather.burrow@csiro.au
Ultrasound scanning for genetic evaluation and in feedlots

Brian Sundstrom

Breedplan’s present ability to produce such high quality Carcase EBVs is a major product of the genetics program of the Beef CRC. One key element has been thorough validation, and deeper understanding of ultrasound scanning for fat depth, eye-muscle area and marbling (intramuscular fat, or IMF%).

Scanning of carcase traits is now widely used in the stud industry. Breedplan Carcase EBVs are calculated over 90% from scans with a little abattoir data (see http://breedplan.une.edu.au for Breednotes on Scanning, Carcase EBVs and an accredited scanner list).

The role of ultrasound in feedlot steers to predict their marbling potential is not so clear as described below. CRC work suggests marble scans around 70 days may help find the best steers to feed on for longer periods.

Evaluating scanning

To produce carcase EBVs, how effective is scanning of breeding cattle compared to using actual slaughter feedback of progeny, and how can they both be used?

To answer this question, the CRC collected three scans (at weaning, end of growout and pre-slaughter) on all its thousands of commercial steers and heifers of known Breedplan parentage, along with their carcase measurements at slaughter. The CRC used the slaughter data to assess the accuracy of scanning, and to evaluate the breeding value of their sires.

At the same time, bull and heifer progeny of the same sires were scanned in the stud herds, to produce a separate sire evaluation, which could then be compared.

Whether the EBVs were calculated from the scanning data or from the carcase data, both methods ranked the sires nearly the same. Both methods were very effective at identifying the best (and worst) sires.

Best results however are when both sets of data are used. This CRC work allowed it to be introduced in Breedplan, a world first.

The result is both a strong endorsement for live cattle scanning, and added confidence for breeders that Breedplan carcase EBVs are soundly based.

Scanning for genetic evaluation today

Ultrasound scanning of the carcase traits fat depth and eye muscle area, was introduced in Breedplan in 1989, and in US genetic evaluation programs a few years later. The technology is now well accepted and widely used for genetic evaluation by the majority of studs and breed societies in Australia and North America.

Bulls and heifers in stud herds are scanned when they are in as good a condition as possible. This helps them show their differences in fat depth, eye-muscle area and marbling.

Good predictions of the ranking of sires are being obtained:

- By combining the scans with the pedigree links
- Only comparing like treated animals, and
- Using Breedplan EBVs, rather than the raw measurements.

Bull buyers and breeders can better pick sires that are likely to breed early or late finishing progeny and can use indicators of muscling and yield %. Some people also find the fat depth indicators useful to indicate cow fatness and re-breeding.

Scanning in feedlots to draft cattle

Feeding for the long-fed Japanese market is a costly exercise, with a significant number of cattle failing to produce adequate marbling. If scanning could be used to weed these animals out early, the operation would be much more efficient.

The group scanned and slaughtered on day 70 had the best correlation (0.78), with the abattoir IMF% test (intramuscular fat, by chemical extraction). For the steers carried right through, around day 70 scans and subgroups slaughtered, every 35 days.

A CRC experiment at “Tullimba” research feedlot, cast more light on the role of scanning in feedlots. Two hundred Angus and Shorthorn steers, with Breedplan pedigree links, were fed for up to 184 days. They were scanned, and subgroups slaughtered, every 35 days.

The group scanned and slaughtered on day 70 had the best correlation (0.78), with the abattoir IMF% test (intramuscular fat, by chemical extraction). For the steers carried right through, around day 70 scans and subgroups slaughtered, every 35 days.

This suggests there is potential to draft long-fed cattle based on scanning around day 70, and further investigation is warranted.

Measurement accuracy

Individual measurement accuracy is not as critical for genetic evaluation, because an individual’s EBVs are calculated from three sources:

- The individual animal’s measurement relative to its contemporary group
- The EBVs of other relatives, weighted according to how closely related they are
- Genetic correlation with other traits
Until now, BREEDPLAN has been able to give us Estimated Breeding Values (EBVs) for growth and mature cow size, but has not been able to say at what feed cost. World-leading research on the genetics of feed efficiency by the Beef CRC is providing some answers to this vital issue.

Feed efficiency – the efficiency with which cattle convert feed into beef - is one of the most economically important production traits. Feedlots measure what their cattle eat on a daily basis, and are very conscious that it has a major effect on their profit. Across the industry’s breeding herds, where the breeding females consume perhaps 70% of total feed, cows which convert their feed more efficiently could have a major impact.

Groundwork in the 1990’s by NSW Agriculture at Trangie, funded at the time by the Meat Research Corporation, established techniques for measuring individual animal intake, and used them to demonstrate the potential for an industry-wide program to improve feed efficiency. This work has since been incorporated into the Beef CRC and has expanded into a major research program on feed efficiency.

This work has since been incorporated into the Beef CRC and has expanded into a major research program on feed efficiency. There are links to many other projects such as breed society progeny tests and gene marker research.

What is NFI?

- Feed efficiency for genetic evaluation in Australia is measured as Net Feed Intake (NFI). NFI is the feed consumed by cattle under (-) or over (+) that expected for their weight and rate of gain. This means that efficient cattle of any size can be selected. This is preferable to Feed Conversion Ratio (FCR, the weight of feed required per kilogram of liveweight gain) as selection on FCR leads to bigger cattle, which may not suit all environments.

- NFI EBVs are now available in BREEDPLAN for breeders doing the required testing. Negative EBVs indicate lower feed intakes see example in box

- NFI has similar heritability to growth, so good selection progress is possible once practical testing options are widely available

- Testing currently involves the costly procedure of feed intake measuring individuals in a standard 70-day test. Several studs are now successfully doing this on farm, or at central test stations

- A blood test for IGF-1 (Insulin-like growth factor) has been shown in CRC research to be a promising early predictor of NFI and is also related to some fatness measures. It was incorporated into BREEDPLAN in 2004 to improve the accuracy of NFI EBVs (see details page 19).

Research results and correlations with other traits

The trait, as measured on young bulls and heifers, is of similar heritability to weight gain. Several experimental lines of steers, sired by High and Low NFI EBV Sires, have demonstrated this by showing that when given ad lib access to a similar

Interpreting NFI EBVs

EBVs for Net Feed Intake (NFI) are reported as kilograms of feed eaten per day. Like most EBVs they can be positive or negative, relative to breed average. The more negative, the less feed eaten and the more efficient. For example, two bulls with these EBVs: Bull A + 0.5 kg/day (Breed Average is 0) Bull B – 0.7 kg/day

A simple interpretation, is that Bull B having more negative NFI EBVs, would be expected to breed ‘more efficient’ progeny, than Bull A or a breed average bull. If the two bulls were similar in weight EBVs and joined to average cows, progeny of B would gain the same, but eat 0.6 kg less per day than the progeny of A (half the difference of 1.2 between the Sire EBV, as the cows contribute half the genes).
Producing Quality Beef

One of the automatic feeding units at Tullimba Feedlot, used to measure and record the individual intake and feeding pattern of up to 12 cattle in the pen. Public test facilities are available in NSW, Victoria and WA, and the unit has been commercialised by Ruddweigh for on-farm testing. The new IGF-1 test and future gene marker research will speed up the identification of superior feed-efficient genetics.

New research – Insulin-like Growth Factor (IGF-1) blood test used for 2004 EBVs

The CRC research group is also looking for gene markers and physiological tests to increase the accuracy of the NFI EBV and/or to reduce cost of finding superior stock. The first of these, a blood test for the protein IGF-1, has been introduced to BREEDPLAN in 2004.

The blood test is conducted by the Australian company Primegro Ltd, which has the exclusive right to commercialise this Australian Intellectual Property. IGF-1 is moderately heritable (0.4) and correlated to NFI (0.6). Low IGF-1 readings correlate with better efficiency. Data from a large number of blood test results in BREEDPLAN herds has been used in the January 2004 Angus NFI EBV calculations. Hereford IGF-1 data will be used from mid 2004. Breeders should take IGF-1 blood samples at or before weaning to give best genetic responses.

This analysis has been done by AGBU* using a two trait model. As the correlations with other traits become known, NFI will be incorporated into the full multi trait BREEDPLAN model.

Further information: See the BREEDPLAN web site or contact Dr Robert Herd, senior NSW Agriculture researcher on this project (02 6770 1808) or for IGF-1 information, contact Primegro (08 8354 7711).

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diet to that on which their parents were selected, they show the predicted changes in NFI in the feedlot.

A fair question is therefore: “would these results hold under grazing?” Steers from the High and Low efficiency lines from “Trangie” have been grown out on pastures of varying quality. In one experiment their intakes were measured via slow release rumen capsules. Both lines had similar intakes, but the High line grew faster and therefore had better feed efficiency.

Continuing CRC research will, among other things, determine the relationship with some other traits affected by selecting for NFI. In particular, the meat quality traits such as tenderness will be carefully studied. To date the only significant finding is a small link with leanness (cattle with lower NFI EBVs, being slightly leaner and possibly lower marbling). While this needs to be watched, the correlation is quite low (less than the correlation between birth weight and final weight), and can therefore be managed by selecting on both traits.

Heifers retained for breeding in research herds, in early results, have to date shown no effect on fertility or other production traits. As cows, the negative NFI EBV cow lines appear to also be more feed efficient under grazing.
“Our involvement in the CRC and what we have learned has paid our operation tremendous benefits”, says Sam White, Principal of Bald Blair Angus near Guyra, on the NSW northern tablelands.

Bald Blair has been one of the participating herds since the inception of the CRC in 1993, providing weaner cattle and being heavily involved in evaluating their sires with data in the CRC.

Bald Blair is a commercially focused Angus stud that has been operating since 1898. The commercial herd supports the stud and specialises in producing high quality feeder steers for the Japanese B3 market.

BREEDPLAN and TGRM (Total Genetic Resource Management) are two technologies that have revolutionised the mating decision making that occurs in the Bald Blair breeding operation. Understanding the effect of growth paths is another powerful tool to come out of the CRC. “They have immediate use and we received immediate profit as a result of it” Sam said.

“Yard weaning and the management of the setback that can occur before weaning is critical. Since 2002 was such a tough year with such a massive drought, we know there are going to be cattle that are fatter and aren’t going to yield as well as a result of the dry times”.

Net Feed Intake (NFI) testing commenced at Bald Blair in 2000. Net feed intake testing is a costly exercise and requires a large labour component but the CRC has shown that there is a difference in the amount of feed consumed by animals. It’s measurable and moderately heritable, therefore it is a desirable trait in our industry.

Bald Blair has incorporated NFI into its breeding program. The benefits of measuring net feed intake have been evident in their custom feeding program and they are convinced it is a relevant trait to be delivered to industry.

Bald Blair has adopted the use of gene marker technologies. Sam believes using Genestar technology for selecting marbling is a must, since they are a pure bred Angus herd. “There is an absolute profit and direct benefit from focusing our operation and selecting for marbling,” he said.

The Bald Blair commercial herd targets the Japanese B3 market, so it is important for us to maintain marbling, and improve it in terms of its frequency, as there is a direct profit to be made, Sam believes.

Bald Blair is involved in breeding and marketing alliances to market some of their stock. “By recording data and using CRC technologies, this gives our operation a marketing edge,” Sam said.

Bald Blair is an experienced user of BREEDPLAN. When they first started recording traits they included birth weight, growth and milk. Now there are EBVs for calving ease, carcase, fertility, mature cow weight and more recently Net Feed Intake - a total of 18 EBVs.

“They are all part of the selection decision and they have to be taken into account when we are mating the breeding herd,” said Sam. “There are a lot of EBVs to make decisions on, and in addition to that, we use another eight structural scores and three DNA markers. There is a lot to think about.”

There are decision support packages that help to do this and they include BREEDOBJECT and TGRM. Both packages are decision support systems that help work out the best combination of these traits to maximise the genetic gain that Bald Blair is getting in its herd.

“As a cooperating breeder in the CRC we have had significant gains by making a lot of changes in breeding and management from 1993 to 1999. The gains are occurring at a slower rate now, because it’s mainly genetics. There are more decisions to be made and more traits to be taken into consideration.”

Bald Blair is aiming for long-term genetic gain by utilising available technologies.

More information: Sam White Ph: 02 6779 2141
BREEDPLAN EBVs (Estimated Breeding Values) are widely used by bull buyers and breeders. Currently, all breeds have EBVs relative to their own base figures, so EBVs of different breeds cannot be directly compared.

To improve this situation, Meat and Livestock Australia has funded the development of multibreed EBVs which will allow different breeds to be put onto a common base.

Using data from the CRC and the specially designed Victorian multibreed experiment, geneticists at the Animal Genetics and Breeding Unit (AGBU – closely involved with the Beef CRC) have developed Australia’s first conversion table for BREEDPLAN multibreed EBVs. (Table 1 below)

Comparisons of four breeds for birth, growth and carcase weight traits have initially been possible. More breeds and traits will be added, as new data becomes available.

Example using table 1: To compare an Angus bull with a birth weight EBV from Angus BREEDPLAN with a Limousin bull with its Limousin BREEDPLAN birth weight EBV, add from Table 1, 0 to the Angus EBV and 6.4 to the Limousin EBV. The resulting figures for the two bulls will then be comparable to each other. (This is further illustrated in Table 2.)

Note: Like EBVs the adjustments may change over time, so check the date of such tables to see if a more recent table has been produced.

Using multibreed EBVs
- Stud breeders may compare their stock with other breeds and perhaps review selection priorities.
- Commercial pure breeders, crossbreeders and composite developers can better select breeds and sires.

In crossbreeding situations, multibreed EBVs only hold if the bulls being compared are mated to the same, unrelated breed. For example, if breed average 2001 drop Simmental and Angus bulls were mated to Shorthorn cows.

From Table 2, the Simmental/Shorthorn cross calves are predicted to be 3.2kg heavier at birth (half the difference between their multibreed EBVs of 10.4 and 4) than the Angus/Shorthorn crosses. Similarly at 400 days, the Simmental crosses are predicted to be 17kg heavier (half the difference between 86 and 52).

Brian Sundstrom, Cattle breeding specialist, NSW Agriculture. Ph: 02 6773 3555 http://breedplan.une.edu.au

Table 1: Multibreed EBV Adjustment Table (March 2003)

<table>
<thead>
<tr>
<th>BREED</th>
<th>Gest. length</th>
<th>Birth Wt</th>
<th>200d Wt</th>
<th>400d Wt</th>
<th>600d Wt</th>
<th>Carcase Wt</th>
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</thead>
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<td>Angus</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poll/Hereford</td>
<td>1.1</td>
<td>2.8</td>
<td>9</td>
<td>21</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Limousin</td>
<td>9.2</td>
<td>6.4</td>
<td>13</td>
<td>25</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>Simmental</td>
<td>6.4</td>
<td>8.7</td>
<td>31</td>
<td>63</td>
<td>71</td>
<td>n/a</td>
</tr>
</tbody>
</table>

(Adjustments from Table 1 are added to the BREEDPLAN EBVs for breed average 2001-born animals within their breed).

Table 2: Examples of Multibreed EBVs for breed average stock.
**DNA technologies - towards better genetic prediction**

**Brian Sundstrom**

Around the world, scientists are studying the genes and DNA of living organisms, and how they control life. In our industry, molecular geneticists are searching among the 40,000 pairs of genes in cattle for those which control the important productive traits.

DNA technologies resulting from this work have many potential uses in the cattle industry. They fall into two groupings, Genetic prediction and Phenotypic uses. The Beef CRC has research involving several of these areas, but mainly in genetic prediction.

**Genetic prediction**

DNA technologies have great potential to improve the genetics of seedstock herds, with flow-on to the commercial herds of clients through better bulls. Small but very significant beginnings have been made in this direction in Australia with the world's first availability of gene marker tests for commercial production traits.

These technologies will be able to enhance the accuracy of predicting mating outcomes through better EBVs and selection indices.

Areas of genetic prediction potentially assisted by DNA research, include:

- Parentage verification
- Gene and gene marker assisted selection
- Monitoring and avoiding inbreeding
- Avoiding genetic disorders.

**Phenotypic uses**

Phenotypic uses are those describing a current group of cattle. For example:

- Drafting at feedlot entry into groups for differential feeding according to their marbling potential
- Trace backs on live cattle or meat
- Transgenics: This is expected to first be used for the production of pharmaceuticals. Transgenic animals may also be possible in the future, by introducing genes from other species, for example, to introduce disease resistance. The Beef CRC is not working in this area.

The CRC has a large and continuing molecular genetics program. CRC researchers have been closely involved in finding the first genes identified to influence commercial production traits, and assisting to quantify their effects.

The first three of these were commercialised in 2002 and 2003 by Genetic Solutions Pty Ltd, as GeneSTAR® Marbling and Tenderness (two tests). [http://www.geneticsolutions.com.au](http://www.geneticsolutions.com.au)

While the finding of these first genes is a very important development, it must be remembered that many genes are likely to be involved in the expression of most commercial traits.

Current work by the CRC includes searching for more of the genes controlling marbling and tenderness, as well as those involved with other meat quality traits, feed efficiency and tick resistance.

**CRC research on DNA for genetic prediction**

There are several promising leads at various stages of investigation and/or commercialisation. Figure 1 shows some of them, and indicates how gene markers are identified and developed into commercial gene tests.

The Beef CRC has databases with carcase and performance records on many thousands of slaughter cattle of known genetics. Even though the cattle have been slaughtered long ago, this data is an enormous asset for the further development of gene marker tests. DNA samples have been kept for this purpose and are also being used to test genes found by other research groups.

Most geneticists believe the key future role of DNA in genetic prediction, will be by complementing existing programs such as BREEDPLAN. (Figure 2 shows the general principles and Figure 3 specifically the carcase traits).
Figure 1
The process of developing gene markers, and potential new markers in the gene discovery.

Figure 2
Gene marker data from tests in seedstock herds is being used by geneticists at the Animal Genetics and Breeding Unit (AGBU) to develop new methods of enhancing BREEDPLAN EBVs. A limitation at present is obtaining full sets of this privately held information.

Figure 3
Schematic model of current data sources for BREEDPLAN carcase EBVs and potential addition of DNA data.
Does selection for carcase traits affect female fertility or feed efficiency?
CRC Northern Breeding Program

Heather Burrow and Brian Sundstrom.

Does selection for meat quality, carcase yield or feed efficiency affect fertility and adaptation to harsh environments? The Beef CRC has a major project studying links between the genetics of beef quality, feed efficiency and female reproductive fitness in northern Australia.

Results from this trial will also provide the genetic correlations, which will further strengthen how BREEDPLAN calculates fertility EBVs.

The project is jointly funded by the Beef CRC, Meat and Livestock Australia (MLA), and the Australian Centre for International Agricultural Research (ACIAR). There is an important component of the project in South Africa.

Project participants

Key sponsors breeding calves for the project are the Northern Pastoral Group (NPG) of Companies; Stanbroke, NAPCo, Consolidated Pastoral Co, AA Co, E & G Maynard, J McCamley, C. Briggs, Kidman Holdings and QDPI.

The breeding program commenced in 2000 with 4,800 calves to be generated over four years. Some 3,000 each Brahmans and Red Composite cows, have been joined to Sires high and low in Yield% and IMF% EBVs and with known gene marker profiles as well as sires nominated by the industry partners.

Steers are grown out at various locations in NSW and Queensland. At around 420 kg they go on feed for 110 days in the “Tullimba” research feedlot, until they reach 320-340 kg carcase weight. They are then processed for detailed carcase information.

The genotypes of heifers are allocated across different research station growout environments. These range from hot dry climates with no ticks and low worm burdens to dry tropics with hot, humid summers, unimproved to partly improved spear-grass country with varying levels of tick, worm and buffalo fly burdens.

Progress

Ultrasound scanning is used to monitor ovarian activity once heifers reach 200kg, to study factors affecting puberty. Figure 1 shows the type of image from ovary scans. Progress has been amazing, considering the drought. The fourth, and last, calving was completed in summer 2002/03.

Early results

Before releasing full results for projects such as this, all the data must be collected and carefully analysed.

Early results in heifers up to 2 years of age show strong breed and environmental effects on age and weight at puberty.

Some generalised preliminary results show a significant relationship between rump (but not rib) fat depth scanned at the start of joining, and subsequent pregnancy. As expected from industry experience in both northern and southern Australia, the leaner females are showing lower conception rates. This appears to happening in all classes of breeding females -lactating and non-lactating, and across different age groups.

Current trends are for the composite lines to cycle at lower levels of fatness than the Brahmans.

All cattle are also having flight time recorded. The steers are being tested for feed efficiency, then fully evaluated for meat quality. When the steer results are combined with the flight time and fertility data of related females, a better understanding of the complex interactions will be gained. This will be fed into the BREEDPLAN model to allow studs and their clients to progress their herds in these areas.

Ovary scans are used to monitor ovarian activity and age of puberty.

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North Australian Pastoral Company integrates production with composite genetics - John Bertram

The North Australian Pastoral Company Pty Ltd (NAPCo) started in 1877 and comprises 13 properties stretching from the Barkly Tablelands in the Northern Territory to the south western Queensland channel country and down to Roma. Across this wide expanse the company runs approximately 180,000 head of cattle that started with the Shorthorn breed and now is part of an extensive composite breeding programme.

Yard weaning has long been part of the company’s management tools. However, the results of studies from the CRC have enabled the company to introduce objective measures for testing temperament. Steve Millard, a General Manager for NAPCo, said “Flight time testing has now been introduced into the recording of temperament in animals destined for the stud breeding programme to ensure docile animals and the demonstrated link to superior production traits”. He said “In addition, the company has adopted the use of gene marker technology to identify animals carrying tenderness and marbling traits necessary for their market specifications”.

As part of the four composite stud groups, the company has devoted one whole group of about 400 head to the northern CRC fertility research project. This group will provide further evidence of the fertility traits expressed in the company’s composite cattle as well as genetic markers currently being researched. Mr Millard said the company is conducting a genetic analysis for EBVs to further enhance their selection opportunities in their composite breeding program.

More information:
Steve Millard NAPCo
Ph: 07 3221 2266
Regional growth path studies in southern environments

Brian Sundstrom and John Wilkins

Beef producers now have the chance to see Beef CRC research being applied closer to home. Projects in four states are aiming to find the best combination of genetics and growth path to fit the local production environment and markets.

There are four sites across southern Australia, Struan in South Australia, Wagenup in Western Australia, Hamilton in Victoria and Griffith in New South Wales. They are each testing nutritional options relevant to their region, allowing lines of steers of different genetic potential (for carcase type) to be grown at different rates, and finished for various markets.

The individual sites have varying end points, but are strongly linked by common themes in objectives, design, some genetics and experimental resources.

NSW trial design

The NSW trial is briefly described here as an example, but we recommend you obtain information about your nearest site through your state department.

The first two years were at “Bringagee” station near Griffith, but the drought forced some of the cattle to be moved in 2003 to NSW Agriculture research station at Grafton.

Groups of 500-700 Hereford cows were involved at each of the 5 matings for Spring and Autumn calving groups. These are being joined by AI to five carcase types, each represented by eight sires (40 total):-

- Angus - High Yield % EBVs
- Angus - High IMF % (marbling) EBVs
- Angus - High Yield % and IMF % EBVs
- Wagyu Black and Wagyu Red
- Charolais and Limousin

After weaning, the steer progeny are grown out on pasture at either High or Low growth rate. Feed quality is managed so they reach (average) 400kg feedlot entry weight at either 13 or 19 months of age, before they go on to be finished for 100-150 days in a commercial feedlot.

This split calving allows the Low growth group from one calving and the High group from the following calving to come together for finishing and slaughter. This is essential for valid comparison of performance and carcase quality between groups.

The experiment at Hamilton in Western Victoria has a similar basic design. Some of the grass finished slaughter groups from Hamilton were processed at the same time and at the same abattoir, further strengthening links across project sites.

In 2003 the final NSW calving and first slaughters took place, but considerable time is still needed to collect and analyse all the grow out and slaughter data.

Watch for results from your nearest “regional combinations” experiment as they come through.

For more information contact NSW: Steve Exton 02 6938 1950; Vic: John Graham 03 5573 0908; SA: Mick Deland 08 8762 9160; WA: Brian McIntyre 08 9368 3736.

Steers exiting “Jindalee” feedlot near Wagga Wagga, just prior to processing at the Cargill works.

Design of growth path treatments for steers to reach target weights for feedlot entry (NSW site). All animals are treated the same until weaning, then follow fast or slow growth paths to feedlot entry at same group average liveweight. There will be four intakes with matching fast and slow treatment groups, after the initial “pilot” first intake.
A simple measure of Flight Time has emerged from research by the Beef CRC as a particularly useful objective gauge of temperament in cattle. Not only can it weed out the poor performers in a feedlot, but also it is practical to use in a breeding program to select quieter cattle, and to improve meat tenderness.

Using flight time has another benefit too - the industry is becoming more conscious that cattle with poor temperament pose a higher risk of injury to both the animals and the handler.

How is temperament measured?

An animal’s flight time is a measure of its temperament. It is simply an electronic measure of the time taken for an animal to cover a small distance (about 1.6 metres) after leaving the crush (see Fig 1).

Animals with a short flight time (say 0.4 seconds) leave the crush faster and have poorer temperament than animals with a long flight time (say 1.5 seconds).

The flight time measurement is quick, simple, objective, repeatable and heritable, meaning that you can effectively use a single measure of flight time for selection.

Flight time and feedlot performance

The Beef CRC has new evidence that poor temperament affects the profitability of a feedlot, because it lowers production and raises costs.

In one feedlot experiment, the difference in daily weight gain between animals with the best and worst temperaments was about 0.4 kg per day, amounting to 70 kg difference in live weight at the end of the 85-day feeding period.

The differences were remarkably consistent across British and tropically adapted breeds. Steers with slow flight times (good temperaments) grew faster and had heavier carcases than steers with poor temperaments (see Figures 2 and 3 page 28).

The more docile animals had higher feed intakes and better feed conversion ratios (kg feed eaten per kg weight gain) than their more temperamentally counterparts.

In another experiment, CRC researchers studied groups of cattle selected prior to feedlot entry for high and low temperament. Nervous British breed (Angus x Hereford cross and Hereford) steers had significantly lower average daily gains and significantly higher levels of sickness. After 78 days on feed, nervous animals had grown at 1.04 kg/day compared to the 1.46 kg/day of the calm animals, a difference of 0.42 kg/day between the groups.

Not one of the calm animals was pulled from the feedlot pen for sickness, while 42% of the nervous animals were taken to the hospital pen at some time during the feeding period. This is a strong indication that nervous animals have a higher tendency to get sick than those animals with a more relaxed nature.

This indicates that the flight time measurement can be used to identify cattle with the right temperament to achieve maximum feedlot performance.

Using flight time to improve meat quality

The Beef CRC has also discovered that in tropical breeds, the simple measure of flight time is a powerful way to improve the genetics of meat tenderness. There are also indications it could have a smaller, but positive potential role in temperate breeds.

This is a major breakthrough, as measuring tenderness directly in breeding stock is almost impossible.

Flight Time – a useful measure of temperament

- A low flight time (fast exit from the crush) indicates poor temperament, resulting in lower weight gains and poorer performance, compared to the more relaxed animal (slow exit from the crush) with a higher flight time.
- Animals with a slow flight time (good temperament) grow faster in feedlots to achieve higher final weights and heavier carcases, with better feed conversion ratios.
- Measures for temperament are highly heritable and good genetic progress can be achieved by selection for this trait. You can improve temperament by selection and culling.
- Some of the genes involved in temperament are the same as those influencing meat tenderness. Animals with poor temperament (fast flight time) have a genetic tendency to produce progeny whose beef is tougher.
It works because there is a strong genetic correlation between flight time, and meat tenderness. This means that as you select for quieter temperament in the herd, there is a correlated response, which automatically improves meat tenderness.

Seedstock producers can easily measure flight time in their breeding stock. Once sufficient records are sent to BREEDPLAN, they will be used to calculate EBVs in some breeds, and this will help commercial breeders select their bulls.

Table 1. Genetic relationships between flight time at weaning and carcase and beef quality attributes of 3,594 Brahman, Belmont Red and Santa Gertudis animals.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Correlation with Flight Time</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail beef yield percentage</td>
<td>0.11</td>
<td>Low correlation – cattle with low (fast) flight times (poor temperament) have a very small tendency to produce progeny with lower retail yield</td>
</tr>
<tr>
<td>Intramuscular fat percentage</td>
<td>-0.05</td>
<td>Very low correlation - the two are virtually independent – flight time of parents has very little influence on marbling in their progeny</td>
</tr>
<tr>
<td>Striploin shear force</td>
<td>-0.48</td>
<td>Cattle with lower flight times (poorer temperament) are very likely to breed progeny with higher shear force (tougher beef)</td>
</tr>
<tr>
<td>Striploin meat colour</td>
<td>-0.18</td>
<td>Cattle with lower flight times may tend to breed progeny which have slightly higher (darker) meat colour scores</td>
</tr>
<tr>
<td>MSA MQ4 score</td>
<td>0.47</td>
<td>Cattle with lower flight times are very likely to breed progeny which produce lower meat quality scores (have poorer eating quality)</td>
</tr>
<tr>
<td>MSA tenderness score</td>
<td>0.41</td>
<td>Cattle with lower flight times are very likely to breed progeny which produce lower tenderness scores (tougher meat)</td>
</tr>
</tbody>
</table>

The genetic correlations between flight time at weaning and a number of carcase and beef quality traits are shown in Table 1.

In the CRC studies, cattle were handled regularly and carefully, especially prior to slaughter, and processed to strict standards. This was important, because Bos indicus cattle are known to be more sensitive to processing treatment, and this sensitivity could be linked to the temperament differences being studied.

In this trial, there was very little difference in eating quality between the low and high flight speed animals themselves. This indicates that best practice handling and processing can override the genetic tendency for toughness and still produce acceptable beef.

The real problem here is that this does not improve the underlying genetics in the next generation, and poor processing can still produce poor quality beef.

Selection of cattle for improved temperament will go a long way to guaranteeing eating quality of cattle in the existing herd and to improving eating quality in future generations.

The Limousin breed has been measuring docility, a related measure, and using it to produce BREEDPLAN EBVs for temperament. This has been very successful in producing measurable improvement (see below) It is quite likely BREEDPLAN will use docility score and flight time as correlated traits to improve the accuracy of selection in some breeds.

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</tbody>
</table>

What is a genetic correlation?

Genetic correlations indicate how strong is the relationship between two traits at the genetic (next generation) level. They range from -1.0 to +1.0.

A high correlation (positive or negative) indicates that some of the genes controlling one trait also control the other. For example, there is a strong genetic correlation between birth weight and weaning weight.

A zero relationship indicates the two traits are independent of each other.
Limousin breeders have tested 17,000 animals since 1995 to develop docility EBVs for their breed. These EBVs have allowed the Limousin breed to make genetic progress for docility.

Breeders have been using two subjective tests to measure the flightiness of their animals. They are the crush test (scoring the behaviour of an animal when put into a crush using a scale of 1-5) and yard test (scoring the behaviour of an animal when put into a yard on their own and a handler attempts to hold them in a corner). The flight time test was used for the large herds when measuring equipment was available. All are measures of docility and are all correlated with each other.

Estimated Breeding Values (EBVs) for docility for sires, dams and calves have been calculated using all of the scores and pedigrees available from the past 7 years. Since 2002 docility EBVs have been reported for sires, dams and calves.

Has the Limousin breed made genetic progress?

There has clearly been a big improvement in the average docility EBV of the 20 most widely used sires across the breed. By following the average EBV for the calves born each year we can track the genetic change for the breed.

Note there was very little change from 1990 to 1996 but as EBVs became available, the average docility EBV has increased from +0.5 for 1996 born calves to +4.4 for 2002 born calves.

Further information: Alex McDonald, Australian Limousin Breeders Society, Armidale, alex@limousin.com.au, 02 6771 1648

Using flight time to breed quieter cattle

Ruddweigh Australia Pty Ltd has developed a commercial prototype of the machine to allow breeders to easily measure an animal’s flight time on-property (www.ruddweigh.com.au).

Further information: Heather Burrow, Rockhampton, Heather.Burrow@csiro.au or 07 4923 8139

Using flight time

For better feedlot performance:

• Measure flight time at or before feedlot entry
• Cull cattle with the worst temperament, indicated by fastest (lowest) flight times

For genetic improvement of temperament and meat quality

• Record flight times shortly after weaning, early in life
• Select cattle with slow (high) flight times
• Cull animals with fast (low) flight times, and those which behave badly in the crush
• BREEDPLAN has indicated that when sufficient data from stud herds is submitted, EBVs can be produced.

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Health and welfare research breaks new ground

Ian Colditz and Sharon Pettiford

The science that underpins the Beef CRC’s program in Health and Welfare has confirmed some things which practical cattlemen have always believed, and has broken new ground in the objective measurement of welfare and behaviour.

Not only has it confirmed strong links between stress, meat quality and disease resistance, but studies on temperament have linked poor temperament with feedlot performance and genetic factors causing meat toughness.

New techniques for measuring stress are being used to develop better pre-slaughter management systems for industry, and a factual basis for describing the welfare of cattle.

The significance of stress in cattle

Stress responses are defence reactions of the body to protect it against challenges like extremes of weather, injury, and infection. They can be activated when animals are transported, mixed with unfamiliar animals or introduced to new surroundings. Stress reactions divert nutrients away from growth to defence of the body, and during the early phases, reduce immunity against disease.

This is a particular problem as cattle enter feedlots, as they have usually been transported, introduced to a new environment and mixed with unfamiliar animals, some of which may be carriers of infectious viruses. These stresses lead to an increased risk of infections such as respiratory disease.

The first objective of the Health and Welfare Program was therefore to improve the general standard of health of cattle kept under intensive management systems, especially by finding ways to reduce the incidence of respiratory disease. This work has given us a better understanding of the stressors that weaken disease resistance and reduce meat quality.

Community attitudes towards animals, and notions of what constitutes good livestock welfare, continue to change. Quality Assurance schemes such as CATTLECARE and the National Feedlot Accreditation Scheme (NFAS) include animal welfare standards and in some cases this is being extended to product labelling. Foreseeing these trends, the CRC program has been developing measures of acceptable animal welfare for the intensive beef industry. Objective criteria are important, as many perceptions of animal welfare are driven by emotion and media images.

Measuring strength of the immune system in cattle

A series of tests was developed by the CRC to study how various stressors affect the immune system of cattle. For instance, a study at Grafton on supplementing cows and creep feeding calves found that supplementing calves strengthened their immune system.

Associations between yard weaning, temperament and feedlot performance

Before the CRC began, the problem of respiratory disease in feedlot cattle had been identified in a Meat Research Corporation survey. Following this work, Lloyd Fell and colleagues at NSW Agriculture examined the benefits of yard weaning southern cattle, in terms of their feedlot performance (refer article “Yard Weaning Feeder Cattle” page 32).

They found that calves weaned in yards for five to ten days at a density of four square metres per head and fed good quality hay grew at around 0.1 kg per head per day faster and had less disease problems during feedlot finishing. The financial benefit of yard weaning (early 1990’s) was estimated to be $33 per head during feedlot finishing.

This study was extended within the Beef CRC to examine associations between temperament and feedlot performance (see page 26). Nervous cattle with fast flight times had higher levels of the stress hormone cortisol, poorer growth (1.04 v 1.46 kg/head/day) and more health problems than quiet cattle with slow flight times.

Yard weaned cattle had more social interactions with other cattle in the feedlot pen than did paddock weaned cattle and were more robust to the challenge of disease following feedlot entry.

Effect of mixing unfamiliar cattle on feedlot performance and meat quality

Hereford and Angus steers being finished for 70 days at ‘Tullimba’ were mixed four, two or one week before slaughter and compared with unmixed control cattle. Mixing did not influence feed intake, average daily gain (ADG) or physiological measures of stress responses.

Testing revealed that meat was slightly tougher in the cattle mixed one week before slaughter. The positive correlation between flight time and blood cortisol (r²=0.27) seen in these cattle suggests that feedlot animals with fast flight times have more active stress.
producing quality beef

key health & welfare messages

1. 80% of illnesses which occur in the feedlot happen in the first 30-40 days on feed
2. Health and growth rate of cattle during feedlot finishing is improved by yard weaning
3. Quiet cattle grow faster and have fewer health problems during feedlot finishing
4. Flight time is correlated with average daily gain during feedlot finishing
5. Adaptability of cattle to new environments (eg the feedlot) can be improved by both genetic selection for flight time and husbandry practices such as yard weaning
6. Cattle with fast flight times can lose more weight during long distance transport (eg 1500km)
7. Mixing unfamiliar steers of similar weight and in similar proportions during the last week of feedlot finishing can lead to tougher beef. Mixing earlier does not appear to affect meat quality.
8. Acute stress in the last 15 minutes before slaughter results in meat of lower quality. This effect is invisible in the meat.
9. Avoid exposing cattle to multiple stressors at the one time if possible
10. Skills and objective criteria are being developed to assess the welfare status of cattle in Australian production systems

effect of acute pre-slaughter stress on meat quality

the effect of acute stress in the last 15 minutes before slaughter on meat quality was examined (refer Meat Science articles, page 7). Six to eight prods with an electric goad resulted in meat of lower quality in the four criteria assessed by consumers in a MSA tasting panel, in comparison with cattle handled quietly when moved from lairage (abattoir yards) to the knocking box.

indices of animal welfare for the intensive beef industry

studies by csiro and NSW agriculture have concluded that to assess welfare of cattle, it is best to use behavioural assessments in combination with blood tests to measure activation of the stress hormone pathway and immune function.

current research

the concluding phase of health and welfare research within the CRC is examining:

- the neurophysiological basis of the behavioural responses associated with flight time in cattle
- better predictors of how cattle will respond to stress
- associations between stress responsiveness and growth rate
- effect of holding time before slaughter at the abattoir on meat quality
- interactions between temperament, handling practices and performance in Bos indicus cross cattle
- biochemical basis of the effect of acute pre-slaughter stress on meat quality

further information: Sharon Pettiford, Beef CRC, Phone 02 6773 5033 or Ian Colditz, CSIRO Livestock Industries, Locked Bag 1, Post Office, Armidale, NSW 2350, Phone 02 6776 1460
ian.colditz@csiro.au

low stress feedlot environment; healthy, happy cattle.
Innovative breeding at Mount Eugene

John Bertram

Mount Eugene is a commercially focused Belmont Red, Bonsmara and Senepol stud operating commercially since 1969. The commercial herd demonstrates the functionality of these cattle in a sub tropical environment and the many wins in carcase competitions is a testimony to the versatility of these cattle for domestic and export Japanese B1 market.

The BIA “Seedstock Producer of the Year” award in 1998 is a clear recognition of the demonstrated success of Geoff Maynard in applying progressive beef technologies.

Mount Eugene has been integral with the development of BREEDPLAN in the tropical environment using Belmont Red cattle since 1992. Geoff has recorded and used selection for growth EBVs, fertility and carcase scan measures as part of the property’s everyday management.

Mt. Eugene supplied approx 20 bulls for the northern crossbreeding project conducted at Duckponds. In addition, the property has supplied approximately 1,000 steers and heifers representing over 30 sires, making them one of the major herds supplying tropically adapted steers for the growth pathway feeding trials at Tullimba feedlot.

As a result of information obtained in the CRC studies, Geoff said “we were able to identify for our clients specific lines of cattle for their particular markets, for example, higher marbling.” In the latest CRC project, Mt. Eugene co-operated with The Halbestaters from Mandalay to supply approximately 250 progeny to be evaluated for fertility traits in the far northern environments, in addition to feed efficiency trials now being conducted at Tullimba, with a composite Belmont Red mix.

The fertility trials using younger heifers in differing northern environments are of great interest to Geoff. He has incorporated some of the AI results gained using different products in the large artificial breeding programs at Duckponds during the 90’s. Geoff firmly believes in the greater productivity conferred by African derived breeds in the north where the beneficial influence on fertility rates will provide the greatest effect on profitability that the north can expect.

“Yard weaning has always been part of the management strategy at Mt. Eugene but the incorporation of grain into a backgrounding ration has followed the CRC results” Geoff said. “I am keen to review results of the feed efficiency trials at Tullimba, and to utilise any possible applications to our breeding program”.

Mt. Eugene has extensively used the DNA gene marker technologies for both tenderness and marbling traits. Geoff believes in utilising the GeneStar technology as an adjunct for selecting marbling to supply to the domestic market. “In this operation, ‘fertility is king’, he said, “but the addition of a low level of marbling is beneficial to the eating quality standards.”

Mt. Eugene is aiming for tropical adaptation with long-term genetic gain through the combination of superior genetics from several genotypes.

More information: Geoff Maynard
Ph: 07 4996 5233

Geoff Maynard (left) at Mt Eugene in 1998, shortly after winning the BIA Seedstock Competition of the Year. He is pictured here with Danny Wilkie, Objective Livestock Marketing, National President of the Beef Improvement Association at the time.
How can I add value to my feeder cattle? Through some relatively simple, low cost strategies, beef producers can increase returns from their feeder operation. This is primarily by supplying cattle that will perform better in feedlots.

The benefits are two-fold — improved growth rate and reduced sickness. Feedlots are increasingly offering price premiums for cattle that have been ideally prepared.

By understanding and applying optimal management strategies, feeder cattle producers are in a stronger position to negotiate a better price for their calves. Many feedlots now have a preferred supplier policy. They are reducing their intake of cattle with unknown backgrounds, largely due to the associated uncertainty with their performance and health.

Why are there differences?

Cattle consigned to feedlots are confronted with a variety of physical and psychological challenges and experiences. They are transported, inducted through yards and crushes, mixed with strange stock from different origins and exposed to a variety of stressors and infectious agents. Their capacity to handle these challenges has a big impact on how they perform.

Growth rate and sickness are two key issues for feedlots with respiratory diseases being the biggest health concern. Cattle are most likely to suffer from respiratory disease and poor weight gain if they are stressed before and during the first few weeks in the feedlot. Smooth, low stress adaptation to the feedlot environment is very important. It is critical that feeder cattle have the social and immune capacity to adapt quickly and easily to the feedlot environment.

What’s important?

Pre-feedlot preparation is the key. Cattle producers can significantly improve the performance of feeder cattle going into feedlots by following a simple pre-feedlot program involving yard-weaning and pre-feedlot respiratory disease vaccination.

Guidelines for yard weaning:

- Well built weaner proof yards with good quality water
- Pen stocking density of 4 square metres per head for 180–260 kg calves
- Round bale feeder with good quality hay or silage each day
- Kept in yards for 5–10 days
- Some human presence each day. Walk through and around the yards
- Reasonably sloped, non bog surface
- Solid opaque pen sides made from 1.2m rubber belting (optional)

To be healthy and profitable a feeder steer has to:

- Get onto feed and water quickly in the feedlot
- Have strong resistance against respiratory disease
- Adapt easily to the initial social/psychological and metabolic stress involved with getting onto feed
- Achieve good feed conversion efficiency and weight gain
- Accept vehicles, people and horses nearby at all times
- Not suffer from foot abscesses etc.

What does yard weaning involve?

Weaning is a critical learning time for cattle. The process of confining calves in a yard for 5–10 days after they have been weaned from their mothers does several things. It encourages social interaction in a confined environment (similar to a feedlot) and exposes them to a variety of external stressors, such as vehicles, people and yard noises. They become used to these and are subsequently less stressed when they enter a feedlot. The benefits of the simple procedure of yard weaning are principally realised during the feedlot stage of production due to the learned responses at weaning.

Do pre-feedlot vaccinations help?

In this trial, experimental pre-feedlot vaccinations against bovine respiratory diseases (BRD) produced better liveweight gain and reduced sickness (Figures 1 and 2). The combination of yard weaning and vaccination is optimal, with up to 8% better growth rates due to vaccinations.

This result indicated that there was a need to develop new vaccines, which were not available commercially at the time.

Since then, new vaccines for IBR, Pestivirus & BRD have been developed and commercialised.

Optimal yard weaning – what are the benefits?

In the MRC project (DAN.069) described below, calves were either (a) weaned in a paddock; (b) yard weaned with minimal...
handling or (c) yard trained — which was the same as yard weaning with some extra handling and feeding of grain in a trough. A vaccination treatment was imposed across the three against BRD. Calves were run in commercial feedlots over three years and their feedlot gain and sickness levels recorded (see charts).

Yard weaning at high density resulted in significant increases in performance, when compared to paddock weaned calves. The yard weaned and yard trained cattle had a higher weight gain. The yard weaned, vaccinated group gained an average of 1.53 kg/day compared to 1.28 kg/day for the paddock weaned, unvaccinated control group. These represent the top and bottom performance. Best results were achieved by combining yard weaning and pre-feedlot vaccination for BRD.

**Increasing returns from feeder cattle**

Vaccinated, yard weaned calves settled onto feed faster and grew faster over the 90 day feeding period than the paddock weaned calves. In one year they grew 60% faster in the first month on feed.

The proportion of yard weaned cattle pulled because of sickness was less than half that of the paddock weaned animals. Yard weaning and correct vaccination will maximise the chance of calves performing well.

**Key benefits**

By preparing your cattle optimally, it is possible to achieve:

- Cattle that start gaining weight sooner in the feedlot
- Lower livestock health costs due to less sick pulls in the feedlot
- Less deaths and sub-clinical respiratory disease in the feedlot
- A higher proportion of finished stock making the higher priced target market
- Higher growth rates can mean reduced times to finish cattle with big feed cost savings
- Higher growth rates also mean increased throughput per annum for the feedlot
- A negotiated premium for your prepared feeder cattle with your feedlot buyer

Market access is the other benefit. Feedlots will buy your cattle again and/or pay a higher price if they are confident of the performance potential.

**The bottom line**

Is pre-feedlot preparation cost effective? The best groups of feeder cattle are those that are socially established at yard-weaning. The worst are those animals that are thrown together from multiple sources at feedlot induction. For technologies to be picked up by producers they must be effective, simple to apply, cost effective and not overly labour intensive.

For more information


MRC Project DAN.069 May 1997 “Reducing Feedlot Costs by Pre-boosting: A tool to improve the health and adaptability of feedlot cattle”. Available from MLA.

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**Weight Gain Comparisons— 90 days on feed**

In trials over three years, Yard weaned (YW) and Yard trained (YT) cattle performed better than paddock weaned (PW) cattle in the first 90 days on feed. Adding vaccination to each treatment (YW-V, YT-V and PW-V) further improved their performance.

**Morbidity – Percentage of cattle treated for sickness**

Yard Weaned and Yard Trained cattle were healthier in the feedlot than Paddock Weaned cattle. A mixed group of commercial cattle (Comm) from saleyards had a much higher rate of morbidity (sickness).

**After 90 days on feed**

<table>
<thead>
<tr>
<th></th>
<th>Improvement in Gross Margin ($/head)</th>
<th>Additional Costs ($/head)</th>
<th>Estimate of Added Value ($/head)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yard Weaning with hay or silage for 10 days</td>
<td>$30.50</td>
<td>$5.00</td>
<td>$25.00</td>
</tr>
<tr>
<td>Yard Weaning plus pre-feedlot vaccination</td>
<td>$33.00</td>
<td>$15.00 (estimate)</td>
<td>$18.00</td>
</tr>
</tbody>
</table>
Do environmental stressors affect the growth of feedlot cattle?

Ian Colditz

The susceptibility of individual cattle to stressors varies, as do most traits producers can measure. Previous CRC research has highlighted the variation between cattle in the temperament trait flight time, and has shown that there are strong associations between flight time, meat quality and growth rate. These are being used to estimate EBVs for flight time in BREEDPLAN.

The physiological basis of a temperament trait like flight time is a complex issue under research in CRC. Temperament may affect the sensitivity of an animal to stressors such as the intensity of animal to animal interactions that occurs in the feedlot environment.

In a recent study we examined the associations between a number of physiological measures and growth rate in 210 Hereford and Angus steers during 70 days finishing at ‘Tullimba’. Growth rate in the feedlot was significantly affected by breed, flight time, blood cortisol (a stress hormone), white blood cell count and haemoglobin.

To further extend our understanding of how stressors affect growth rates, Lysandra Slocombe, a Beef CRC PhD scholar is examining haptoglobin levels in these cattle.

Haptoglobin is a host defence protein produced in the liver of animals during stress and immune responses. When animals produce it, they are diverting nutrients away from muscle growth to the synthesis of defence proteins in the liver.

It is of particular interest in studies on the effects of stress on growth. We await the outcome of Lysandra’s analyses with interest.

Further Information: Ian Colditz or Lysandra Slocombe 02 6776 1460

New cattle vaccines boost feedlot performance and herd fertility

Sharon Pettiford and Bob Gaden

Bovine Respiratory Disease (BRD) is the biggest cause of sickness and mortality in Australian feedlots. When NSW Agriculture demonstrated that experimental vaccines could provide good protection, money was invested through the Beef CRC to develop and commercialise vaccines to combat respiratory disease.

As a result of this work, two vaccines have been commercialised and another is expected on the market shortly. These will protect against three of the main diseases which make up the BRD complex.

- A vaccine against the agent that causes infectious bovine rhinotracheitis (IBR), bovine herpes virus 1 (Rhinogard, commercialised and distributed by Q-Vax) has been available in Australia since 13 November 2000, and is used in feedlots
- A new vaccine against pestivirus (Pestigard, available through CSL Animal Health) was released in September 2003. This has significant benefits to both breeding herds and to feedlots
- A vaccine for one of the major infectious agents causing bovine respiratory disease, Mannheimia (Pasteurella) haemolytica, is almost ready for commercial release and will have its main application in backgrounding prior to feedlot entry.

What is Bovine Respiratory Disease?

Various surveys have identified BRD as causing between 50% and 90% of sickness and death in Australian feedlot cattle. Respiratory disease is estimated to cost our cattle industry $60m a year.

The most common pathogens seen in the BRD complex in Australian are Infectious Bovine Rhinotracheitis (IBR) virus, Bovine Viral Diarrhoea (BVD, or pestivirus) virus, PI3 virus and bacterial pathogens including Mannheimia haemolytica, Pasteurella multocida and Haemophilus somnus.

BRD is now understood to be a complex disease involving many contributing factors, which combine to produce a severe, often fatal, pneumonia.

Cattle likely to be affected by BRD have usually been exposed to a wide variety of stresses such as weaning, transport, weather extremes, dust, dietary changes, handling and co-mingling as they pass through saleyards and are inducted into feedlots. This process also increases the likelihood of being exposed to a number of respiratory pathogens such as RSV, IBR and PI3 viruses.

All of the above combine to reduce the animal’s natural defence mechanisms, allowing dangerous bacteria such as Mannheimia to become established in the lung and ultimately give rise to BRD. BRD usually occurs within the first 3 to 4 weeks of entry to the feedlot.

Prevention of BRD

Prevention of BRD is best achieved through sound management practices combined with vaccination.

Management practices should aim to reduce stress in cattle, smooth their transition into the feedlot environment and limit their exposure to dangerous respiratory pathogens at times when they are particularly vulnerable. Good practices include avoiding saleyards, implementing yard weaning and backgrounding prior to feedlot entry.

Vaccination for BRD using newly released vaccines is another good management strategy that can further reduce the incidence of BRD.

Pestigard vaccine

What is Pestivirus?

Pestivirus, also known as Bovine Viral Diarrhoea (BVD), is a highly infectious disease, common throughout Australia. The presence of Pestivirus in your herd can result in reduced conception rates and abortion. It also suppresses the natural immune system in cattle, and makes them much more susceptible to other diseases, particularly during periods of stress, such as at feedlot entry.

When breeding cattle are exposed to Bovine Pestivirus for the first time during
pregnancy, they may experience early embryonic loss, abortion, or term delivery of abnormal and/or small calves. This can cut fertility rates by 30-50% in a newly exposed naïve (non immune) cow herd.

Some foetuses can become persistently infected in utero from exposure during the first third of pregnancy. These animals are referred to as “carriers” or “persistently infected” calves.

Persistently infected animals survive with difficulty and are unthrifty. They constantly shed the virus, acting as a source of infection for other cattle throughout their usually shortened life (up to 1-2 years).

**Virus spread**

The virus is shed by persistently infected animals in their saliva, nasal secretions, faeces, urine, milk and semen, and is then transmitted to other cattle, most commonly by direct contact. Close contact between cattle increases the risk of transmission.

In low stress situations, such as on pasture, animals can become infected with pestivirus without developing any signs of illness. Infection poses a risk to female cattle (that is, to their unborn offspring) only if their first exposure to a persistently infected animal occurs during the joining period.

Vaccination

Tony Shannon and colleagues at NSW Agriculture have developed a vaccine against pestivirus based on an Australian isolate of the virus. This vaccine was commercially launched as Pestigard in September 2003.

Active immunisation against Pestivirus in a cow herd and its replacement heifers will decrease the incidence of reproductive loss and of carrier or persistently infected calves.

Active immunisation of weaner steers will help cattle adapt to their first month in a feedlot by helping reduce BRD.

**Who should use Pestigard?**

**Cow Calf Producer**

Vaccination of your breeding herd is recommended, as testing for the disease is 2 to 4 times more expensive than the cost of the vaccination on a per animal basis. To protect against pestivirus, Pestigard vaccine should be administered to your:

- Heifers: 6-8 weeks pre-joining with the second dose 4-6 weeks later. An annual pre-joining booster thereafter
- Cows: 2-4 weeks pre-joining providing they have been previously vaccinated, otherwise follow the requirement for heifers above
- First season or new season bulls: 6-8 weeks pre-joining and the second dose 4-6 weeks afterwards, with annual booster thereafter
- Bulls previously vaccinated: an annual booster 2-4 weeks pre-joining.

**Backgrounders**

Pestigard should be administered to your steers that are being backgrounded for feedlot entry 6-8 weeks before feedlot entry with the second dose to be administered at least 2 weeks prior to feedlot entry.

**Rhinogard vaccine**

*What is Rhinogard?*

Rhinogard is a live intranasal vaccine for the control of infectious bovine rhinotracheitis (IBR), one of the major causes of the bovine respiratory disease complex (BRD) in feedlot cattle. Treatment with Rhinogard can have a beneficial effect on live weight gains and feed conversion ratios.
Who should use Rhinogard?

Rhinogard is a one-dose vaccine. Because it produces nasal mucosal immunity very quickly, it is suited for use on entry to the feedlot.

**Intervet’s Mannheimia haemolytica vaccine**

Within the CRC, Chris Prideaux and colleagues at CSIRO Livestock Industries (CLI) Geelong developed a conventional (killed) vaccine, which will help prevent respiratory disease associated with Mannheimia haemolytica (M. haemolytica) infection in feedlot cattle. Mannheimia haemolytica infection is a major component of the Bovine Respiratory Disease (BRD) complex.

Extensive registration trials have been conducted, and the vaccine is now in the final stages of approval by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The vaccine has already been successfully used in a limited number of commercial feedlots under the APVMA permit system.

Who should use Intervet’s Mannheimia haemolytica vaccine?

When the vaccine becomes available, producers and backgrounders who are preparing their animals for feedlot entry should ideally vaccinate prior to feedlot entry during a backgrounding phase. The second dose can be given 2-3 weeks prior to entry or at induction.

**Acknowledgments:**

The following people provided the technical information for this article: Dr Keith Walker NSW Agriculture Ph: 02 4640 6371; Dr R Griff Dalgleish, Marketing Manager, Intervet Australia Ph: 03 9336 9800; Dr Peter Young QDPI/Q-Vax Ph: 0409 593 093

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**Table 1 Summary of vaccine recommendations**

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Who should use it</th>
<th>Benefit</th>
<th>Recommended use*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pestigard®</td>
<td>Breeder</td>
<td>Herd fertility</td>
<td>2 doses for heifers and new bulls before joining, annual booster before joining</td>
</tr>
<tr>
<td></td>
<td>Backgrounder</td>
<td>Stronger disease resistance in herd and in feedlot</td>
<td>2 doses, the second 2-3 weeks before feedlot entry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Less susceptible to BRD; stronger immune status</td>
<td></td>
</tr>
<tr>
<td>Rhinogard®</td>
<td>Feedlot</td>
<td>Less susceptible to BRD</td>
<td>At feedlot induction</td>
</tr>
<tr>
<td>Mannheimia haemolytica vaccine</td>
<td>Backgrounder</td>
<td>Less susceptible to BRD</td>
<td>2 doses, the second 2-3 weeks before feedlot entry or at induction</td>
</tr>
<tr>
<td></td>
<td>Feedlot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* If you supply cattle to particular feedlot(s), discuss your vaccination plans with the livestock manager or buyer. While the vaccines are new and experience is being gathered, their preferred vaccination practices may change.

** At December 2003, this vaccine is in the final stages of approval before release.
New knowledge generated by the Beef CRC about growth and nutrition has big implications for the people who breed, grow, finish and trade cattle, and for those who use the carcases to meet customer needs for meat quality.

We have a new understanding of how growth rate early in life can significantly affect subsequent growth rate, carcase yield and meat quality.

The CRC’s nutrition experiments have been very powerful because they have been overlayed on the 9,000 head core breeding program, where all cattle were closely monitored from their genetic origin through to their ultimate meat quality. This has enabled scientists to separate and measure the different effects of genetics and nutrition along the way.

How the work was done

For example, to examine the effect of growth rate during backgrounding (from weaning to the start of the finishing phase), the incoming weaners were split into three equal groups. Grazing for each group was managed so they had fast, medium or slow growth rates.

After the backgrounding trial period, as each group reached its target feedlot entry weight, it was then halved equally for finishing either on pasture or in the feedlot.

When the slaughter and meat quality analysis was complete, it was then possible to answer many questions about cause and effect. For example:

- Did fast backgrounding growth produce more marbling in the finished product compared to slow backgrounding growth?
- Do cattle with slower backgrounding growth catch up in the feedlot? Is this likely to be more profitable for the feedlot than fast backgrounding growth?
- Does fast backgrounding growth produce meat that is more tender after they are finished in a feedlot? Is it different if they are finished on pasture?

The Beef CRC has improved our understanding of how early growth affects growth at later stages of life, carcase yield and meat quality. Studies on pre- and post birth growth restrictions are continuing.

The articles on pattern of growth (Page 38) and marbling (page 40) contain the main messages for producers from this work.

Feedlot nutrition

The main point of interest for the CRC was to see if feedlot nutrition could enhance the expression of marbling. This would add value to our export beef products, especially to Japan.

Several approaches were studied, including a protected lipid product (Rumentek®) and grain processing methods. There appear to be no magic ways to enhance marbling. The basic principles are to use the right genetics and feed a grain-based diet.

For more about marbling see page 40. Details of feedlot work are outside the scope of this publication.

Current and future research

In practice, there is wide variation in pattern of growth, carcase yield and meat quality in commercial cattle. Genetics may determine their potential, but nutrition and other factors influence how their potential develops and is expressed.

A project presently under way may help explain why some cattle perform much better than others. It is looking at the earlier stages of life, to see how nutrition in pregnancy and soon after birth affects later growth, carcase yield, marbling and other meat quality traits.

Perhaps there are critical points when nutrition can trigger more marbling potential, or a higher proportion of muscle tissue. Likewise, there could be key times when a shortage of nutrition destroys some of their potential.

In future this knowledge could lead to strategies for producers to maximise the value and potential of their cattle. For example, a breeder of high quality feeder steers for the Japanese market may one day be able to feed a supplement at critical times during early life to enhance the development of marbling.
Why is growth rate important?

Have you ever wondered how the pattern of growth and nutrition affects the type of cattle you produce?

Growth at two key stages in an animal’s development can influence your ability to meet market specifications and therefore affect your profitability. These are:

- a significant growth “check” (or restriction) before or after weaning
- backgrounding growth rates prior to feedlot entry

It’s important to understand how these growth effects work and where the critical points exist. You can then manage decisions that optimise cattle performance and enhance your market access.

What is a growth check?

Many producers think of a growth check in terms of a percentage reduction in growth rate, but the concept is best defined in cellular terms.

An animal has a set rate of cell development that is dictated by the genes, the nutrient supply and the disease status. When a restriction occurs that has a long term effect on cell development, this constitutes a growth check.

Cattle may arrive at a particular weight through various growth patterns, but the consequences of growth patterns on carcass composition differ, depending on the timing and extent of prior nutrition.

Practical implications

Specifications for feedlot entry require animals to be a minimum weight and maximum age.

They usually also include other specifications like fatness, frame size and breed.

Managing cattle to target weight and fat thickness can be easier if you have a good understanding of the effects of previous growth and nutrition (Figure 1) upon future growth and development.

What sort of differences matter?

It is difficult to define this exactly, but the following examples will give you some idea:

1. 300kg cattle growing at 1.3 kg/day, and growth drops to 0 kg/day for 6 weeks — growth check is after the critical point of around 180 - 250kg. No significant long-term effect would be expected - except marbling is likely to be reduced.
2. A growth check to 0 kg/day before 180kg would start to substantially influence body composition. If returned to good feed, re-growth would be slower. When these cattle are finished they would be lighter and fatter. If it occurred after 300kg, they would experience compensatory growth.
3. Cattle growing at 0.4 kg/day. This is a serious growth check already. There is little scope for growth to go down further and the sooner you can move it up, the better off the animal’s long term prognosis will be.

So there is no single percentage reduction that defines a growth check. It depends on when you start and how severe the growth check is.

Early versus late growth check

Whether a growth restriction is “early in life” or “later in life” changes at around 180 - 250kg liveweight, which is usually around weaning time.

- If the check occurs before 180 – 250kg you end up with fatter & less efficient cattle to finish. Upon re-feeding, muscle growth may not catch up and laying down of fat may start earlier than normal.
- If it occurs after 180 - 250kg you end up with leaner & more efficient cattle to finish. Upon re-feeding, muscle usually catches up and laying down of fat may be delayed.

Making it all work

Identify the key principles that affect your operation and keep it simple.

- If the restriction occurs early in life, the effect is usually permanent, and greater than if the restriction occurs later in life.
- With EARLY restriction and recovery in cattle, these will be fatter at the same weight as well grown cattle.
- With LATE restriction and recovery in well grown cattle, these will be leaner at same weight as well grown cattle.

If you are supplying the B3 Japanese high marbling market, higher growth during backgrounding is desirable in order to get the best marbling, but remember marbling potential is governed by genes.

If you are supplying the domestic high yield & low fat market, lower growth during backgrounding is desirable for the lotfeeder. These cattle grow faster in the feedlot.

If you are a grass finisher and this year’s cattle grow very slowly under 180kg and then go back onto “good feed” afterwards, they’re likely to be fatter than usual when they finish. For example, this could mean that this year’s mob would exceed the fat specification at 450kg when they’re ready for Woolworths compared with last year’s cattle that grew pretty well to the same weight on good feed.

Key benefits

As a beef producer, you can benefit by understanding the carryover effect from good or poor nutrition. You can anticipate the effect it will have on later growth performance and their potential to reach market specifications for weight and fat depth.

You can decide if you should take steps to fill the feed gaps. Some stages are more important than others in an animal’s lifetime growth and development. The market you’re supplying will largely determine whether or not it’s viable to supply extra feed to fill significant growth gaps.

One of the keys is to use a selling method that will reward you for your trouble. You can do this by either

- Retaining ownership of the cattle yourself through to slaughter, or
- establishing a relationship with a feedlot or processor that understands and acknowledges the benefits of continuous growth.

Cattle that were restricted early in life grew out to be fatter and those restricted later in life were leaner.
Early weaning and subsequent growth

Hutton Oddy

In northern Australia, early weaning (at three to four months of age) is carried out to increase reproductive rate of the cow herd. But if early weaners are not fed enough, they may be significantly older at turn-off than normally weaned cattle.

John Lindsay at Queensland Department of Primary Industries Swan’s Lagoon Research Station, has investigated the performance of early weaned, Bos indicus-type calves. His aim was to find the optimum level of supplement needed to achieve 420 kg feedlot entry, taking into account the subsequent performance of the cattle in feedlots.

These results indicate that early weaners on a low plane of nutrition (approx 0.4 kg/day growth rate) in their first dry season:

- can take four months longer to reach feedlot entry weight than weaners on medium or high post weaning feeding regime
- may grow slower in the feedlot
- usually don’t recover their ability to gain weight normally
- have a greater variation in the weight of their carcase
- produce tougher meat.

Feeding to achieve a medium growth rate (0.6 kg/day) in the first dry season is likely to be the most cost-effective strategy.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Age to reach 420 kg</th>
<th>Feedlot gain (kg/d)</th>
<th>Proportion in carcase weight class</th>
<th>LD Compression (kg)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;279 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>280-299 kg</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;500 kg</td>
<td></td>
</tr>
<tr>
<td>Low (0.4 kg/d)</td>
<td>26</td>
<td>1.32</td>
<td>0.31</td>
<td>0.19</td>
</tr>
<tr>
<td>Medium (0.6 kg/d)</td>
<td>24</td>
<td>1.56</td>
<td>0.12</td>
<td>0.44</td>
</tr>
<tr>
<td>High (0.8 kg/d)</td>
<td>22</td>
<td>1.59</td>
<td>0.05</td>
<td>0.56</td>
</tr>
</tbody>
</table>

* a measure of toughness, a higher value being tougher

Table 1. Effects of nutrition following early weaning on age to reach feedlot entry (months), feedlot gain, proportion of animals in carcase weight category, and baseline toughness of their meat (LD compression) (from J.A. Lindsay)

Do better-doing cattle produce better beef?

Bob Gaden and Diana Perry

An analysis of growth of 7,000 CRC cattle has shown that within contemporary groups, the faster growing individuals are sometimes more tender to eat, but only by the narrowest of margins.

The most consistent finding was that in the groups, the faster growing individuals in the finishing phase produce more palatable steaks.

Where groups grew at different rates during backgrounding, the faster grown groups produced better beef, but most of the difference was due to them reaching slaughter weight at a younger age.

All the CRC cattle were grown well from birth to slaughter, without any significant setbacks. Significant setbacks would affect meat quality differently.
The facts on marbling

Peter Dundon

Marbling is defined as fat within the muscle of cattle. It is included in the Meat Standards Australia (MSA) beef grading scheme and is visually assessed using certified standards by trained graders. It is important because it contributes to flavour, juiciness & tenderness and some of our export markets pay hefty price premiums for it.

The major market for marbled beef is Japan. Australian consumers purchasing meat in supermarkets tend to shy away from highly marbled beef and are far more “fat sensitive” than Japanese consumers. Remember, Japan’s per capita consumption of beef is roughly a sixth of Australia’s 40kg.

So, what influences the development of marbling? Marbling develops readily in animals with the right genetics, when given the right nutrition.

Without the genetic potential, cattle will not develop marbling no matter how long, or how well you feed them, but what you feed them does matter.

The higher the net energy level in the diet - the better the chances are of achieving higher levels of marbling. Grain is generally much better than pasture due to its higher energy levels. This is why the majority of marbled cattle targeted for Japan, are finished in feedlots.

It’s important to remember that what the cattle eat prior to entering the feedlot has a large effect upon how the cattle grow and develop in the feedlot.

Cattle that have been on poor nutrition prior to feedlot entry generally have less marbling at slaughter than those that have had good nutrition. So it’s important to ensure that young cattle don’t suffer significant growth setbacks.

CRC research has confirmed that genetic rankings for marbling generally hold over a range of nutritional treatments. That is, animals will rank the same for marbling, whether they are finished on grass or grain.

The general belief has been that marbling is a late maturing trait. This is not so. CRC research has proved that intramuscular fat develops at the same rate as other fat depots in the body. Because of this, it is difficult to specifically promote the development of marbling alone, since it is linked to the rest of the fat in the body.

The Beef CRC and Meat and Livestock Australia looked at ways to nutritionally manipulate marbling. These included canola oil plus calcium, Rumentek™, low protein diet, high protein diet and different grains (maize, barley and oats). Attempts to change marbling with these rations were unsuccessful.

However, because marbling has a heritability of around 30 to 50%, it is possible for producers to select for it just as they would for other traits such as growth and fertility. This heritability is quite high, so marbling can be selected for, with reasonable success.

What can you do to enhance marbling?

How is marbling measured?

Marbling Score is assessed visually on the cut surface of a chilled, quartered carcase, compared against AUS-MEAT and MSA standards.

Visual marbling score assessed by trained graders is positively correlated (about 70%) to a chemical analysis of intramuscular fat % (IMF%)

Ultrasound scanning is used to measure the IMF% of live cattle. Marbling fat is liquid at body temperature and becomes more visible in meat as it is chilled. For the same chemical fat content, higher visual marbling scores are obtained when:

1. Temperatures are less than 5°C – this is important since most carcases are brought up to about 10°C early in the morning before boning – this usually coincides with the grading or visual assessment step.
2. Time of chilling is longer and carcases have hard fat
3. Carcases are assessed at 5/6 rib (fat content and marbling is less at the 10/11/12th ribs)

Marbling is assessed against AUS-MEAT standards.

Marbled beef is highly valued by our export customers in Japan, and increasingly in Korea.
Hormonal growth promotants (HGPS) are widely used to increase liveweight gain and reduce the age of turn-off of cattle, particularly in northern Australia, but new studies by the Beef CRC reveal that HGPS cause toughening of premium cuts of beef in the carcass.

CRC has worked together with MLA and the MSA consumer testing program to define the meat quality effects in detail. As a result, some domestic markets are likely to review their buying policy for HGP –treated cattle. Producers should check whether this will affect the value of their carcasses, and see how the extra liveweight performance offsets any reduction in carcase value.

**Benefits of HGPS**

The increased liveweight gain from a single implant is usually around 10 to 20 kg over 100 to 150 days, provided that sufficient feed is available for the animal. The better the feed quality, the greater the response.

In most markets, where HGP-treated cattle are accepted without discrimination, this means greater weight and value at sale, or earlier turnoff.

These benefits are particularly important to feedlots, where faster gain to target weight will result in significant saving in feed costs.

The returns compare very favourably with the few dollars it costs to implant HGPS.

**Effect on Retail Beef Yield**

The extra liveweight gain of HGP treated cattle means more beef is produced, but HGPS do not significantly change the proportion of meat in the carcass.

In a northern Australia experiment, even repeated treatment with oestradiol implants, or an aggressive twice-yearly strategy involving alternative use of a combination of oestrogens and androgens, had no significant effect on retail beef yield (RBY) as a percentage of the carcase.

Increased carcase weight from oestradiol treatment was associated with slightly increased fatness, but repeated use of androgen implants may reduce carcase fatness slightly.

**Effects on Meat Quality**

CRC and other research has shown that HGP application has a negative affect upon meat eating quality (as measured by MSA consumer MQ4 score) and the more aggressive the implant strategy, the higher the likelihood of an increased toughness.

The research found the effect was variable across different muscles (cuts), with those muscles that showed the greatest post-mortem ageing rates having the largest penalty in terms of eating quality. Cuts in this category are mainly the high-priced grilling cuts. For example, testing revealed that the penalty for a muscle such as the striploin, which normally improved rapidly with ageing after slaughter, was 12 eating quality points 5 days after slaughter (on a 100 point scale). After further ageing, the difference reduced to a low level. A muscle such as the oyster blade, which normally shows little or no change with ageing, showed little effect of HGP treatment on palatability.

Currently the MSA prediction model (see box) does not penalise on the basis of HGP but a HGP effect will be introduced in the next model upgrade, expected by early 2004. In this upgraded MSA Model the HGP penalty will be different for different muscles. At this stage the MSA model will not distinguish between the different types of HGP on the market, rather it will be the one penalty for all HGP types.

Research has also found that HGPS can have a negative effect on intramuscular fat or marbling, with a decrease of up to 10% in MSA marbling score. This effect occurs because HGPS increase protein deposition in the animal and therefore the fat is diluted and marbling score decreased. This will also affect the MSA grading result.

**The MSA prediction model**

When eligible carcases are graded by MSA, computer software (the MSA prediction model) uses all known factors about the carcase to predict the actual eating quality and ageing potential of each cut. Factors include maturity (ossification score) weight, Bos indicus content, marbling and many others. The model is upgraded regularly, as new research results on eating quality are released (More details on this on page 8).

**Sustained HGP use in Northern Australia**

A near maximum growth response to treatment with oestradiol in northern Australia is likely to occur when treatment with the 100 day implant is repeated during the period of the year when there is sufficient feed available but liveweight gains are moderate. If little feed is available and growth rates are low or animals are maintaining weight, treatment with HGPS is likely to be a waste of money and effort.

- Sustained growth promotion can be achieved by repeat implantation with oestrogenic hormones, or by alternate treatment with an oestrogen followed by a combined implant (oestrogen and androgen).
- The more frequently animals are re-boosted with a new implant, the greater the response in liveweight gain. Sustained but lesser rates of response can also be achieved from long-acting 400 day implants.
- Under the pastoral conditions of northern Australia, steers with a single implant containing only an androgen are unlikely to exhibit accelerated growth.
- Greater responses in liveweight gain are achieved when steers are continually experiencing positive liveweight gain, rather than maintaining or losing weight.
- Research demonstrated that once an implantation strategy is started – it should be continued for sustained benefit.

**Hormonal growth implants commercially available in Australia for use in steers include those with oestrogenic (female hormone) like activity (oestradiol-17 and zeranol), those with androgenic (male hormone) like activity (trenbolone acetate and testosterone propionate) and combinations of the two.**
Best implant strategies for Northern pastoral areas:

By regular implantation of steers with oestradiol, growth promotion can be sustained during periods in which growth rates are moderate. Importantly, during periods when growth rate is near zero, growth promotion is unlikely to occur.

- Implant every 100 days during the growing season with a 100-day implant, followed by a longer life implant, for example 200 days, for the duration of the dry season.
- Alternatively, a 200-day implant would ensure accelerated growth in the event of unseasonal rains or an early break to the wet season.

How can you add value to profit from increased growth? Maximum profitability was obtained by utilising the extra carrying capacity that resulted from earlier turn-off of faster growing steers.

This is an important result that many producers in the north can adopt.

Marketing implications

- Some markets such as the European Union and some domestic markets already exclude HGP-treated cattle.

- Some domestic buyers are likely to introduce discounts to the price to producers, based on the new knowledge of HGP effects. Producers need to assess whether the increased growth benefit from using HGPs will outweigh any negative outcome.

- Currently, in most markets, producers are paid largely upon weight (c/kg) and adjustments are made for P8 fatness. If there is any price adjustment for meat quality, it is usually only for pH or Meat Colour.

- Few markets currently reward producers for more specific meat quality attributes, however this will change over time as more accurate, value based marketing systems are developed and adopted by industry.
The Beef CRC has made industry education and training a major priority since it began in 1993. This has helped boost the industry, which has for a long time been reluctant to invest in training and new technology.

Targeted emphasis has been placed upon customising training events to specific end-user groups.

Short courses

As results became available from CRC research, 3-5 day short-courses have been developed that provided information specifically on factors affecting meat quality.

Over the past 10 years, groups such as meat processors, agribusiness agencies, producer alliance groups, breed societies and various industry bodies such as MSA have enrolled in courses offered by the Beef CRC.

John Thompson and the meat science crew continue to offer Meat Quality short-courses for industry clients. These are charged on a fee for service basis.

Feedlot Management Certificate

The Certificate in Agriculture in Feedlot Management at UNE has been running for the past seven years. It aims to provide education for management-level personnel or people aspiring to management positions in the feedlot sector.

This course has been well patronised with 53 students from across Australia enrolled in 2003. It is Australia’s only management-level, targeted feedlot course.

Many winners of the Australian Lot Feeders Association Young Lot Feeder of the Year have completed the certificate course and it has strong industry recognition.

Workshops and Schools

The Armidale Feeder Steer School

The Armidale Feeder Steer School has established itself as one of the premier events on the beef education calendar.

Run over 3 days, the Beef CRC in conjunction with the Angus Society and NSW Agriculture offers the perfect balance of technical and live cattle practical sessions.

This school has been one of the major methods of releasing the latest research results to industry, with significant flow-on effects passed through industry.

It originated in Armidale, but has since been taken across Australia to locations such as Alice Springs, Emerald, Glenormiston, Busselton, Tennant Creek, Melbourne and Dongara.

In each of these locations the program has been adapted to the specific needs of the beef producers in those regions.

Supply Chain Workshops

The CRC has recently begun offering Supply Chain Management workshops.

These are 1 to 2 day activities that are run in conjunction with commercial cooperators such as feedlots and agribusiness companies.

This formula has proven to be very successful, as the beef producers involved are immediate stakeholders and directly linked to the supply of cattle for specific markets.

For example, a one day event was run in conjunction with Rangers Valley Feedlot at Glen Innes, NSW. It was specifically designed for potential suppliers of feeder steers for the long-fed B3 Japanese market, with particular emphasis upon marbling.

Speakers covered pre-feedlot health preparation, breeding and genetics, growth and nutrition and information about temperament and flight speed. Demonstrations of live feeder steer selection formed a major part of the program.

Tertiary students

The Beef CRC has put significant resources into both undergraduate and postgraduate education.

New undergraduate subjects in meat science and technology and feedlot management have been developed and are being offered at several tertiary institutions across Australia.

Postgraduate students are linked to CRC research projects and many are undertaking projects with commercial partners, ensuring the science is considered and applied with commercial implications in mind. After graduating, many of the students have taken up beef industry positions, many at a management level.

Opportunities for beef producers

The Beef CRC Industry Training Program will continue to offer valuable activities for beef producers and tertiary students, many of which are supported by FarmBiS funding for those eligible.

For further information of coming events contact Peter Dundon on 0428 598 696.
The Armidale Feeder Steer School

Peter Dundon

The Armidale Feeder Steer School is held each year in February and is one of the CRC’s main training events. The school is jointly run by the Cattle and Beef CRC, NSW Agriculture and the Angus Society of Australia.

The aim of the school is to assist breeders and producers of feeder cattle to implement optimum breeding, nutritional and marketing techniques to increase their returns.

Each year, approximately 80 producers, lot feeders and agribusiness personnel from around Australia attend. Previous delegates rate it as one of the best events on the beef training calendar, covering all the important areas affecting production and profitability.

The school is entirely focused on practical understanding and adoption of management strategies to better target the feeder steer market. The proven balance of theory and “hands-on”, practical live animal sessions makes learning easy.

Leading Beef and Feedlot Industry speakers cover the industry outlook, and the critical areas of feeder steer management which impact on profitability. Other speakers include leading research, extension and industry personnel, including leading large pastoral company representatives.

Around 70 head of cattle from grass and grain backgrounds including bulls, steers and heifers at varying weights, ages and condition scores are used for demonstration. These are a key feature of the school, which is quickly sold out.

Latest developments in beef grading, video image analysis, measurement of meat palatability and ultrasound scanning are demonstrated during a meat quality session at the Beef CRC Headquarters.

A visit to Rangers Valley Feedlot to see specialist Japanese production is now an optional part of the program and has proven very popular. They also provide animals at various stages of feeding for the demonstration sessions.

Other highlights include sessions covering health requirements of feeder steers, live animal assessment of feeder and slaughter steers, value based marketing and integrated breeding and marketing alliances.

The cost is usually around $700, which covers all meals and accommodation over the three-day program. Many producers are eligible for FarmBi$ assistance, enabling them to attend.

For information and bookings contact: Peter Dundon, ph: 02 6773 3981, or Sharon Pettiford 02 6773 5033 at the Cattle and Beef CRC.
Further information

As research in phase two of the Beef Quality CRC draws to a conclusion, many of the scientists and extension specialists involved in this work are moving on to new challenges. For further information about the application of this work to your cattle business, contact:

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