final**report**

Project code: SBP.006V2

Prepared by: WA McKiernan, JF Wilkins, JF Graham, GD Tudor, MPB Deland, BL McIntyre, B Orchard, JRW Walkley, L Davies, GR Griffith, J Irwin
Beef CRC for Cattle and Beef Quality

Date published: 2007

ISBN: 9781741912395

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Regional Beef Systems to meet Market Specifications

Regional Combinations

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

NSW DEPARTMENT OF PRIMARY INDUSTRIES

Abstract

The experiments in the Regional Combinations project were designed to quantify the responses in carcase and meat quality traits in beef cattle genetically diverse for those traits when subjected to different growth paths between weaning and finish.

The results provide immediate guidelines for selection of cattle genetic types and design of management systems to consistently hit targeted market end points. The findings provide input data and a biological basis for currently evolving predictive models for beef producers to implement optimum systems to maximise productivity and profitability.

The most important responses to growth treatments in carcase traits were the effects on fatness, with consequent effects on meat quality, favouring faster growth. In general faster growth improved compliance to carcase specifications and produced better economic outcomes as reflected by higher gross margins. Faster growth allows more rapid turnover of sale animals delivering them to market at younger ages, advantageous for both production and profit.

Selection of sires on Estimated Breeding Value or breed characteristics produced expected responses in the progeny, and no interactions with growth rate were observed. The absence of interactions enables confident predictions of carcase traits under a variety of growth regimes.

Effects of selection for retail beef yield and intramuscular fatness on the outcome at slaughter can be evaluated (for both current and future markets) as a trade-off between the value of total output against quality traits, as determined by discounts and premiums in payment grids. Carcase weight will continue to be the key determinant of carcase value but value adding is likely to assume greater importance. Differences in yield and fatness traits due to genotype affected meat quality and profitability.

Economic analyses at a farm level quantified the effects on beef enterprise profitability. Analyses of impacts at an industry level showed the potential for both growth path and time-of-calving technology to generate significant economic benefits overall for the cattle and beef industries across southern Australia.

Executive Summary

The Regional Combinations project was conducted at four sites in southern Australia - the overall design and methodology was described by McKiernan et al. (2005). The research was designed to build on the nutritional and genetic principles affecting the quality of beef production studied in previous CRCs by focussing on regional beef production systems.

The combined effects of different growth paths and genetic potential on performance and carcase traits were examined in detail to determine the best combinations to meet targeted market specifications. This provided the production information to evaluate the regional outcomes economically and to identify the most profitable and biologically efficient systems within representative environments across southern Australia. Accurate prediction of end product will be facilitated by the application of data generated here to growth models currently being refined within the CRC for Beef Genetic Technologies for industry use.

Different growth treatments were imposed following weaning (Fast ~ 0.8kg/day, Slow ~ 0.6 kg/day and Compensatory ~ weight loss and then reclaimed – WA site only) to animals of diverse genetic potential for carcase traits (retail beef yield and intramuscular fat), and the consequences on carcase and meat quality examined. Data were analysed to examine the effects of growth treatment post weaning and both sire carcase type (defined by either breed type or EBV for carcase traits) and sire carcase class (sire type grouped into high yield, high IMF or combined high yield and high IMF classes).

The sites involved had different market targets and finishing regimes but a common underlying experimental design.

Effects of growth treatment

At the New South Wales (NSW) site there was a large effect of prior growth treatment on cattle growth rate during their subsequent feedlot finishing. This effect of compensatory growth also appeared to be greater in the higher growth potential types.

Growth treatment influenced all fatness traits. At all sites, faster grown animals had greater subcutaneous and intramuscular fat (IMF%) and also had higher dressing percentages. The conclusion of faster growth promoting greater fat deposition was re-enforced in the NSW results by the groups showing compensatory growth in the feedlot that were previously slower grown. Effects on fatness were consistent but not always evident in visual marbling. At the NSW site the Fast growth treatment cattle had larger eye muscle areas (EMAs) but with yield unaffected. At the Victorian (Vic) site also, yield was unaffected by growth path, but at the Western Australian (WA) site the Fast growth treatment had the lowest yield. The differences in yield in WA were inversely associated with both P8 and rib fat which were lowest in the Slow growth treatment and highest in the Fast. That response was not offset by increased muscling as in the NSW site and to a lesser extent at the Vic site.

There was a small but significant advantage to the Fast growth treatment in eating quality of the strip loin cut, as predicted from the Meat Standards Australia (MSA) model, at the Vic site, which was also evident in the WA data. Actual palatability results from the NSW site, with a strong trend for better eating quality in faster grown animals when assessed via consumer taste panels confirms this observation.

At the NSW site, there was a trend for better compliance of the Fast growth treatment carcases to grid specifications for almost all traits. The Fast growth carcases better met both

P8 fat and fat colour specifications, resulting in an overall increase in compliance of about 10% over the Slow growth treatment.

Fast growth path animals at the WA site had the lowest rates of compliance to specifications (35% versus 43 and 50% for the Slow and Compensatory growth treatments respectively). The major reasons for failure were excessive carcase weight and fatness (but due more to project design requiring common slaughter times than treatment effects). However, Fast growth animals achieved very high levels of compliance for fat and meat colour.

While the carcases from the Vic site had relatively low compliance rates overall, the indices of “customer satisfaction” again favoured those from the Fast growth path (18.7%) compared to the Slow (8.5%).

At the NSW site there was a large ($176/ha) difference in the gross margins for pre-feedlot production between the Fast and Slow treatments favouring the Fast grown animals, even after accounting for the higher cost of producing pasture capable of sustaining faster growth. There was a considerable advantage to the Slow treatment animals for weight gain in the feedlot (compensatory growth) compared to the Fast, which resulted in higher gross margins for Slow treatment animals. However, the difference in the feedlot phase was much smaller than the difference pre-feedlot hence insufficient to outweigh the economic advantage of the Fast growth treatment overall.

Results from the Vic site further demonstrated the importance of finishing cattle on a fast growth path to enable quicker turnover, ensuring that periods of higher stocking rates while finishing cattle prior to slaughter are kept to a minimum. While the highest gross margin/cow was achieved with the Slow growth group, a better economic indicator, the highest gross margin per hectare, was achieved using a Fast growth treatment post weaning.

Economic analyses of post weaning production for the WA experiments were heavily influenced by finishing regime, since Fast growth treatments were feedlot finished compared to pasture fed for the others. The Slow and Compensatory treatments in the winter calving management group were more profitable than the Fast growth treatment. The advantage to the grass fed alternatives was mainly due to the lower cost of feed. The reverse was true for the autumn calving treatment where the Fast growth treatment was the most profitable option. In this case there was little difference in the cost of feed and the animals in the Fast growth treatment achieved greater income from sales.

Effects of sire carcase type

Results at all sites showed significant effects of sire carcase type for live weight and virtually all carcase traits measured in the progeny. Differences in sires chosen on breed type, or EBV within breed type, for fat and/or yield traits, were reflected, as expected, for those traits in their progeny. Specifically, the progeny of Angus sires chosen for high RBY% or high IMF% EBVs differed in subcutaneous fatness, IMF% and RBY% carcase traits as predicted, demonstrating that EBVs (generated by BREEDPLAN) can be used with confidence.

In NSW and Vic there were clear differences in actual or predicted eating quality between carcase types and between carcase classes favouring the progeny of high IMF% sires. The trends in the WA data are consistent with the NSW observations. The differences between carcase types in palatability identified by taste panel were much greater than predicted by the MSA model, and this was most likely due to differences in IMF% not reflected in marble scores in the NSW carcase information. High yielding types produced carcases of acceptable eating quality, but not as good (almost double the proportion failing 3 star MSA eating quality) as those with higher IMF characteristics. Differences between sire types for carcase traits were reflected in laboratory measurements of meat quality traits that are useful predictors of palatability.

There was little difference in intramuscular fatness traits between the Black Wagyu progeny and those of Angus sires selected for high IMF%. This indicates there is enough genetic variability within the Angus breed to increase IMF%, and without compromising live weight or carcase weight (HSCW) which was often seen in Wagyu sired progeny.

Responses to sire type in EMA and retail beef yield were clearly in line with expectations based on genetic merit, with the European types significantly superior to all others in most cases.

Results from current analyses indicate there are likely to be few, if any, interactions between backgrounding growth and genetic merit that affect carcase traits at finish for the range of growth rates observed here. Thus the ranking of progeny of different sire types for various carcase traits should be similar under different growth regimes.

Effects of dam breed and sex of progeny

The effects of the breed of the dam (both sire and dam of dam) on performance of the progeny were examined at both the Vic and South Australian (SA) sites. Most traits were influenced by the sire breed of the dam, demonstrating the importance of considering both dam and sire breed when targeting specific markets. There were no dam breed by sire breed interactions in the effects on the progeny.

Results from the Vic, SA and WA sites were very consistent - heifers grew slower and had lighter carcases than steers. They were fatter and had higher marbling scores than the steers and had lower RBY% (Vic and WA), while steers had slightly better compliance to carcase specifications and thus receiving less discounts and higher prices than heifers.

Effects of calving season

There was little difference in carcase traits due to calving season at either the Vic or WA site.

Changing calving time from autumn to winter in the WA experiment did not affect reproductive rates but increased profitability to weaning by 9% when stocking rate was unchanged, and by approximately 53% when the stocking rate was increased by 10%. This clear economic advantage in production to weaning for the winter calving system was due to better alignment of animal requirements to feed availability, which had a major effect on the cost of production through reduced supplementary feed costs. The profitability post weaning was driven by the cost of finishing rather than costs related to season of calving (see below).

For the Vic site, autumn born calves were 30 kg heavier at weaning than spring born, but 19 kg lighter at slaughter. However there was little difference in the gross margins for post weaning production due to time of calving.

Meeting market specifications and economic analyses

The production systems and market targets across the sites used here were quite different. Thus the results of analyses of compliance to specific market specifications highlighted the importance of an end point focus and the design of systems to achieve the desired outcome for the targeted product.

The standout, common outcome at all sites was the influence of final or carcase weight on overall product value. The reward for meeting carcase quality specifications is overshadowed by the dominant effect of total weight on carcase value under current payment systems. Presently price signals are masked and do not actively encourage changes in production systems to improve compliance for quality traits. Future changes to pricing systems to increase emphasis on carcase quality or yield traits will need to have sufficient incentives to justify changes in breeding and production systems.

In NSW the 3 Angus sire carcase types performed better than others at meeting grid specifications in both Fast and Slow growth treatments. Types with higher growth potential (particularly the Charolais) had lower compliance levels due to lower P8 fatness and were often too heavy. It is suggested that for these types for feedlot finishing, the weight at feedlot entry as well as the time on feed, will impact strongly on compliance to particular carcase specifications.

In the Vic and SA systems, whilst the percentages of carcases meeting both fat and HSCW specifications were low overall, the Limousin sired progeny performed best and the Wagyu sired performed worst, in the latter case due to the majority being underweight.

A notable feature of the WA results was the poor performance of the RBY&IMF sires compared to the other groups in meeting specifications for meat colour, but there were only 2 sires in the former group. The proportions of RBY and IMF sired animals that met specifications as well as the discounts and average prices received indicated similar meat quality characteristics. These two groups were also rated similarly in customer satisfaction and average price by the distance from specification analysis (see below). However in both payment systems the RBY sired animals had an advantage in overall value through their greater HSCW.

A new methodology - “distance from specifications” - was used to examine compliance rates as well as the conventional method of fit to the relevant standard abattoir grids. This method may offer a good alternative to pricing carcases with the aim of conveying clearer and more precise market signals.

The NSW data identified weight gain as the biggest driver of profitability of production pre-feedlot, highlighting the differences due to carcase types and gain achieved within growth treatments. The Charolais carcase type, even within the slower growth treatment, outgrew all other breed types and was the most profitable. During feedlot finishing, the results were variable, with the Charolais types achieving the best gross margin following slower pre-feedlot growth (due to high compensatory growth), and next to worst following the faster pre-feedlot phase. The Red Wagyu type, the slowest growing, performed worst in terms of gross margin. High growth breed types have much to offer in terms of overall profitability because of their extra weight at sale, but need to be managed carefully to ensure acceptable compliance for other traits. The WA economic analyses confirmed these findings with the RBY sired animals having an advantage in overall value through their greater HSCW. The Vic site analyses also showed the importance of producing cattle with heavier slaughter weights, highlighted when comparing the Wagyu ($376/ha) to the other breed types ($412/ha).

The major effect on profitability post weaning at the WA site was the cost of the feedlot finishing for the Fast growth treatment compared to pasture finish. Thus the response to growth treatment (following weaning), within calving times, was variable. The Slow and Compensatory treatments in the winter calving management group were more profitable than the Fast growth treatment. However, the reverse was true in the autumn calving system, where the Fast growth treatment was the most profitable alternative.

Industry impact

The results from gross margin economic analyses at a farm level were aggregated up to the level of the Australian cattle and beef industry using an existing model of the world beef market. These analyses suggested that both the fast-growth rate technology and the time-of-calving technology have the potential to generate significant economic benefits for the Southern Australia cattle and beef industries. The cumulative present values of each technology are around $70 million over a 15-year time horizon at a 7 per cent real discount rate, with benefits in the first year of around $2-3 million and benefits after five years of around $9-10 million. Although not valued formally, it is evident that individual producers running specific breed types could also achieve greater returns by better targeting their cattle to appropriate markets that suit the growth and carcase types they produce.

Results from this experiment are not prescriptive but provide guidance on the alternatives in tailoring solutions to various situations and predicting the economic impacts. The results highlight the utility of the data for this purpose.

Contents

1 Background

1.1 General Background

Several genetic and nutritional principles (such as effect of various carcase types and growth restrictions) affecting beef production were examined in earlier studies as part of the CRC for Cattle and Beef Industry (Meat Quality) – Beef CRCI. There is a need to apply and expand this knowledge specifically genotype by environment interactions to assess impacts on meeting beef market specifications.

Consistently supplying slaughter cattle with high compliance to targeted specifications for both the domestic and export beef trade is still seen by many producers as difficult. Beef producers are now presented with bulls having estimated breeding values (EBVs) for various carcase traits within breeds, as well a large selection of breeds with various carcase attributes. These, combined with genetic differences in growth, makes selection of sires to suit their production system and environment a difficult and daunting task for most producers.

It is therefore necessary to determine the growth pathways that best achieve targeted specifications when sires with differing potential for carcase and/or growth traits are used, and examine the economic consequences of not meeting those targets.

There is a large amount of variation within and across breeds in meat quality traits and EBVs for retail beef yield percentage (RBY%) and intramuscular fat percentage (IMF%) are now available via BREEDPLAN. Use of these EBVs should allow producers to select bulls with meat quality traits that, together with the appropriate growth path, help them improve market compliance rates.

The Regional Combinations project allowed the validation of using these carcase and growth EBVs, combined with controlling growth paths, to predict likely market compliance. Higher compliance to the targeted product should improve the profitability of the enterprise, and assist the industry to improve quality assurance as well as consistency of supply.

Studies within CRCI examined various aspects of production and meat quality affected by genotype and growth path (rate). However, there remain many unanswered questions concerning optimum regionally specific production systems to meet market specifications. Issues regarding growth and the ability to capture and predict responses in commercial herds under different conditions remain to be tested. We do not know the effects of combinations of growth path (rate) and genotype, under different conditions, and how they impact on variability in carcase traits/meat quality and ultimately compliance with market specifications. This information is vital to assessing the profitability of production systems.

1.2 Specific Background

Results from similar studies in the first term, Beef CRCI (1993–2000), were reported by Robinson *et al.* (2001) and Upton *et al.* (2001). They studied the effects of prior ‘backgrounding’ growth (i.e. weaning to the start of the finishing phase) on subsequent growth and body composition on a limited representation of breed/carcase types (Angus, Hereford, Murray Grey and Shorthorn). Their results indicated a small effect on finishing growth rate in favour of animals having slower growth during backgrounding and a tendency for those with higher backgrounding growth rates to have higher intramuscular fat levels.

Gregory *et al.* (1994) reported unfavourable genetic correlations between traits affecting carcase composition and palatability, indicating that genotypes with high yield potential may have lower eating quality. It is important to examine this (potential) antagonism in the context of the Australian domestic beef trade requirements, as both yield and eating quality can have large effects on carcase value.

In their report on studies within the first term of the Beef CRC, Robinson *et al.* (2001) suggested that growth depression pre–finishing reduced intramuscular fat in the carcase. However, Pethick *et al.* (2004) cited examples where this did not occur and in fact slower growth resulted in more intramuscular fat. Pethick *et al.* 2004 concluded that there was limited published data available on the effect of pre-finishing growth and the pattern of response may differ between breed types.

Although intramuscular fat is only one component of meat quality, it is becoming increasingly important as an issue for Australian beef producers in meeting more stringent and changing market specifications. In the development of the Meat Standards Australia (MSA) grading system, intramuscular fat has been shown to be positively correlated with improved eating quality (Egan *et al.* 2001). Minimum levels of intramuscular fat (as practically assessed by marble score) are now included in some high quality domestic and export market specifications (Cargill Beef Australia *pers. comm*.), apart from the mandatory higher levels required for the premium B3/B4 grades for the Japanese markets (Bindon 2001).

In determining responses to the growth and genetic treatments, many aspects of live animal production and characteristics of the carcase affecting compliance and quality need to be examined. Carcase and meat quality traits other than yield and intramuscular fat also need to be assessed for response to the genetic and nutritional treatments imposed.

Approximately 37% of the Australian beef product is consumed domestically (Bindon and Jones 2001). The domestic market is therefore still the biggest single market destination for Australian beef product (ABS 2004). The estimated value of Australian beef in the domestic market was $5.57 billion in 2002-2003 (Meat and Livestock Australia (MLA) website - Beef Fast Facts 2003 MLA 16183). The majority of the supply for the domestic market is derived from the higher rainfall areas of southern Australia where turnoff rates and cattle values are higher than for the pastoral regions of northern Australia (MLA website - Australian Beef Industry 04.2 MLA November 2004).

Any change in cattle type or production method which will impact on the quality of beef product destined for the domestic market should be tested against that market's acceptability standards. A report by MLA (MLA 2002) stated that consumer confidence in beef was growing since the introduction of the MSA grading system. The report showed that 80% of consumers scored the quality of beef they bought at 7 out of 10 or better, and that 37% volunteered that the quality of beef had improved in recent times. It was also reported that MSA impacted on over 50% of domestic product even though it is not branded to that extent.

The Regional Combinations project was designed to address all of the above issues to quantify effects on output and profitability in beef production systems in different environments across southern Australia.

2 Project Objectives

2.1 General Project Objectives

- To quantify the effects of post weaning nutrition, as affecting growth rate, within and between genotypes varying in propensity for meat quality (yield and/or traits influencing eating quality) or growth on end product carcase compliance and meat quality.
- To determine and/or validate the optimum combinations of beef cattle genetics and growth/nutritional pathways to achieve targeted specifications across various environments in southern Australia.
- To examine the capability (regionally specific) and cost (economics) of the above combinations achieving greater compliance rates.
- To increase the uptake of beef production technology generated by this and other CRC initiatives throughout regional Australia.

2.2 Specific Project Objectives

Four sites across Southern Australia were established by June 2001, representing regionally specific production environments (nutrition, climate and management) in which to conduct this applied research.

Research protocols were developed by June 2001 based on:

- regionally relevant and market focused end point/points
- production systems suitable to the region
- genetic treatments based on sire variation in growth and/or carcase traits
- imposition of growth treatments to induce variation in growth pathways to market end points
- inclusion of sufficient numbers of sires and dams to allow valid comparisons
- inclusion of genetic cross-linking with the other regional sites

Progeny generated were assigned to growth treatments following weaning and monitored for performance to slaughter. At slaughter carcases were assessed for market compliance (acceptable and preferred specifications) and meat quality (meat yield and traits affecting eating quality) as per individual site protocols (January 2002 through to January 2006).

Different growth pathways were used at the four sites because of varying market requirements but a number of principles were common across sites.

- Evaluation of the effects of the imposed growth and genetic treatments on the production and carcase characteristics of the experimental animals, and the consequences for rates of compliance to regional market specifications.
- Evaluation of the genotype x environment interactions on the above.
- Determination of the impact of the production system on meat yield and meat quality.
- Implementation of experiments validating known and/or investigating possible solutions to specified regional issues limiting production and market compliance.
- Economic analyses of the regional beef production systems.

3 Methodology

A complete description of the experimental design, methods and measurements was reported by McKiernan *et al.* (2005) and is included as an addendum to this report, as Appendix 9.6, as published in the journal. Following is a brief synopsis of the overall project methodology, and further description of methods particular to each site will be given within the respective Results and Discussion sections.

3.1 Genetic and growth treatments

Genetic

Sires were chosen to generate genetically diverse experimental progeny for the carcase traits intramuscular fat (IMF%) and retail beef yield (RBY%). They were chosen on Estimated Breeding Value (EBV) data for those traits where available, otherwise on performance expected as a characteristic (carcase class) of the breed from which they were drawn. The carcase classes chosen were:-

I. High RBY % class – drawn from Charolais, Limousin and Belgian Blue breeds and from Angus chosen on the basis of high EBVs for RBY%.
II. High IMF % class – drawn from the Black Wagyu breed and from Angus chosen on the basis of high EBVs for IMF%.
III. Class high for both RBY % and IMF % – drawn from Angus chosen on the basis of high EBVs and from the Red Wagyu breed.

These classes will subsequently be referred to as “RBY”, “IMF” and “RBY&IMF”.

There were different sire types within each carcase class on the basis of being drawn from different breeds. Each carcase class, but not all sire types or sires, were represented by progeny at all sites. Many of the sires used were common across sites thus establishing the genetic links required for combined analysis of effects, and in particular to allow examination of genotype by environment interactions.

Growth

To represent production systems typical of most areas of southern Australia three broad post weaning growth paths were established to test the ability of the progeny to meet market specifications. One growth path was used in SA, 2 in NSW and Vic, and 3 in WA:-

I. High growth path to achieve 0.7 – 1 kg per day from weaning to the start of a feedlot or pasture finishing phase.
II. Moderate/slow (or conventional) growth path aimed at achieving approximately 0.5 – 0.6 kg per day from weaning to feedlot entry or pasture finishing phase.
III. Weight loss immediately post weaning followed by a period of rapid compensatory growth on pasture to finishing weight (WA only).

The treatments imposed to create these growth paths will subsequently be referred to as “Fast”, “Slow” or “Comp” growth treatments

3.2 Statistical analyses

Statistical analysis procedures were similar for all sites, and used the PC software package Genstat 9 (2006), with a linear mixed model REML procedure. The initial model had most Fixed and Random Effects in common, reflecting the similarity in design across sites. The procedure involved iterative runs to refine the model, eliminating random terms showing negative (or aliased) variance components, and by removing non-significant fixed effects. The final model was then used to evaluate treatment effects and produce predicted means.

The initial model used for the NSW site was the basic template and was modified as required to suit the other sites to account for some differences in experimental design and/or extra features affecting responses. The model included the Fixed Effects :- growth treatment, season of birth, (carcase) “class” of sire (as above), “type” of sire (within class) and all interactions. The Random Effects included:- sire (within type), dam, kill, replicate (within growth treatments), year of birth and all interactions (chiller grader, laboratory run and tasting event were also used for appropriate parameters). An “animal pedigree” matrix to account for the association between individuals through common sire and/or dam was also included within the random effects structure. “Class” as a main effect was deleted when generating sire “type” means. Age at start of treatment was included as a co-variate in all analyses, but was often not significant. “Dimensional” traits (P8 and rib fat depths and EMA) can be affected by the size of the carcase so the model needed to account for differences in HSCW to detect effects independent of response in HSCW (growth rate response). HSCW was in fact included as a co-variate for all other carcase traits and was significant in most cases.

Modifications to the NSW model relevant to the other sites include the following:-

For Fixed Effects - all other sites included sex (NSW examined steers only); there were no imposed growth treatments at the SA site;
For Random Effects – Vic, SA and WA included breed information for the dams of the animals in the experiments (grand-sire and grand-dam breeds); Vic and SA also both had a term for property of origin. For the WA analyses, weaning live-weight was included as a covariate in analysis of slaughter live-weight and HSCW, while P8 fat scan was included as a covariate for the analysis of P8 fat depth at slaughter. Log transformations were found necessary for analyses of some traits for the WA site.

An additional procedure was used for the NSW site only, which involved a “spline analysis” of the live-weight data in the growth period before feedlot entry. This is described in the additional methods section for the NSW site below.

In the following reporting of results, “significant” differences can be assumed to mean P values less than 0.05 if not specifically stated in the text.

3.3 Carcase specifications and economic analyses

The profitability of beef production systems is affected by numerous factors such as management constraints, costs of production and product value, with genetic potential setting upper limits. A major driver (through impact on product value) should be compliance to specifications of the target market(s). Thus, defining treatment effects on an animal’s ability to meet these is a vital component of this project in examining herd profitability. Each site had a similar, yet slightly different target market particular to the region or production system it represented.

Carcase data were examined for compliance to specifications using two systems. The first of these was for compliance to the abattoir grid as the basis of the usual method of payment. The second used an alternative system of assessing compliance and valuing carcases based on the “distance from specifications” model developed by Rutley (2006), which calculates the distance for each trait from the nominated specifications of an “ideal carcase”.

The system is described in detail in the analysis of “Meeting Specifications” (4.1.4.5.2) in the section of this report for the NSW site.

Economic evaluation was conducted using gross margin analyses. For the NSW and Vic sites this was done with the aid of the Beef-N-Omics package (Dobos *et al.*1997, 2006). This methodology is fully described in “Economic analyses” (4.1.4.6) in the section of this report for the NSW site. For other sites the gross margin methodology is described in the site section.

3.4 Additional management treatments

The effect of time of calving on management and costs of production (and thus herd profitability) was identified as a variable that could be incorporated into the design (and analysis) of both the WA and Victorian experiments. Matings were timed for calves to be born as per current industry practice (autumn in WA and Vic) or at times that better align calving with pasture growth (winter/spring in WA and spring in Vic).

4 Results and Discussions

4.1 Details, Results and Discussion – NSW site

4.1.1 Summary

A total of 43 sires was used, sampling 3 carcase "class" categories - defined as high potential for retail beef yield (RBY), high for intramuscular fat (IMF) or high for both traits. EBVs for the carcase traits of interest (as available) were used in selection of the sires, which were drawn from Angus, Charolais, Limousin and Wagyu (Red and Black) breeds (giving 7 sire/carcase "types"), and all mated by artificial insemination to Hereford dams from a single herd. Steer progeny were grown at either conventional (approximately 0.5 kg/d) or accelerated rates (approximately 0.7 kg/d) from weaning to group mean feedlot entry weight of approximately 400 kg. Fast and Slow groups from successive calvings were managed to enter the feedlot at the same time as described by McKiernan *et al.* (2005). Following the backgrounding period, all animals had identical treatment during a 100 day commercial feedlot finishing phase prior to slaughter.

The combined effects of the different growth paths and genetic potential on performance and carcase traits were examined in detail to determine the best combinations to meet the targeted product. This provided the production information to evaluate the outcome by economic analyses to identify the most profitable and biologically efficient systems.

Faster growth pre-feedlot resulted in increased subcutaneous fatness and EMA. Faster growth resulted in increased IMF%, although not evident in marble scores. Slower growth during backgrounding resulted in faster (compensatory) growth in the feedlot, which impacted on fatness traits at slaughter. An effect of this compensatory growth was to decrease the advantage in P8 fat of the Fast treatment steers over the Slow between feedlot entry and exit. This re-enforces the conclusion of faster growth promoting greater fat deposition that was demonstrated in the Fast groups at feedlot entry.

RBY% was not significantly affected by growth treatment. There was a strong tendency for the Fast growth treatment to have better eating quality when assessed via taste panel. There was a large difference in gross margin for pre-feedlot production favouring the Fast growth treatment. Slow growth treatment animals of all types displayed compensatory growth in the feedlot and they were more economical to feed than the Fast treatment cattle. There was a trend for better compliance of the Fast growth treatment to carcase grid specifications for almost all traits. The Fast growth path carcases better met both P8 fat and fat colour specifications, resulting in an overall increase in compliance to specifications of about 10% over the Slow growth treatment.

The magnitude of the economic difference pre-feedlot, combined with the carcase advantages reported here strongly favoured the faster growth option.
Results at the NSW site showed significant effects of sire type for virtually all carcase traits measured. Sire selection by breed type or EBV within breed type, for fat and/or yield traits, resulted in expected progeny differences for those traits.

There was a clear difference in eating quality between carcase types and between carcase classes favouring the high IMF types. The high yield types although having generally acceptable eating quality had almost double the percentage of carcases failing MSA 3 star rating (by taste panel) than the high IMF types. These results also highlight the impact of selection for yield or meat quality traits for current and future markets.

The 3 Angus carcase types performed the best in meeting all grid specifications in both Fast and Slow growth treatments. Types with higher growth potential (particularly the Charolais) had lower compliance levels due to lower P8 fatness and they were often too heavy. These data suggest that in the case of feedlot finished animals, the timing of age and weight at entry as well as the time on feed will determine the compliance to particular carcase specifications. A new methodology, “distance from specifications”, was used to further test compliance, and this method may offer a good alternative to pricing carcases with the aim of conveying clearer and more precise market signals.

Results here identified weight gain as the biggest driver of profitability of production pre-feedlot, highlighting the differences due to carcase types and gain achieved within growth treatments. The Charolais carcase type, even within the slower growth treatment, outgrew all other breed types and was the most profitable. During feedlot finishing, the results were variable, with the Charolais type achieving the best gross margin following Slow pre feedlot growth (due to high compensatory growth), and next to worst following the Fast. The Red Wagyu type, the slowest growing, performed worst.

High growth breed types have much to offer in terms of overall profitability because of their extra weight at sale, but need to be managed carefully to ensure acceptable compliance to other traits in the specifications.

Evidence presented here supports the conclusion that there are likely to be few if any interactions between backgrounding growth and genetic potential that affect carcase traits at finish for the range of growth rates observed. This knowledge impacts on the way beef producers, in future, can reliably predict market outcomes from various breed and growth combinations.

4.1.2 Background

The NSW experiment (along with the other sites) was designed to provide a population of animals with diverse genetic potential for the carcase traits of retail beef yield (RBY) and intramuscular fat (IMF). The steers were managed to achieve different growth rates in order to have them reach a finished market target at near equivalent weights but different ages. The combined effects of the different growth paths and genetic potential on performance and carcase traits were examined in detail to determine the best combinations to meet the targeted product. This provided the responses to treatment as well as the information to evaluate the compliance of carcases to market specifications and to conduct economic analyses with the overall aim of identifying the most profitable and biologically efficient systems.

To improve economic returns, increased output must not compromise meat quality, since acceptance by the customers (intermediate and end consumers) is vital to maintaining product value in the long term. However few premiums are currently paid for meat quality. Therefore in the shorter term the emphasis should be to ensure at least acceptable quality is maintained when output is increased. It is expected that traits affecting meat quality will assume greater importance in the future and attract price premiums, providing incentive for producers to tighten the focus on their product. Preliminary analyses of the NSW data supported historical research that more beef is produced from higher yielding carcase types, and that fatness traits can be manipulated by genetics and management. The current experiment allowed us to examine responses to growth treatments in steers with a wide range of carcase potential to refine predictions and concurrently examine effects of carcase traits on meat quality.

4.1.3 Additional Methods

At this site, a total of 43 sires were used, sampling the 3 carcase “class” categories - defined as high potential for retail beef yield (RBY), high for intramuscular fat (IMF) or high for both traits. EBVs for the carcase traits of interest (as available) were used in selection of the sires, which were drawn from sires of Charolais, Limousin , Angus (for RBY), and Black Wagyu and Angus (IMF) and Red Wagyu and Angus (both RBY&IMF) - giving 7 sire “types” within the 3 sire “classes”. All matings were by artificial insemination (AI) to Hereford dams from a single herd.

There were two growth treatments - steer progeny were grown at either conventional (approximately 0.5 kg/d) or accelerated rates (approximately 0.7 kg/d) from weaning to group mean feedlot entry weight of approximately 400 kg. These will subsequently be referred to as “Slow” or “Fast” growth treatment groups. Fast and Slow groups from successive calvings were managed to enter the feedlot at the same time as described by McKiernan *et al.* (2005). Following the backgrounding period, all animals had identical treatment during a 100 day commercial feedlot finishing phase prior to slaughter.

Comprehensive carcase data (AUS-MEAT 1996) were collected on the abattoir kill floor and in the chiller. All cattle were processed at Cargill Beef works, Wagga Wagga. Carcases were also examined with VIAscan imaging equipment in the chiller (Ferguson et al. 1995) to estimate retail beef yield as well as other traits. All chiller assessments (except VIAscan yield) reported here are those taken by MSA-accredited technicians. Samples of meat from the striploin (M. longissimus lumborum) – (cut 2140 AUS-MEAT 1998; cut “STA” MSA classification) were taken at boning and stored frozen after 6 days ageing for later analysis (McKiernan et al. 2005). Samples were assayed in the laboratory for intramuscular fat (IMF%) as well as for the “objective” measurements of shear force and compression, cooking loss and other attributes (Perry et al. 2001). Consumer palatability was assessed from sensory data using MSA taste panel protocols (Polkinghorne *et al.* 1999). MSA feedback (chiller) data were also examined for treatment effects on the predicted meat eating quality (PEQ) as generated by the MSA model (Thompson, 2002).

Economic evaluation was conducted using gross margin analyses with the aid of the Beef-N-Omics package (Dobos *et al.* 1997, 2006). This is more fully described in the “Economic Analyses” section below.

Carcase data were examined for compliance to specifications using two systems. The first was for compliance to the abattoir grid as the basis for the usual method of payment. The second used an alternative system of assessing compliance and valuing carcases based on the “distance from specifications” model developed by Rutley (2006), which calculates the distance for each trait from the nominated specifications of an “ideal carcase”. The system is more fully described in the analysis of “Meeting Specifications” section below.

Feedlot induction

The design of the experiment required that, for each finishing cohort of paired Fast and Slow groups, all steers had to enter and exit the feedlot at the same time, with subsequent slaughter in as restricted time period as possible on the same day. This was to remove any confounding effects of the conditions (environmental including nutritional) while in the feedlot, as well as the conditions at the abattoir (lairage, kill floor, chiller etc), particular to the day of slaughter. Thus differences in individual and group mean live weights at feedlot entry were inevitable. The strategy employed was to send the steers to the feedlot when the mean live weight over all animals was close to 400 kg in the paddock, which resulted in a mean of around 380 kg “induction weight” at the feedlot. It was in fact very difficult to manage the live weight gain in the paddock to get the overall means for Fast and Slow growth groups close together at feedlot entry time. It was not possible to get progeny groups of different sire types within growth treatments to the same mean entry weights while they had to be grazed as one group. To account for possible effects due to differences in feedlot entry weights, a set of predicted values has been used for some analyses and weight covariates used for others.

Statistical analysis
In addition to the statistical procedure described in the general methodology above, the following applied to this site. Live weight data for the period from the start of growth treatments (at weaning for 4 of the 5 calving groups, but delayed for one) until feedlot entry time were analysed using ASREML, a linear mixed model analysis program (Gilmour *et al.* 2002). To model the growth paths a mixed model cubic smoothing spline analysis was used (Verbyla *et al.* 1999). This procedure enabled the description of growth paths as well as the prediction of live and carcase weights where various corrections were required. In particular, a set of data was generated to predict the performance of steers if each growth treatment X sire type group was set to a mean 380 kg feedlot induction weight. The “extra days” taken (compared to the fastest group) for groups of steers to achieve this 380 kg mean was also part of the data generated from this procedure. This was done to adjust for the discrepancies caused by the experimental design in needing to have all steers enter the feedlot at the same time. It allowed the predicted outcome of optimal management scenarios to be evaluated in economic analyses and for comparisons of conformity to specifications.

4.1.4 Results and Discussions

The following section presents results for the main growth and carcase traits of interest. Additional data, that will be fully dealt with in later analyses and reports, are included in Appendix 9.1. These will be referenced, but will not be discussed in any detail this report. The data include live measurements taken at weaning and just prior to feedlot entry (hip height, hip width, stifle width, muscle score, flight speed) as well as ultrasound measurements of fat depths and eye muscle areas at weaning. Also included are VIAscan measurements taken in the chiller and objective laboratory measurements of meat quality. Raw correlations between VIAscan measurements and MSA chiller assessments and between eating quality and fatness measurements are shown in the Appendix.

These data will be examined later for treatment effects and for association with performance and carcase traits.

Preliminary reports only have been presented prior to this document (see Appendix 5).

Steer growth
This section deals with growth of the animals during the growth treatment phase following weaning and also during the feedlot finishing phase when there was no longer any differential nutritional or management treatment.

4.1.4.1 Effects prior to slaughter

4.1.4.1.1 Effects of growth treatment

The predicted means for live weight and body composition traits at the end of the backgrounding (growth treatment) period, and for growth during feedlot finishing phase are shown in Table 4.1.1.

Body composition traits
There was a significant effect of growth treatment on all body composition traits (Table 4.1.1), with the Fast growth treatment having higher values in all cases. These analyses accounted for differences in live weight at the time of measurement so the effect was independent of that on body size, which was in fact in favour of the Slow growth treatment.

Feedlot entry weight
Management was aimed at achieving near equivalent group means at feedlot entry, but there was in fact a significant difference of 16 kg in favour of the Slow group. This was taken account of in comparing subsequent carcase weights.

Feedlot performance
Feedlot exit weight and growth rate was significantly higher in the Slow growth treatment groups compared to the Fast, even after allowance for the differences in induction weight (when included as a covariate). This effect was consistent over all breed types (see below), indicating a general compensatory effect of prior growth on performance in the feedlot.

Carcase weight was required to be used as a covariate for other carcase traits, so this procedure also accounted for the differences that had been already induced by this compensatory growth when examining effects due to sire/carcase types.

By using the induction weight covariate for comparison of treatment effects on feedlot growth rates, we may in fact be removing some of the effect of genetic capacity of the animal, since the feedlot induction weight is a reflection of its growth potential. The effect on the statistics was to narrow the range but not to alter the ranking.

Table 4.1.1. Effect of growth treatment ("Slow" versus "Fast") prior to feedlot entry on predicted means for live body composition traits prior to feedlot entry. Composition traits were analysed using live weight at the time of measurement as a covariate. Also shown are predicted means for performance in the feedlot finishing phase (common nutritional treatment). Maximum numbers *(n)* available for analyses for each group shown

	Slow	Fast	*s.e.d*	P
Numbers of animals (n)	*(260)*	*(299)*		
Live weight (kg) [1]	416.3	394.1	*2.96*	<0.001
P8 fat depth (mm) [2]	3.44	5.23	*0.114*	<0.001
Rib fat depth (mm) [2]	2.31	3.56	*0.123*	<0.001
EMA (sq cm) [2]	55.1	58.9	*0.35*	<0.001
IMF% (scanned) [2]	2.78	3.01	*0.107*	0.059
Feedlot finishing				
Entry weight (kg)	393	377	*2.9*	<0.001
Exit weight (kg)	660	630	*4.5*	<0.001
Exit weight (kg) [3]	648	637	2.9	<0.001
Feedlot growth (kg/d) [3]	2.52	2.39	*0.046*	0.006

[1]Data were analysed using age at start of growth treatment as a covariate
[2]Adjusted for live weight at the time of measurement (covariate)
[3]Adjusted for differences in feedlot induction weight (covariate)

4.1.4.1.2 Effects of sire carcase "type"

The predicted means due to sire type effects for pre-treatment measurements, live weight and body composition measurements at the end of the backgrounding period, and growth during feedlot finishing are shown in Table 4.1.2. There were significant differences between sire type groups for every trait measured. Table 4.1.2 also shows the type means within Fast and Slow growth groups for some traits which should be interpreted in conjunction with Table 4.1.1, showing the overall growth treatment effects.

Traits measured pre-treatment

Pre-treatment measurements (at birth and weaning) included information on gestation length, birth weight and weaning weight, as well as many body conformation measurements (including hip height, muscle score, etc), which will be reported in detail later. These provided background information in relation to sire types that will be examined for association with later performance. There were significant differences due to sire type (Table 4.1.1) for gestation length, birth and weaning weights, with the European types heavier on both occasions. There were also differences due to sex (not tabulated), with males significantly heavier than females at birth (35.6 v 33.6 kg : 6%) and steers significantly heavier than heifers at weaning (215 v 205 kg : 5%).

Table 4.1.2. Effects of sire breed/carcase type on birth and weaning traits (prior to growth treatments), and within growth treatments ("Slow" or "Fast") on predicted means for live body composition traits prior to feedlot entry. Composition traits were analysed using live weight at the time of measurement as a covariate. Also shown are predicted means for performance in the feedlot finishing phase (common nutritional treatment). Maximum numbers *(n)* available for analyses for each group shown

Trait *Numbers of animals (n)*		**Lim**	**Char**	**Angus RBY**	**Angus RBY & IMF**	**Angus IMF**	**Red Wagyu**	**Black Wagyu**	***s.e.d (type comparisons) across*** [1]	***within*** [2]	**P Type**	**P Type *X* Grow**
Pre growth treat.												
(Males and females)		*(128)*	*(108)*	*(234)*	*(239)*	*(233)*	*(149)*	*(143)*	*(1234)*			
Gestation length (days)		286c	285c	283b	281a	281a	285c	283b	*0.69*	N.A.	<0.001	N.A.
Birth weight (kg)		36.9cd	37.6d	35.0bc	33.5b	34.3b	33.2ab	32.0a	*0.62*	N.A.	<0.001	N.A.
Weaning weight (kg)		215cd	221d	211c	209bc	213cd	201ab	199a	*4.3*	N.A.	<0.001	N.A.
Post growth treat.												
(Steers only)	Slow	*(28)*	*(23)*	*(47)*	*(50)*	*(47)*	*(34)*	*(31)*				
	Fast	*(28)*	*(29)*	*(59)*	*(59)*	*(59)*	*(29)*	*(36)*				
Live weight (kg) [3]												
	Slow	418.9	432.3	413.5	418.5	426.4	405.0	399.2	*8.79*		<0.001	ns
	Fast	386.3	418.5	394.1	399.1	398.4	378.7	383.5		*7.37*		
P8 fat depth (mm) [4]												
	Slow	2.63	2.52	3.07	3.10	4.14	4.09	4.53	*0.485*		<0.001	0.014
	Fast	4.86	3.48	5.08	5.71	6.15	5.92	5.44		*0.372*		
Rib fat depth (mm) [4]												
	Slow	1.94	1.81	2.15	2.11	2.82	2.63	2.75	*0.333*		<0.001	0.063
	Fast	3.02	2.54	3.73	4.01	4.19	3.69	3.72		*0.297*		
EMA (sq cm) [4]												
	Slow	58.5	59.4	54.6	55.1	50.5	52.7	54.5	*1.53*		<0.001	ns
	Fast	61.8	61.8	58.0	58.0	56.0	58.7	58.0		*1.23*		
IMF% (scanned) [4]												
	Slow	2.35	1.95	2.60	2.89	3.15	3.13	3.41	*0.210*		<0.001	ns
	Fast	2.67	2.37	3.00	3.32	3.37	3.14	3.20		*0.210*		
Feedlot finishing												
Feedlot grth (kg/d) [5]												
	Slow	2.53	2.64	2.58	2.56	2.62	2.28	2.45	*0.082*		<0.001	ns
	Fast	2.36	2.44	2.42	2.45	2.45	2.21	2.41		*0.085*		
Type means												
Entry weight (kg)		387b	407c	381ab	388b	390b	371a	373a	*7.0*		<0.001	
Exit weight (kg)		646bc	680d	644bc	653c	658c	606a	631b	*10.1*		<0.001	
Exit weight (kg) [5]		640b	651b	647b	647b	650b	620a	639b	*6.5*		<0.001	
Feedlot grth (kg/d) [5]		2.45b	2.54b	2.50b	2.51b	2.54b	2.25a	2.43b	*0.062*		<0.001	

[1]Comparisons between types in the same growth treatment or, [2]between growth treatments for the same type
[3]Liveweight (covariate) at the time of measurements[4] using real time ultrasound imaging on the live animal
[5]Adjusted for differences in feedlot entry weight (covariate)
ab – different suffixes indicate significantly different means

Body composition traits
As for the growth treatments, there were significant effects of sire type on all body composition measurements taken just prior to feedlot entry. It can be seen from Table 4.1.2 that there were higher values for the Fast growth treatments for every type in all traits except for the IMF% in the Black Wagyu, which was a non-significant difference.

For the “fatness” traits of P8 and rib fat depths and IMF%, the Limousin and Charolais groups ranked lowest in every case for both Fast and Slow growth treatments, and the Angus RBY groups were the next lowest in most cases. The Angus IMF and Black Wagyu groups were the most consistently highest ranked in the Slow growth treatment. The Angus IMF was again the most consistently highest in the Fast growth treatment. Some inconsistencies in rankings across growth treatment groups for P8 and rib fat depths in the Red and Black Wagyu and Angus (RBY&IMF) groups produced significant interactions. However the overall effect of type was in general accordance with expectations on the basis of genetic potential for fat deposition.

Differences in scanned eye muscle area were also in accordance with expectations. The potentially higher yielding European types were clearly ahead of the other types in both growth treatment groups.

Feedlot entry weight
There were significant differences in live weight between sire type progeny groups at the time of feedlot entry. The Charolais progeny were significantly heavier than others while the reverse was the case for both the Black and Red Wagyu, which were significantly lighter than others.

Feedlot performance
Differences between sire types in feedlot performance – daily gain and exit weight - were affected by induction (entry) weight, and these differences were reduced when this was included as a covariate. The major difference between groups was the significantly poorer performance of the Red Wagyu group compared to most others. The compensatory gain effect due to prior growth was evident in all groups. Although the interaction was not significant, there was a good association of the size of the difference (compensatory advantage) with the growth rates for the type (raw correlations ~ 0.7). This may suggest that the degree of compensation is related to growth potential when animals have restrictions removed. This warrants further investigation which will be best addressed using a bi variate analysis or similar technique using growth patterns of individual animals. It is proposed to deal with this in the next phase of the analysis.

4.1.4.1.3 Effects of sire carcase “class”

The predicted means due to “class” of sire (grouped by expected yield or fatness potential) for live weight and body composition traits at the end of the backgrounding period and growth during feedlot finishing are shown in Table 4.1.3.

It is evident from results above that live weight differences or growth potential are considerably affected by sire type and this will be substantiated below in effects on carcase traits and meat quality. The grouping of sires into “class” was expected to produce effects in accordance, but such grouping may also mask important differences between types which need to be identified.

Body composition traits

There were significant differences between classes in the fatness traits of P8 and rib fat depths and IMF%, all in accordance with their basis for selection. The trend in the ranking for EMA was as expected but not quite significant.

Feedlot entry weight and feedlot performance

The differences in these parameters between groups classified on class of sire were not significant.

Table 4.1.3. Effect of sire breed/carcase "class" (grouped by expected yield or marbling potential) on predicted means for live body composition traits prior to feedlot entry. Composition traits were analysed using live weight at the time of measurement as a covariate. Also shown are predicted means for performance in the feedlot finishing phase (common nutritional treatment). Maximum numbers *(n)* available for analyses for each group shown

Trait	**High RBY**	**High RBY & IMF**	**High IMF**	***s.e.d***	**P**
Numbers of animals (n)	*(214)*	*(172)*	*(173)t*		
Live weight (kg) [1]	410.6	400.7	402.3	*12.29*	ns
P8 fat depth (mm) [2]	3.68	4.65	5.06	*0.374*	0.002
Rib fat depth (mm) [2]	2.55	3.11	3.37	*0.295*	0.012
EMA (sq cm) [2]	58.93	56.1	54.7	*1.88*	0.06
IMF% (scanned) [2]	2.51	3.11	3.28	*0.213*	<0.001
Feedlot finishing					
Feedlot growth (kg/d) [3]	2.50	2.38	2.49	*0.098*	ns
Entry weight (kg)	391	380	382	*11.8*	ns
Exit weight (kg)	657	630	645	*22.4*	ns
Exit weight (kg) [3]	646	634	645	*10.0*	ns

[1]Liveweight (covariate) at the time of measurements[2] using real time ultrasound imaging on the live animal
[3]Adjusted for differences in feedlot entry weight (co-variate)

4.1.4.1.4 Interaction of growth treatments with sire carcase types

As discussed above, there were some significant interactions for the body composition traits at the end of the growth treatment period – viz. P8 and rib fat depths. While the interaction effect on feedlot growth was not significant, the trends observed suggested some implications for compensatory growth which is also discussed above.

4.1.4.2 Carcase traits

Hot standard carcase weight (HSCW) was significant as a co-variate for all carcase traits except USDA marble score, carcase yield and MSA predicted eating quality. The effects of growth and sire treatments on the major carcase traits of interest are shown in Tables 4.1.4, 4.1.5, and 4.1.6, with the specific effects on IMF%, EMA and RBY% demonstrated in Figures 4.1.1, 4.1.2 and 4.1.3.

4.1.4.2.1 Effects of growth treatment

Table 4.1.4 shows the effects of growth treatment on carcase traits.

Hot standard carcase weight (HSCW) and dressing %

Carcases were heavier in the Slow groups, both with and without feedlot entry weight as a co-variate. This was a direct result of the higher daily gain in the feedlot. There was no significant difference in dressing percentage due to growth treatment.

P8 and rib fat depths

Fat depths were higher in the Fast groups compared to the Slow. This was significant for rib fat and almost so for P8 (P ~ 0.07). This was likely due in part to a carryover effect of the fatness observed at feedlot entry.

Visual marble scores and intramuscular fat (IMF) %

There was little difference due to prior growth in the visual AUS-MEAT or USDA marble scores on chiller assessment. However, the chemical IMF% measured in the laboratory was significantly greater in the Fast groups. This is illustrated in Figure 4.1.1.

Table 4.1.4. Effect of growth treatment ("Slow" versus "Fast") prior to feedlot entry on predicted means for subsequent measurements on carcases at slaughter. Carcase traits were analysed using HSCW as a covariate as appropriate. Maximum numbers *(n)* available for analyses for each group shown

Trait[1]	**Slow**	**Fast**	***s.e.d***	**P**
Numbers of animals (n)	*(260)*	*(299)*		
HSCW (kg)	368	352	*2.7*	<0.001
HSCW (kg)[2]	363	357	*1.8*	0.002
Dressing %	55.8	56.2	*0.2*	ns
P8 fat depth (mm)	16.9	17.7	*0.43*	0.07
MSA Rib fat depth (mm)	9.7	11.2	*0.39*	<0.001
MSA AUS marble score	1.36	1.39	*0.035*	ns
MSA USDA marble score	347	347	*4.8*	ns
IMF%	3.61	4.15	*0.170*	0.001
MSA EMA (sq cm)	81.3	82.9	*0.60*	0.008
VIAscan carcase yield %	68.1	68.0	*0.18*	ns
MSA pred. eating quality[3]	57.7	57.7	*0.19*	ns
Ossification score	184	181	*1.2*	0.006

[1]Data were analysed using age at start of growth treatment as a co-variate
[2]Adjusted for differences in feedlot entry weight (co-variate)
[3]Predicted eating quality (PEQ) from MSA model for the (grilled) strip loin ("STA" – MSA cut)

Eye muscle area (EMA)

EMA was significantly greater in the Fast groups, even after the carcase weight co-variate adjustment.

Carcase yield

There was no significant difference between the growth treatment groups in retail beef yield as estimated by VIAscan imaging. The larger values for fat depths and EMA due to faster growth counteracted each other, resulting in little absolute difference in yield.

Predicted eating quality

The eating quality for the striploin cut predicted from the MSA model did not differ between groups with both having means with "3 Star" MSA rating. This will be discussed further in a section below on meat quality.

Ossification scores
As expected, the ossification scores were higher for Slow groups due to their older age at slaughter. The difference of 3 units was significant and corresponded to a mean difference of 5.4 months in age.

4.1.4.2.2 Effects of sire carcase "type"

Table 4.1.5 shows the effects of sire type on carcase traits.

Hot standard carcase weight (HSCW) and dressing %
As seen above, feedlot growth was affected by induction weight and this effect was also carried through to exit and carcase weights. There were significant effects due to sire type in HSCW, but the sizes of the differences were reduced when feedlot induction weight was applied as a co-variate. The Red Wagyu group was significantly lighter than all others. There were also significant differences in dressing % in favour of the Limousin and Black Wagyu, with the Angus IMF the lowest.

Table 4.1.5. Effect of sire type on predicted means for carcase traits at slaughter. Traits were analysed using HSCW as a covariate as appropriate. Maximum numbers available for analyses for each group shown *(n)*

Trait[1]	Lim.	Charol.	Angus RBY	Angus RBY & IMF	Angus IMF	Red Wag.	Black Wag.	*s.e.d or (n)*	P
Numbers of animals (n)	*(56)*	*(52)*	*(106)*	*(109)*	*(106)*	*(63)*	*(67)*	*(559)*	
HSCW (kg)	365.8c	380.8d	359.5bc	362.1bc	360.6bc	338.2a	352.1b	*6.60*	<0.001
HSCW (kg)[2]	364.1b	365.2b	363.1b	360.9b	359.1b	347.6a	359.9b	*4.71*	0.011
Dressing %	56.7c	55.6ab	56.1bc	55.6ab	55.1a	56.4bc	56.5c	*0.41*	<0.001
P8 fat depth (mm)	15.7b	12.7a	18.9c	18.1c	19.5c	17.8b	18.2c	*1.00*	<0.001
MSA Rib fat depth (mm)	9.7ab	7.3a	11.1bc	10.7bc	12.6c	10.1b	11.6bc	*0.97*	<0.001
MSA AUS marble score	0.96a	1.11b	1.41c	1.57d	1.58d	1.40c	1.59d	0.074	<0.001
MSA USDA marble score	300.1a	311.9a	348.2b	371.2c	370.7c	355.1bc	372.7c	*9.7*	<0.001
IMF%	3.05a	2.76a	3.69b	4.29bc	4.53c	4.06bc	4.79c	*0.30*	<0.001
MSA EMA (sq cm)	85.1c	85.2c	81.5ab	81.6b	79.1a	81.2ab	80.9ab	*1.24*	<0.001
VIASscan carcase yield %	68.9d	69.3d	67.9bc	67.9bc	67.1a	68.1c	67.2a	*0.31*	<0.001
MSA pred. eating quality[3]	56.6a	57.2ab	57.6b	58.3bc	58.5c	57.2ab	58.2bc	*0.39*	<0.001
Ossification score	180a	180a	181a	184ab	181a	183ab	188b	*2.5*	0.015

[1]Data were analysed using age at start of growth treatment as a co-variate
[2]Adjusted for differences in feedlot entry weight (co-variate)
[3]Predicted eating quality (PEQ) from MSA model for the (grilled) strip loin ("STA" – MSA cut)
ab – different suffixes indicate significantly different means

P8 and rib fat depths
The differences in both P8 and rib fat depths between sire type groups were as expected, with the higher yielding Euro types lower than most other groups for P8 with the Black Wagyu and Angus types all similar. The trend was the same for rib fat.

Visual marble scores and intramuscular fat (IMF) %
The differences in intramuscular fat as shown in visual marble scores and laboratory measurements were the clearest example of expression of genetic potential. There were dramatic differences in both marble scores and measured IMF between the groups of highest

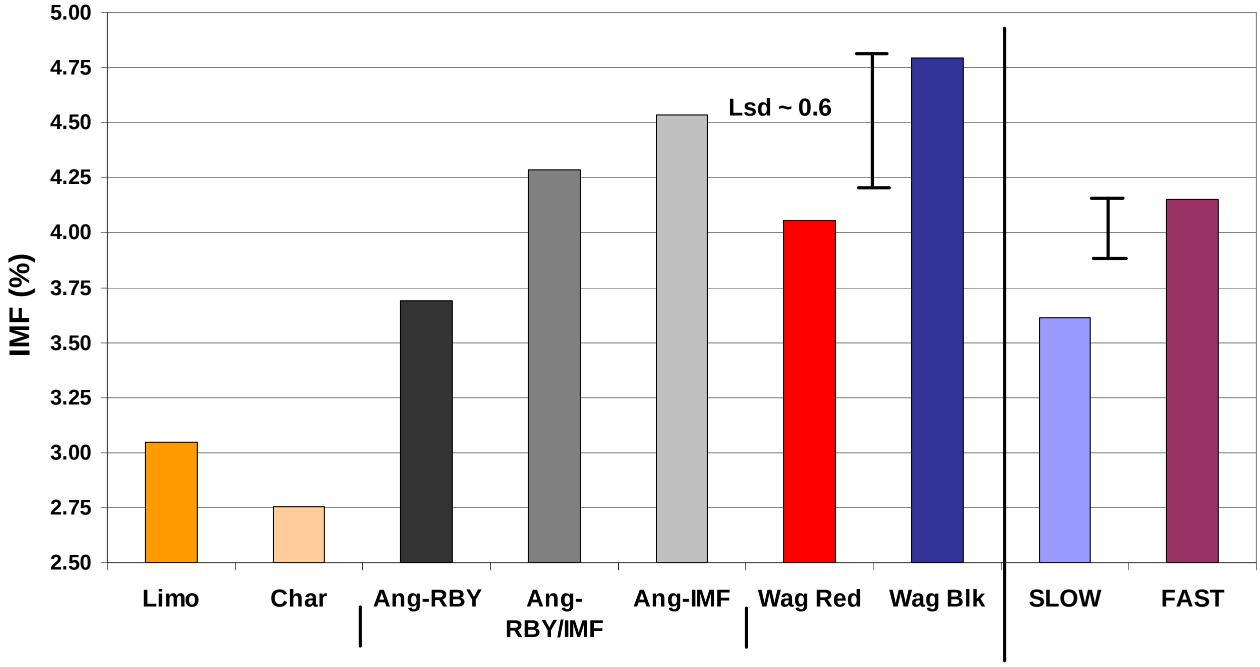


Figure 4.1.1. Predicted means (and least sig. diffs.) for IMF% as affected by sire type and growth treatments (n = 451)

and lowest IMF% potential. Additionally there was a well defined gradation in the IMF levels in particular that was consistent with the expectations within the Angus types. This is well illustrated in Figure 4.1.1 which shows the effects of both sire type and growth on IMF%. There were differences in IMF% across types that were not apparent in visual marble scores. The Black Wagyu had the highest IMF%, and while it was not significantly different to the 2 highest Angus types, it was clearly well above all others.

Eye muscle area (EMA)
This trait also gave results well in line with expected genetic potential. The high yielding European types were significantly well above all others, which in turn were all quite similar. This is illustrated in Figure 4.1.2.

Carcase yield
The differences in EMA shown in Figure 4.1.2 were reflected in the retail beef yield as estimated by VIAscan imaging, with the types of higher potential performing generally as expected. It is noted that the progeny of Angus sires selected for both RBY and IMF had an equivalent mean for yield to those of the RBY only group, but a lower (non-significant) mean for IMF than for those of the IMF only group (Figure 4.1.1). While these are suggested trends only, they may be explained by the mean EBVs for the sire groups in that the mean for RBY for the "both traits" group was closer to the RBY only group than their mean for IMF was to the IMF only group.

Predicted eating quality (PEQ)
There were significant differences between types in the eating quality for the strip loin cut predicted from the MSA model. This will be discussed further in the section below on meat quality. All group means were in the range for "3 Star" MSA rating.

Ossification scores
Ossification scores differed between types but only significantly for the Black Wagyu compared to most others.

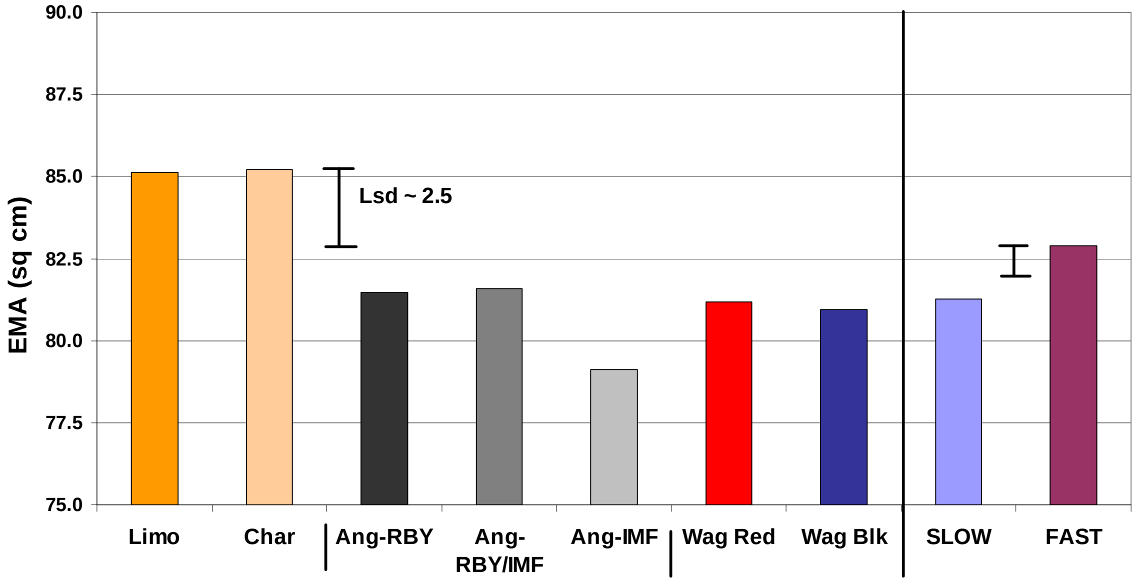


Figure 4.1.2. Predicted means (and least sig. diffs.) for eye muscle area (EMA) as affected by sire type and growth treatments (n = 557).

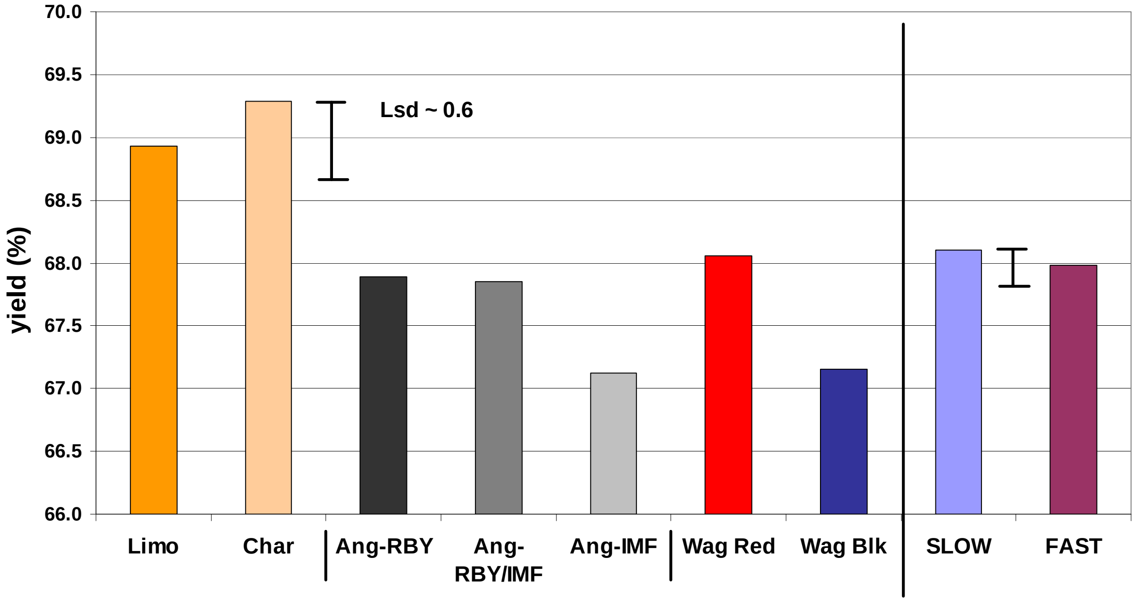


Figure 4.1.3. Predicted means (and least sig. diffs.) for retail beef yield as estimated by VIAscan imaging as affected by sire type and growth treatments (n = 555).

4.1.4.2.3 Effects of sire carcase "class"

As discussed above, the grouping of sires into "class" was expected to show effects in accordance, but such grouping may also mask important differences between types which need to be identified. Significant effects of sire class were found on most of the carcase traits as shown in Table 4.1.6.

Hot standard carcase weight (HSCW) and dressing %
Differences in HSCW and dressing % were not significantly affected by sire class.

P8 and rib fat depths
Differences in the subcutaneous fat depots at the P8 and rib sites were not significantly affected by sire class, although the trend was for the highest values in high IMF group and the lowest values in the high yielding group.

Table 4.1.6. Effect of sire "class" (grouped by expected yield or marbling potential) on predicted means for carcase traits at slaughter. Traits were analysed using HSCW as a covariate as appropriate. Maximum numbers *(n)* available for analyses for each group shown

Trait[1]	**High RBY**	**High RBY & IMF**	**High IMF**	***s.e.d***	**P**
Numbers of animals (n)	*(214)*	*(172)*	*(173)*		
HSCW (kg)	368	351	357	*11.2*	ns
HSCW (kg)[2]	364.1	355.1	359.5	*4.61*	ns
Dressing %	56.1	56.0	55.8	*0.64*	ns
P8 fat depth (mm)	15.8	18.0	18.9	*2.10*	ns
MSA Rib fat depth (mm)	10.0	10.5	12.3	*1.23*	ns
MSA AUS marble score	1.20a	1.52b	1.63b	0.154	<0.001
MSA USDA marble score	325.7a	368.2b	377.1b	*16.3*	0.002
IMF%	3.22a	4.18b	4.66b	*0.34*	<0.001
MSA EMA (sq cm)	83.7	81.4	80.0	*1.63*	0.052
VIAscan carcase yield %	68.7b	68.0b	67.1a	*0.51*	0.008
MSA predicted eating quality[3]	57.3a	58.0a	58.6b	*0.51*	0.04

[1]Data were analysed using age at start of growth treatment as a co-variate
[2]Adjusted for differences in feedlot induction weight
[3]Predicted eating quality (PEQ) from MSA model for the (grilled) strip loin cut
ab – different suffixes indicate significantly different means

Visual marble scores and intramuscular fat (IMF) %
There were significant differences in both AUS-MEAT and USDA visual marble scores as well as in laboratory measured IMF. These were in complete conformity to the grouping by higher or lower yield and IMF.

Eye muscle area (EMA)
The differences in EMA due to class of sire bordered on significance (P ~ 0.52) with the trend as expected with the high RBY group having the highest EMA.

Carcase yield
Yield of retail beef followed the same pattern as for EMA but in this case the difference between the high RBY group and the high IMF group (lowest yield) was significant. This further demonstrates the expression of genetic potential in progeny groups of sires selected on carcase EBV's.

Predicted eating quality (PEQ)
Eating quality predicted from the MSA model was significantly higher in the groups of high IMF potential. This will be discussed further in a later section.

4.1.4.2.4 Interaction of growth treatments with sire carcase types

The interaction of growth treatment with sire carcase type was not significant for any of the carcase traits, with one exception. This was for the rib fat depth measured by VIAscan (P ~ 0.034; data not shown), and in this case the measurements by the MSA chiller assessor did not agree with the data causing the interaction. The MSA means were greater for the Fast growth for all 7 types, while greater for only 3 of the VIAscan means. However many of the differences were small in both sets of measurements, and most non-significant.

Thus the evidence is strong to support the conclusion that there are likely to be few if any interactions between backgrounding growth and genetic potential that affect carcase traits at finish for the range of growth rates observed here.

4.1.4.3 Meat quality and palatability

Meat quality and palatability are important issues for beef production in both the short and longer terms. In the immediate market, carcase value is driven mainly by output of saleable beef – thus by carcase weight and yield. Currently the producer is not directly rewarded for better yielding animals and thus it is carcase weight (determined by growth rate) that is the obvious driver of returns. However there is increasing awareness of the importance of quality traits to establishing and maintaining more demanding markets both domestically and globally. Thus we need to know if such traits can be combined with growth and yield in a way that does not compromise carcase value and thus profitability. There is strong evidence from published research that reliable eating quality is well related to intramuscular fat deposition.

The following tables (4.1.7 and 4.1.8) show the results relevant to eating quality (including some parameters previously appearing in tables above but shown again for comparison with quality specific data).

There were no significant treatment interactions in the analyses of the meat quality traits

4.1.4.3.1 Effects of growth treatment

The effect of growth treatment on CMQ4 score approached significance (P ~ 0.07), with the higher mean for the Fast grown groups (Table 4.1.7). This trend is consistent with the significantly higher IMF for the Fast growth treatment. The contribution of growth rate in the MSA prediction model (estimated by ossification and carcase weight) to PEQ is small (Thompson 2002), which could account for there being no difference between growth treatment groups in these data (Table 4.1.5).

Table 4.1.7. Effects of growth rate and of sire breed/carcase "class" (grouped by expected yield or marbling potential) on meat quality traits and palatability as assessed by chiller and laboratory measurements and by sensory testing using taste panels. Maximum numbers (*n*) available for analyses for each group shown

	Growth				Class				
Trait	**Slow**	**Fast**	***s.e.d***	**P**	**High RBY**	**High RBY & IMF**	**High IMF**	***s.e.d***	**P**
(Chiller - n)	*(260)*	*(299)*			*(214)*	*(172)*	*(173)*		
MSA AUS marble score	1.36	1.39	*0.035*	ns	1.2	1.5	1.6	*0.15*	<0.001
MSA predicted. eating quality[1]	57.7	57.7	*0.19*	ns	57.3	58.0	58.6	*0.51*	0.04
(Lab chemical - n)	*(216)*	*(235)*			*(168)*	*(145)*	*(138)*		
IMF%	3.61	4.15	*0.170*	0.001	3.22	4.18	4.66	*0.34*	<0.001
(Lab objective - n)	*(188)*	*(173)*			*(141)*	*(111)*	*(109)*		
Shear force (N)[2]	40.0	40.8	*1.15*	ns	41.0	42.1	37.5	*2.34*	ns
Compression (N)[2]	16.2	15.8	*0.25*	0.048	16.2	16.3	15.4	*0.43*	0.08
Cooking loss (%)	22.6	22.8	*0.30*	ns	22.4	23.2	22.6	*0.52*	ns
(Sensory - n)	*(226)*	*(226)*			*(179)*	*(135)*	*(138)*		
CMQ4 score[3]	53.2	55.4	*1.35*	0.067	52.9	52.4	58.5	*2.57*	0.04
% samples failing 3 Star[4]	28	28			34	30	19		

[1]Predicted eating quality (PEQ) from MSA model for the (grilled) strip loin ("STA" – MSA cut)
[2]Shear force and compression expressed as Newtons (N = kg force x 9.81); N > 45 considered approaching "tough"
[3]Sensory eating quality - clipped CMQ4 score using MSA testing protocol for the (grilled) strip loin ("STA" – MSA cut)
[4]Raw data only from sensory tests – samples below CMQ4 score 48 ("3 Star" cut off)

4.1.4.3.2 Effects of sire carcase type and class

There was a clear association in the data of better eating quality with higher marbling/IMF% (Table 4.1.8). This is well illustrated in Figure 4.1.4 showing sensory test results in relation to IMF%. The Black Wagyu and Angus IMF groups had the highest CMQ4 scores and predicted eating quality, and the lowest scores for shear force and compression. Conversely, the Red Wagyu and Limousin groups produced the poorest results for these parameters, with the Red Wagyu significantly lower than all others except the Limousin for consumer detectable palatability. While all groups returned mean CMQ4 scores greater than the 48 cut off for MSA "3 Star" rating, many samples within groups fell below that level – 45% of samples in the Red Wagyu group compared to around 20% in the best groups.

The ranking of sire types for the CMQ4 scores from actual sensory tests compared to that of the means predicted from the MSA model showed fairly good agreement, particularly for the higher IMF types. There was very good agreement in the ranking of both IMF and shear force with CMQ4 scores. The ranking of both shear force and compression was also closely associated with IMF%.

The association of better eating quality with higher marbling/IMF% was seen again in the means grouped by class (Table 4.1.7), with the high IMF category clearly superior to the others. The mean for the "both traits" category was considerably affected by the poor result from the Red Wagyu type (Table 4.1.8).

Although there were significant differences due to sire type in the predicted eating quality of the strip loin (PEQ score), the variation was not large (Table 4.1.8).

Table 4.1.8. Effect of sire breed/carcase type on meat quality traits and palatability as assessed by chiller and laboratory measurements and by sensory testing using taste panels. Maximum numbers *(n)* available for analyses for each group shown

Trait	Lim.	Charol.	Angus RBY	Angus RBY & IMF	Angus IMF	Red Wagyu	Black Wagyu	s.e.d *or (n)*	P
(Chiller - n)	*(56)*	*(52)*	*(106)*	*(109)*	*(106)*	*(63)*	*(67)*	*(559)*	
MSA AUS marble score	0.96a	1.11b	1.41c	1.57d	1.58d	1.40c	1.59d	0.074	<0.001
MSA pred. eating quality[1]	56.6a	57.2ab	57.6b	58.3bc	58.5c	57.2ab	58.2bc	*0.39*	<0.001
(Lab chemical - n)	*(42)*	*(39)*	*(87)*	*(91)*	*(88)*	*(54)*	*(50)*	*(451)*	
IMF%	3.05a	2.76a	3.69b	4.29bc	4.53c	4.06bc	4.79c	*0.30*	<0.001
(Lab objective - n)	*(39)*	*(32)*	*(70)*	*(69)*	*(68)*	*(42)*	*(41)*	*(361)*	
Shear force (N)[2]	44.5c	39.8b	39.3ab	40.2b	38.8ab	44.2c	36.2a	1.68	<0.001
Compression (N)[2]	16.5b	16.3b	15.9ab	15.8ab	15.6ab	16.9b	15.1a	0.40	<0.001
Cooking loss (%)	21.9a	22.3a	23.0ab	22.8ab	22.7ab	23.7b	22.6ab	0.57	0.048
(Sensory - n)	*(52)*	*(42)*	*(85)*	*(84)*	*(81)*	*(51)*	*(57)*	*(452)*	
CMQ4 score[3]	51.6ab	53.9b	53.3b	55.9bc	58.8c	48.5a	58.3c	2.157	<0.001
% samples failing 3 Star[4]	38	33	32	21	19	45	19		

[1]Predicted eating quality (PEQ) from MSA model for the (grilled) strip loin ("STA" – MSA cut)
[2]Shear force and compression expressed as Newtons (N = kg force x 9.81); N > 45 considered approaching "tough"
[3]Sensory eating quality - clipped CMQ4 score using MSA testing protocol for the (grilled) strip loin ("STA" – MSA cut)
[4]Raw data only from sensory tests – samples below CMQ4 score 48 ("3 Star" cut off)
ab – different suffixes indicate significantly different means

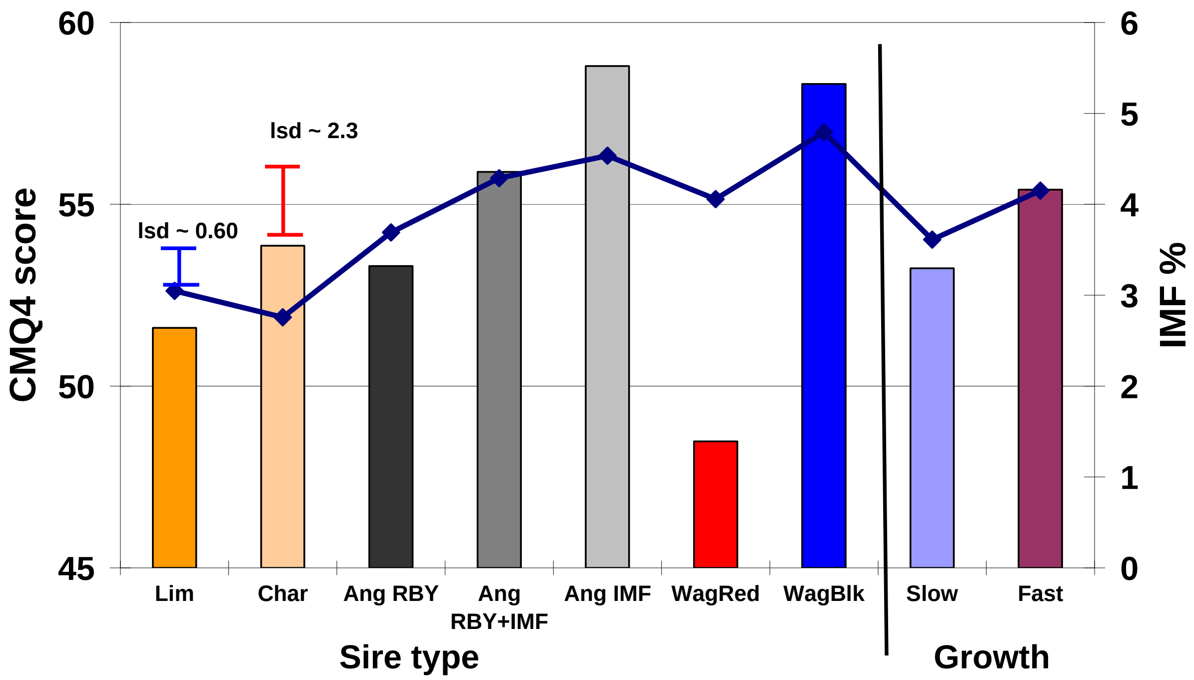


Figure 4.1.4. Predicted means (and least sig. diffs.) for eating quality (bars - CMQ4 scores) and IMF% (line) as affected by sire type and growth treatments (n = 452).

4.1.4.4 Discussion of effects on carcase traits and meat quality

The main focus of this study was on the carcase traits of marbling/IMF and retail beef yield, these being major determinants of current and future carcase value. The results showed clearly that choosing sires on genetic potential for these traits was effective in producing the targeted attributes in their progeny. It would no doubt be advantageous if “fatness” and yield traits could be combined to improve eating quality while increasing output.

There is also some scope to alter carcase traits by nutritional management. While this avenue produced fewer and smaller responses in carcase traits, it has a large affect on enterprise profitability. This is due largely to the advantage gained by reaching market targets at an earlier age thus providing faster turnaround and less demand on resources.

An area emerging as an important industry issue is that of age at slaughter. There are likely to be increased penalties in price/kg of carcase weight for animals that exceed age limits for nominated slaughter weight. Whether this is determined by dentition or by ossification is conjectural, but an upper limit of 30 months of age is already proposed by the processors (Cargill Beef, *pers.com.*) for the heavier carcase markets (300-380 kg). On the other hand the processors get greater efficiency from heavier carcases, so the message is clear that high growth rates will become increasingly important to improve profitability to both the supplier (in carcase value/kg) and the processor. Thus it is important to know the effects of faster growth on the carcase in a variety of genetically diverse animals and management situations, and hence the relevance of the results of this project.

Results at this site showed significant effects of sire type for virtually all carcase traits measured but fewer effects due to growth treatment. There were no significant interactions between growth treatment and sire types for important production or carcase traits. This shows that the responses found here should be predictable under different nutritional regimes affecting growth rate and simplifies management advice for optimising production.

The unadjusted data showed the potential performance of the various sire progeny groups under the actual conditions of the experiment. Clearly some groups performed better than others when run and managed as a single herd. However in practical management situations, diverse groups of animals would not be sent to the feedlot at the same time, as required here by the experimental design. Thus the scenarios of feedlot entry at equivalent group mean weights were examined using data predicted from “spline” analysis of growth curves. In analysing carcase traits there was also a requirement to use co-variates to account for differences that were induced by experimental design rather than by treatment response, and to evaluate trait responses at an equivalent carcase weight.

The largest effect of the growth treatment was on compensatory gain during the feedlot finishing phase. The 5–7% advantage in daily gain could significantly affect feedlot profitability as faster growing animals are likely to be more efficient, and it also results in heavier carcases. However the faster growth in the feedlot was found in the steers having slower growth treatment before entry which is at odds with faster turnover for the backgrounding operation.

There was an overall trend for fatness traits to be greater in faster growing animals. This was significant for the rib site and almost so for P8. It was also significant for laboratory measured IMF%. However the responses in IMF% were not always reflected in visual marble scores, since these were not significantly different between growth treatments. The differences in fat traits at slaughter between the pre-feedlot growth treatment groups were impacted by the compensatory growth of the Slow treatment steers during feedlot finishing. The Fast growth animals were fatter than the Slow at both feedlot entry and exit. However, the difference between groups was smaller at exit due to the greater deposition of fat in the Slow group in association with their faster (compensatory) growth in the feedlot. This re-enforces the conclusion of faster growth promoting greater fat deposition as demonstrated in the Fast groups at feedlot entry.

All the fatness traits were significantly affected by sire type and showed clear responses to genetic pre-disposition for fat deposition. The results showed that Angus types with high IMF% potential can exhibit fatness traits equivalent to the Black Wagyu.

The responses to sire type in EMA and retail beef yield were well in line with expectations based on genetic potential, with the 2 European types clearly and significantly ahead of all others.

Examination of treatment effects on meat eating quality was a focus for the NSW site. Laboratory measurements related to tenderness are useful predictors of meat eating quality, as discussed by Perry *et al.* (2001b) and this was apparent in the data reported here. There was a clear association of IMF% and marbling scores with palatability (for consumer taste panel results) as shown in the CMQ4 scores. The agreement between shear force and CMQ4 sensory scores was good and both these parameters were well related to IMF and marble scores. Good association of marbling with the MSA model predictions was to be expected as this parameter has considerable influence on the output (Thompson 2002).

The predicted eating quality means (PEQ) from the MSA model were higher than those for the CMQ4 scores and had much less variation (s.e.d 0.39 v 2.16). This suggests that the model predictions are not as sensitive to differences detectable by tasters. Few model predictions were below the 48 score (cut off for MSA “3 Star”), but many CMQ4 scores from the taste panel results did so. The finding here that eating quality may not always be reliably predicted by the model is likely due to IMF not always being reflected by marble score, which is a significant driver of predictions by the model. Thus it was an important part of the experiment to have the taste panel results to detect responses and trends not exposed by the model predictions.

Results reported by Gregory *et al.* (1994) showed unfavourable correlations between traits affecting carcase composition and palatability, indicating that genotypes with high yield potential may have lower eating quality. It is important to examine this (potential) antagonism in the context of the Australian domestic beef trade requirements, as both yield and eating quality can have large effects on carcase value, and these parameters are likely to assume increasing importance in the future.

The current results provide good evidence that high yielding genotypes can produce meat of acceptable eating quality, although lower than that from genotypes with higher potential for fat deposition. Perry and Thompson (Perry 2003; Perry and Thompson 2005) found that palatability of grilled strip loins was generally improved in animals grown faster during finishing and sometimes in those grown faster during backgrounding. These authors concluded that results in previous reports were often confounded with age at slaughter, which made it difficult to assess the effect of prior growth. Nonetheless, any treatments or genotypes that increase intra muscular fat should improve palatability in practice. Hennessy and Morris (2003) found no effect on eating quality due to differences in growth rate prior to weaning. The animals in their study had higher carcase weights following faster early growth and there was no significant compensatory growth post weaning in the previously slower grown animals, nor any difference in fatness at slaughter. Thus the final carcase fatness appears to have been the main factor affecting eating quality as the heifers were fatter and had higher palatability scores. Results here are also consistent with the conclusions of Purchas *et al.* (2002), who reported faster growth to result in more tender meat and that it was also associated with more intramuscular fat.

Greater output of beef from high yielding carcase types is likely to be accompanied by some decline in both measured and predicted meat quality traits, because of lower fatness. The economics of this trade-off currently favour increased total output and are unlikely to change until discounts/premiums for quality traits are increased from the current levels and provide clear signals and incentives for producers.

The Red Wagyu was an uncertain quantity at the start of the experiment but included due to industry interest in this breed type as a possible dual purpose animal to capture perceived advantages due to the IMF potential of Wagyu types and with the possible added advantage of increased yield. The results showed it ranked between the Black Wagyu and European types for both IMF and yield but did not perform as well as many other groups in total beef production. It does not appear to have the high IMF potential that may attract premiums sufficient to compensate for lower production and was disappointing in eating quality. However, as for other sire type groups, only a small sample of the type was represented, which demands caution be paramount in drawing such conclusions.

The issue of compensatory growth mentioned above was an interesting feature of this experiment in relation to the growth treatments applied. Compensatory gain was defined in a review by Ryan (1990) as "greater than normal growth rate sometimes observed following a period when nutritional restriction...is…such that body weight increases only slowly or is reduced and that this restriction is maintained for sufficient time to allow adaptation to the lower nutritive state". The improvement in growth rate in the feedlot found here following slower prior growth complies with this definition, but the slower growth would not be considered particularly "restricted" (at the NSW site) in comparison to most treatments in experiments designed specifically to examine this phenomenon. Ryan (1990) proposed that cattle and sheep restricted pre-natally, immediately after birth and close to maturity are unlikely to compensate, but that after 3 months of age compensatory growth may be expected, provided the restriction was sufficient to limit their growth to small increases in body weight, maintenance or loss of weight. The steers here fit the age requirement and may extend the conditions for compensatory gain to occur following even relatively mild restrictions in growth, but this may depend on offering a much higher plane of nutrition during the period of compensation. An interesting conclusion of Ryan (1990) was that gut size and activity was reduced during restriction, lowering maintenance requirement, and that part of the compensatory response was in re-establishing gut size and thus fill, particularly in the initial stages. However this was not likely to be long lasting and the continued compensatory response required increased intake and efficiency, which may have occurred in the feedlot finished animals here but these were not able to be estimated. On a separate but related issue, it is difficult to relate the trend in higher dressing % in faster grown animals in the current experiments with the reduction in gut size in restricted animals found by Ryan (1990). Thus the effect seen here would appear to be related to other factors like omental fat and/or visceral organs. Faster grown animals had more external fat so they would need to have considerably less internal fat if that was the main driver of dressing %.

4.1.4.5 Meeting specifications

4.1.4.5.1 Compliance to abattoir grid specifications

Background

The percentages of carcases within each treatment group that met specifications were assessed at 2 levels – standard Cargill grid (Table 4.1.9) and a preferred range for the traits (preferred specs). Additionally, compliance to an optimum carcase specification was tested using the "distance from specification analysis" (Rutley 2006)

Percent meeting specification was determined for the 3 main traits – carcase weight (HSCW), P8 fat depth (P8) and fat colour (FC). The compliance to the meat colour specification is not shown specifically as we considered it a random management effect in these data. There was no significant effect due to treatment on meat colour but it was included in calculations of discounts and total value of carcases. The specification for teeth was not relevant to these animals as only 3 of the total number had 4 teeth.

Results are shown for both standard and preferred ranges, giving percentages of carcases meeting trait specifications individually, percentages meeting both HSCW and P8 specifications, followed by the percentage of carcases meeting all of the 3 trait specifications (equivalent to achieving maximum cents/kg from the grid).

Table 4 .1. 9. Specifications for CARGILL BEEF (Aust) – 100day grain fed steer carcase

Trait	Standard grid*	Preferred specifications	Optimum specifications
HSCW (kg)	300 - 380	330 - 360	350
P8 fat	10 - 32	10 - 18	14
Fat colour	0	0	0
Meat colour	1B - 3	1B - 3	1B - 3
Teeth	0 - 2	0 - 2	0

*Standard grid specifications for maximum price
(Also see Appendix Table 9.1.1 for full grid description including price penalties)

Data adjustment for legitimate comparisons

The experimental design was such that the two growth treatments were required to reach feedlot entry at the same weight. However, this was not possible to achieve on a breed type basis because of their wide variation in growth potential.

Thus, some breed types within each cohort were substantially disadvantaged from a 'meeting specifications' viewpoint due to the experimental design. The design required all cohorts to be introduced to the feedlot when the average live weight of the overall cohort was approximately 400kg in the paddock, giving a feedlot induction weight of 380kg. Some breed types were significantly lighter and others heavier than the average. It can be argued that from a practical perspective it is most unlikely that a commercial beef producer would have all these variable genotypes (as in this experiment) in groups presented for sale. More likely they would have one or two types of similar growth characteristics, or at least enough of one type to make up a relatively homogeneous group (without the extreme variation in weight present in these populations/cohorts). The same principle would apply for groups of cattle assembled for backgrounding and feedlot entry.

To address this issue of variable pre-feedlot live weight and allow a more practical interpretation of the results, the data was statistically adjusted using a 'spline' analysis (see statistical methods) so that the average weight at feedlot entry of each breed type within each cohort was similar (~380kg live weight). Final live weight, carcase weight and subcutaneous fatness were then adjusted accordingly based on the predicted values.

In practical terms this would have meant that certain breed types would have entered the feedlot a number of days before or after the actual entry time. From the 'spline' analysis this number of days was predicted for use as a positive or negative cost factor in economic analyses.

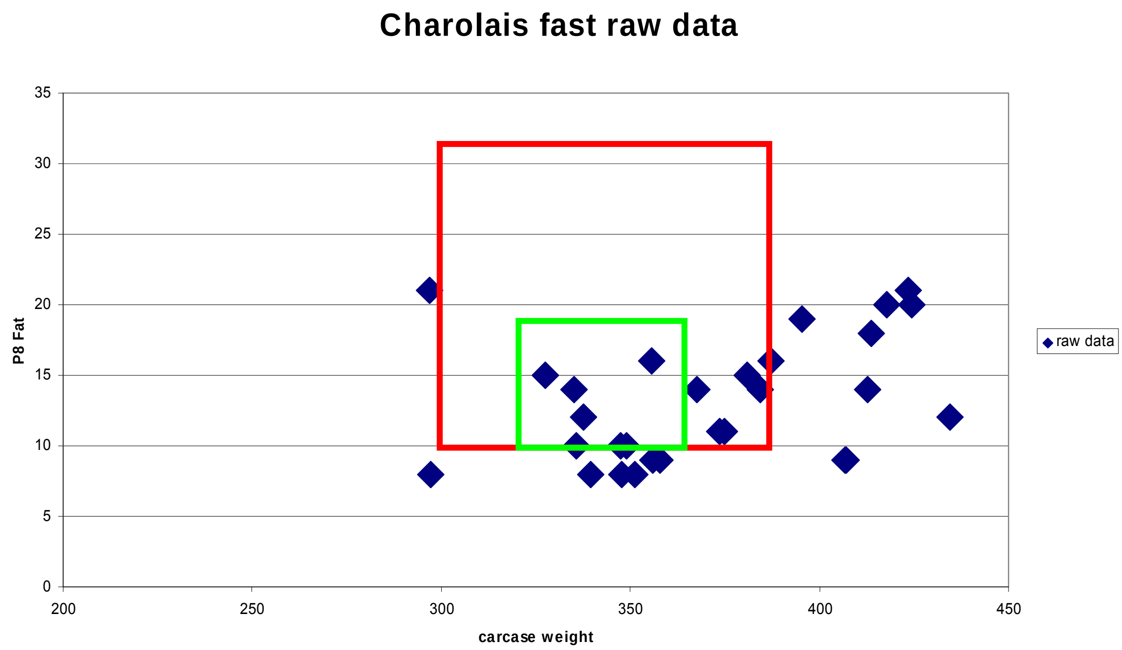


Figure 4 .1 .5. The distribution of un-adjusted live weight for the Charolais breed type within the Fast grown treatment group. The boxes refer to the standard (large) and preferred (small) grid specifications

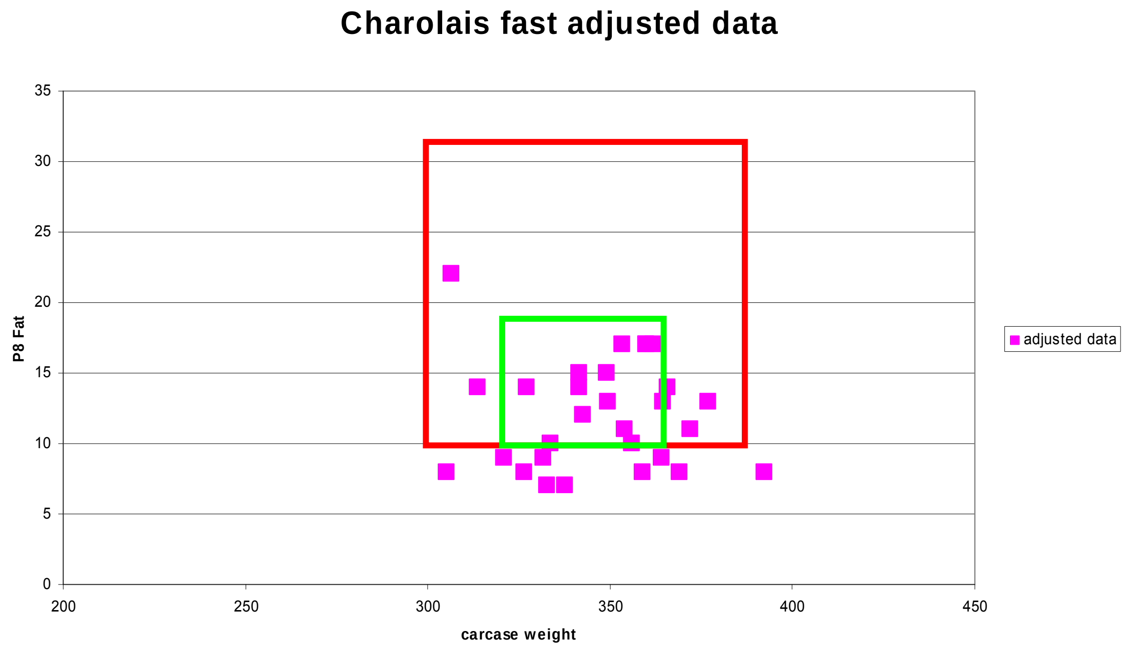


Figure 4.1.6. The distribution of live weight for the Charolais breed type within the Fast grown treatment group following adjustment

The impact of data adjustment on carcase value can be seen by comparing Figures 4.1.5 and 4.1.6, using the Slow growth treatment results.

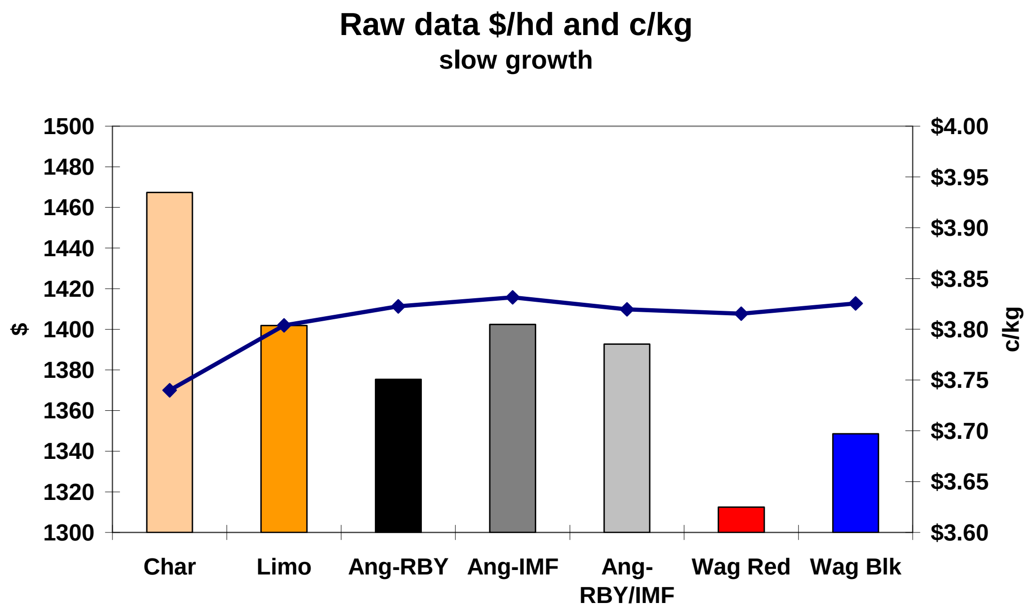


Figure 4.1.7. Average carcase value and c/kg HSCW for breed types within the Slow growth treatment using unadjusted figures

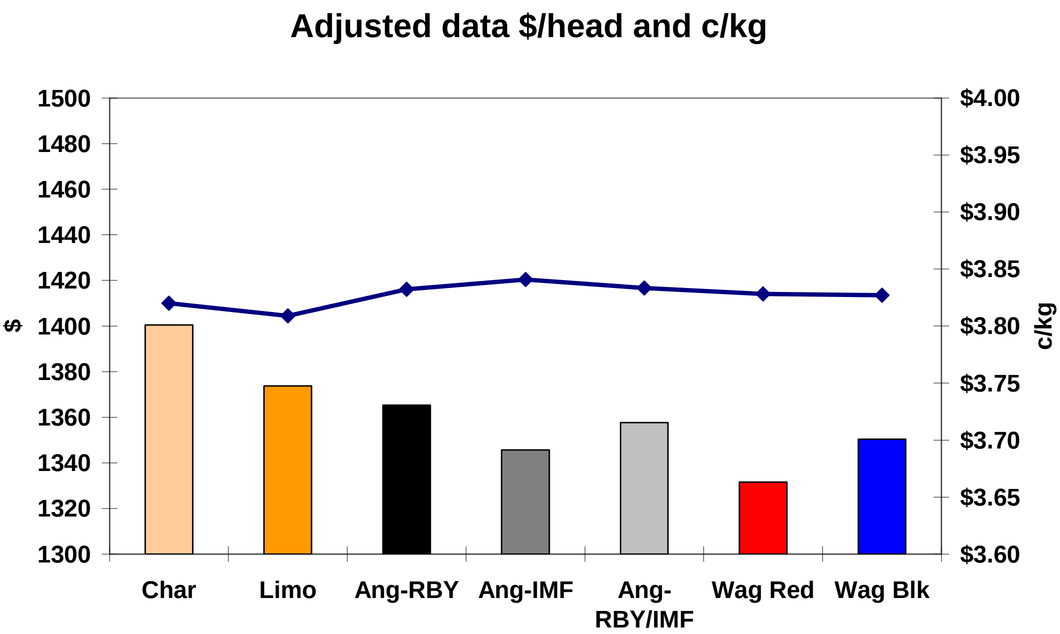


Figure 4.1.8. Average carcase value and c/kg HSCW for breed types within the Slow growth treatment after adjustment

Figure 4.1.7 shows that there was little effect on c/kg except for the Charolais breed type, whose high growth rate and hence heavier carcases were heavily discounted due mainly to being over specification weight. However, it is important to note that although they received a substantial discount on a c/kg basis, the extra carcase weight far outweighed this disadvantage when total value was considered. Figure 4.1.8 shows that after adjustment for feedlot entry weight there was less variation in total values between breed types. When, the Charolais entered the feedlot at the same weight as the other types, the discount in c/kg was negligible, but there was still an advantage in carcase weight and total value. However the total value does not include the advantage that would accrue due to some breed types reaching feedlot entry earlier (see economic analysis).

Valuation of carcases

The comparison of breed types with both Fast and Slow growth treatments for the parameters determining carcase value are shown in Tables 4.1.10 and 4.1.11, which also show the comparative deficit against the best performing groups. The Charolais were clearly the best in the unadjusted data (due to higher carcase weights), and again in adjusted Slow growth. However differences were much smaller in the adjusted Fast growth and the Limousin in fact returned the highest value, with 4 other types including the Charolais close behind.

An evaluation of the unadjusted data (Table 4.1.10) shows a significant advantage to the Fast grown Charolais type in eventual carcase weight (6% to 13% heavier). As indicated above this is substantially due to the experimental design and makes it difficult to do a true evaluation of 'how well various treatments affect meeting market specifications'. The financial message to producers of these steers is clearly swamped by the overall value of the various types – which is substantially weight related. It does not send an un-ambiguous message in terms of 'meeting specifications' as the most valuable carcase is clearly not the most desired (as attested to by the $/kg).

Table 4.1.10. Comparison of breed types within Fast and Slow growth treatments using data unadjusted for feedlot entry weight – averages for carcase weight (Cwt), carcase price ($/kg), carcase value (Grid value$) and $ differences from the highest value breed type

	Lim	Char	Ang RBY	Ang RBY& IMF	Ang IMF	Red Wag	Blk Wag
Slow growth							
N	28	22	47	50	47	34	31
Cwt (kg)	372	392	365	365	367	346	354
$/kg	3.80	3.74	3.82	3.82	3.83	3.82	3.83
Grid value ($)	1417	1466	1394	1394	1404	1320	1354
Value diff ($)	**-49**	**0**	**-72**	**-72**	**-62**	**-146**	**-112**
Fast growth							
N	28	29	59	59	59	29	36
Cwt (kg)	356	370	352	350	347	338	350
$/kg	3.82	3.77	3.82	3.84	3.83	3.77	3.80
Grid value ($)	1362	1393	1342	1343	1328	1277	1331
Value diff ($)	**-31**	**0**	**-51**	**-50**	**-65**	**-116**	**-62**

Table 4.1.11. Comparison of breed types within Slow growth treatment using adjusted mean feedlot entry weights – averages for carcase weight (Cwt), carcase price ($/kg), carcase value (Grid value$) and $ differences from the highest value breed type

	Lim	Char	Ang RBY	Ang RBY&I MF	Ang IMF	RedW ag	Blk Wag
Slow growth							
N	28	22	47	50	47	34	31
Cwt (kg)	361	367	356	354	350	348	353
$/kg	3.81	3.82	3.83	3.83	3.84	3.83	3.83
Grid value ($)	1374	1400	1365	1358	1346	1332	1350
Value diff ($)	**-27**	**0**	**-35**	**-43**	**-55**	**-69**	**-50**
Fast growth							
N	28	29	59	59	59	29	36
Cwt (kg)	351	347	348	345	344	338	349
$/kg	$3.82	$3.82	$3.84	$3.85	$3.84	$3.83	$3.82
Grid value ($)	1340	1327	1335	1329	1321	1294	1330
Value diff ($)	**0**	**-14**	**-6**	**-12**	**-19**	**-46**	**-10**

However, when the data is adjusted (Table 4.1.11) we can be more confident in the messages inherent in the price signals – a better indicator of how well various treatments have enabled the steers to meet market requirements. The price penalties for weight differences are virtually eliminated. Still some price ($/kg) differences between the breed type groups exist and this is reflected in the total value ($) figures. The total value in this case using these adjusted figures does not account for the extra time required to physically achieve the adjusted “same” weight via more time at pasture (as reported in the economic analysis section).

In the Slow growth group, even after adjusting for a standard feedlot entry weight the higher growth potential of the Charolais types still produced heavier carcases and greater return in terms of $ per head. However, in the Fast growth treatment this effect was not evident. The

Red Wagyu types were considerably below the rest in $ value both in the Fast and Slow growth treatments.

Compliance to standard and "preferred" grid specifications

The proportions of carcases meeting grid specifications (compliance rates) for both the standard and preferred ranges are shown in Tables 4.1.12 and 4.1.13. Comparing growth treatments over all breed types (Table 4.1.12), there was a trend for better compliance of the Fast growth treatment to both standard and preferred specifications for almost all traits. The Fast growth path carcases better met both P8 fat and fat colour specifications, resulting in an overall increase in compliance to specifications of about 10%. Although compliance rates were very low for preferred specifications, the larger difference between treatments suggests less variation in faster growing groups. The compliance to combined specifications was heavily influenced by fat colour.

Table 4.1.12. Comparison of pre-feedlot growth treatments over all breed types using adjusted mean feedlot entry weights for percentage compliance to standard and preferred grid specifications for weight and P8 separately and combined, for fat colour and for all 3 traits combined.

	Slow growth	Fast growth
% within grid wt spec	87.6	91.3
% within grid P8 spec	96.1	94.6
% within grid wt and P8 spec	84.6	86.6
% within grid fat colour spec	25.5	32.1
% meeting all grid specs	20.5	29.8
% within preferred wt spec	20.8	55.5
% within pref P8 spec	59.8	60.5
% within pref wt and P8 spec	26.6	34.4
% within grid fat colour spec	25.3	32.1
% meeting pref specs	3.4	11.7

The effect of the imposition of the fat colour specification is quite noticeable. The magnitude of the fat colour effect is similar across all treatment groups but the real effect on product value is debatable. In communication with the processor they believe that strict adherence to such a narrow fat colour specification is a real market requirement for a 100 day grain fed product and were not surprised by the substantial impact on compliance rates. However, in this experiment there were no significant differences for fat colour due to either growth path or breed type.

Within this experiment the trait 'fat colour' was highly variable and inconsistent between measuring/assessment techniques. The raw correlation between the subjective chiller assessment score for fat colour and the objective VIAscan measurement was very low ($r = 0.10$ Appendix Table 9.1.5), possibly because of the discrete nature of the score. Meat colour is also a discrete score and had a better, but still only medium correlation ($r = 0.56$ Appendix Table 9.1.5). This re-enforces the need for processors to fully examine the reliability of such measurements (particularly fat colour), and their current impact on carcase value.

The superior compliance of the Fast growth treatment was consistent for most traits across most breed types for both standard and preferred specifications (Table 4.1.13).

The 3 Angus carcase types performed best in meeting all standard specifications in both Fast and Slow growth treatments. This might be expected given the predominance of this breed type in feedlot finished cattle (especially ≥ 100 day fed) and imply that feedlot operators have designed a system to allow these Angus carcase types to best meet specifications.

In the Slow growth path treatment Charolais and Limousin types are below the other breed types in meeting both live weight and P8 fat specifications – both too heavy and too lean. Their ability to meet specifications overall (including fat colour) are also well below the other breed types.

Table 4.1.13. Comparison of breed types within pre-feedlot growth treatments using adjusted mean feedlot entry weights for percentage compliance to standard and preferred grid specifications for weight and P8 separately then combined, for fat colour and then for all 3 traits combined

	Lim	Char	Ang RBY	Ang RBY &IMF	Ang IMF	Red Wag	Blk Wag
Slow growth - *n*	*28*	*22*	*47*	*50*	*47*	*34*	*31*
Standard grid specifications							
% within grid wt spec	82.1	77.3	89.4	86	95.7	88	93.5
% within grid P8 spec	82.1	90.9	100	100	100	97	93.5
% within grid wt and P8 spec	60.7	72.7	89.4	86	95.7	85.3	90.3
% within grid fat colour spec	14.3	18.2	23.4	32	31.9	23.5	25.8
% meeting all grid specs	7.1	4.6	23.4	26	29.8	17.6	16.1
Preferred specifications							
% within preferred wt spec	39.3	40.1	53.2	44	46.8	44	71
% within pref P8 spec	68	77.3	55	62	53.2	62	51.6
% within preferred wt and P8 spec	21.4	27.3	46.8	26	19.1	29.4	38.7
% within grid fat colour spec	14.3	18.2	23.4	32	31.9	23.5	25.8
% meeting all preferred specs	0	0	2.1	6	2.1	8.8	3.2
Fast growth - *n*	*28*	*29*	*59*	*59*	*59*	*29*	*36*
Standard grid specifications							
% within grid wt spec	82.1	96.6	91.5	93.2	93.2	93.1	88.9
% within grid P8 spec	96.4	65.5	98.3	98.2	98.3	100	97.2
% within grid wt and P8 spec	78.6	65.5	89.8	91.5	91.5	93.1	86.1
% within grid fat colour spec	21.4	37.9	35.6	42.4	35.6	17.2	19.4
% meeting all grid specs	14.3	27.6	33.9	40.7	33.9	17.2	11.1
Preferred specifications							
% within preferred wt spec	50	51.7	64.4	59.3	66.1	44.8	52.8
% within pref P8 spec	53.6	48.3	52.5	49.2	54.2	51.7	50
% within preferred wt and P8 spec	28.6	37.9	40	33.9	33.9	27.6	36.1
% within grid fat colour spec	21.4	37.9	35.6	42.4	35.6	17.2	19.4
% meeting preferred specs	7.1	17.2	16.9	15.3	11.9	0	5.6

Within the Fast growth path the Charolais types performed better than they did in the Slow growth path in meeting market weight specifications, however the reverse was true for meeting P8 fat specifications. The compliance rates for P8 fat for the Charolais types in the Fast growth path were 30% below those of the other breed types.

Carcases from Charolais sired steers were heavier and leaner at the same age compared to those from Angus sires, consistent with previous studies by Hearnshaw *et al.* (1995) who also reported lower compliance to fat specifications.

Although there appeared to be differences in compliance to fat colour between breed types, particularly in the Fast growth group, these were not significant.

The Fast growth treatment improved compliance to overall preferred specifications in all breed types (particularly the Charolais) except for the Red Wagyu types which tended to perform worse.

These data suggest that in the case of feedlot finished animals of particular breed types, the timing of age with weight at entry as well as the time on feed will determine the compliance to particular carcase specifications. For example it may be better to put Charolais types on feed at lighter weights and keep on feed longer to achieve better compliance to the fat and weight specifications.

4.1.4.5.2 "Distance from Specifications" (Dfs) analysis

Background

The following section describes the development of a continuous pricing function for Cargill's 100 Day Grain Fed specification (Appendix Table 9.1.1).

The quality of a commodity may be defined as the product's consistency in meeting defined specifications. Consistency in meeting specifications can be measured in terms of a customer's satisfaction with the product encouraging repeat business as the customer's expectations are met for each purchase. To encourage increased consistency, rewarding small continuous improvements in product quality would be advantageous. The current carcase payment systems based on grids, are a form of discontinuous payment which do not necessarily encourage small increments towards preferred product - thus a continuous payment system should be investigated as an alternative.

The trait 'distance to 'ideal' specification', as we call here "distance from specifications" (Dfs) as defined by Rutley (2006), can be used as the basis for a continuous payment system. To use distance from an 'ideal' point requires the definition of the nominal 'ideal' point (carcase). Once this carcase has been defined the Euclidean distance from the 'ideal' to all other carcases can be estimated and price can be calculated as some function of this distance. Also the average distance of groups of carcases and their variation can be calculated (Rutley 2006).

A continuous pricing function was developed from Cargill's 100 day grain fed carcase specification (Appendix Table 9.1.1), a pre-defined multi-dimensional multi-level pricing grid. The continuous pricing function was applied to the NSW steer data.

The carcase specification grid used here consists of hot dressed weight (Table 4.1.14), hot standard carcase weight (AUS-MEAT 1995) used to define the base price of a carcase and 6 other traits (viz butt shape, P8 fat depth, bruise code, dentition, fat and meat colour) that place the carcase into one of 7 quality grades (Table 4.1.15). Carcases suitable for the premium grade (grade 1) receive the base price, while carcases that fall into other grades are given a discount as defined in Table 4.1.15.

Table 4 .1.14. Carcase base price based on weight ranges.

Carcase Weight (kg)	Steers	Heifers
420 +	$3.52	$3.47
400 - 419.5	$3.82	$3.77
380 - 399.5	$3.90	$3.85
300 - 379.5	$3.91	$3.86
280 - 299.5	$3.86	$3.81
260 - 279.5	$3.42	$3.37
< 259.5	$3.22	$3.17

Table 4.1.15. Price discounts based on carcase trait ranges.

Grade Code	Butt Shape	P8 Fat Depth (mm)	Bruise Code	Dentition	Fat Colour	Meat Colour	Premium/ Discount
GR1	A - C	10 - 32	NIL	0 - 2	0	1B - 3	0
GR2	A - C	10 - 42	1 - 4	0 - 2	0 - 2	1B - 6	- 10 C
GR3	A - C	6 - 9	1 - 4	0 - 2	0 - 3	1B - 6	- 15 C
GR4	A - C	10 - 32	NIL	4	0	1B - 6	- 15 C
GR5	A - C	33 - 42	1 - 4	4	0 - 2	1B - 6	- 20 C
GR6	A - C	6 - 9	1 - 4	4	0 - 3	1B - 6	- 20 C
GR7	A - D	0 +	1 - 9	0 - 8	0 - 9	1A - 7	-1.20

Value based marketing uses price functions of traits that affect price in a continuous manner. From this grid it was deemed that the traits Butt Shape, Bruise Code, Dentition and Meat Colour simply excluded undesirable carcases from the market, rather than influence carcase value in a continuous manner. The remaining traits, hot dressed weight (hot standard carcase weight HSCW; ASUMEAT, 1995), P8 fat depth and fat colour have a continuous influence on carcase value.

Discussions with the procurement manager indicated that the market signals from dentition are increasing over time, July 2005 (15 to 20 c/kg) to March 2006 (60 to 65 c/kg) and this is expected to continue over the next 12 or so months until all carcases with dentition of 4 or greater will receive the maximum penalty, a 120 c/kg discount (Cargill Beef, *pers. comm*.). Therefore grid grade codes GR4 to 6 were excluded from this analysis.

Meat colours 1A and 7 remove carcases from the market, meat colours 1B to 3 are ideal, while meat colours 4 to 6 are satisfactory incurring a 10 cents/kg discount. This trait was initially deemed to simply define a carcase as acceptable or not and was not included in the continuous payment system. However, it was later realised that the discount of carcases with meat colour 4, 5 or 6 was significant and this had to be accounted for, though it was not included in the continuous part of the payment system. Given more time for the development of the continuous payment function this trait could be included with the other continuous traits.

The effect of HSCW, P8 Fat Depth and Fat Colour on price can be seen in Figures 4.1.9 to 4.1.10. These effects have been calculated assuming that other traits are at their preferred level, between 300 to 379.5 kg for HSCW, 10 to 32 mm for P8 Fat Depth and Fat Colour 0 or 1. The points defining these graphs have been presented in Tables 4.1.16 to 4.1.18, underneath each graph respectively.

Figure 4.1.9. The effect of HSCW on price ($/kg)

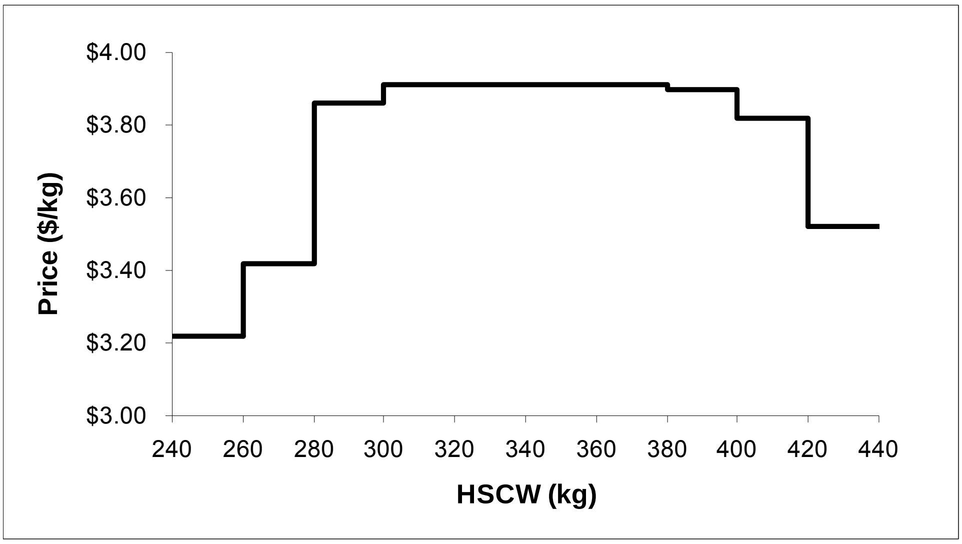


Table 4.1.16. Points defining the grid relationship between Price and HSCW

Carcase Weight (kg)	Price ($/kg)	Distance from 'ideal' (units)
500.0	3.52	
420.0	3.52	1.00
419.5	3.82	
400.0	3.82	0.23
399.5	3.90	
380.0	3.90	0.03
379.5	3.91	
350.0	3.91	
349.5	3.91	0.00
300.0	3.91	
299.5	3.86	-0.13
280.0	3.86	
279.5	3.42	-1.26
260.0	3.42	
259.5	3.22	-1.77
200	3.22	

Note: Distance is always positive. However, for uni-variate distances a negative sign can be used to indicate that the value is less than 'ideal'

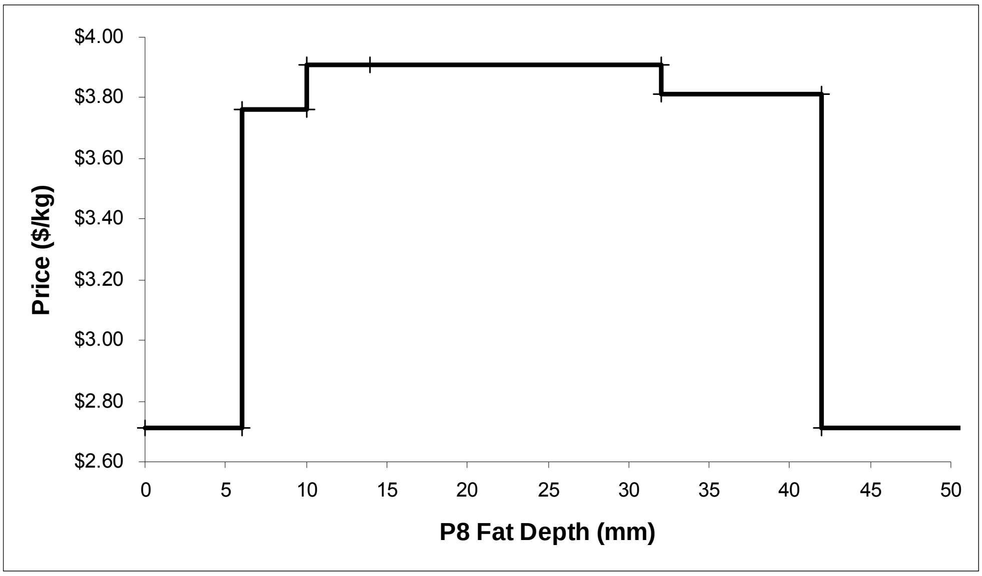


Figure 4.1.10. The effect of P8 Fat Depth on price ($/kg)

Table 4.1.17. Points defining the grid relationship between Price and P8 Fat Depth

P8 Fat Depth (mm)	Price ($/kg)	Distance from 'ideal' (units)
60	2.71	
42	2.71	3.08
42	3.81	
32	3.81	0.26
32	3.91	
14	3.91	
14	3.91	0.00
10	3.91	
10	3.76	-0.38
6	3.76	
6	2.71	-3.08
0	2.71	

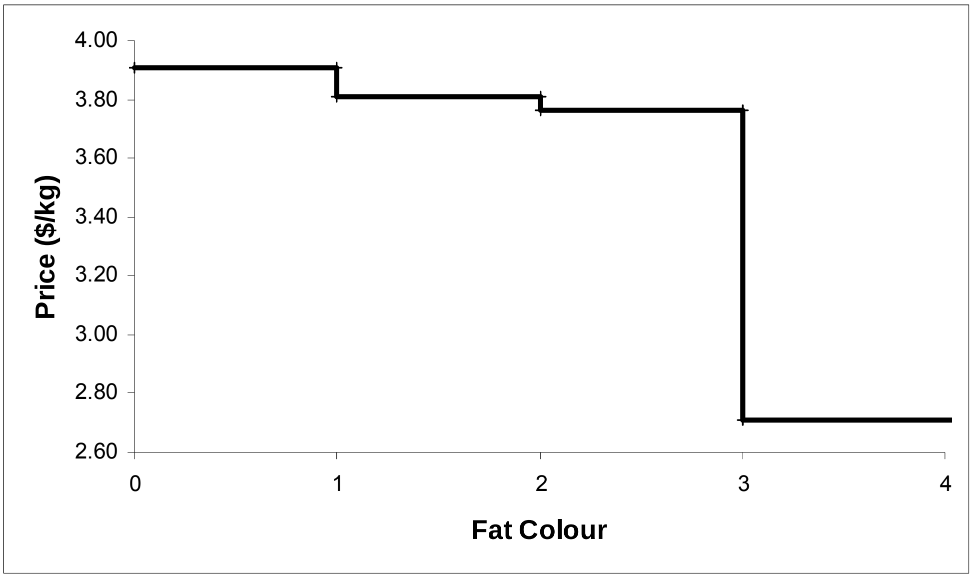


Figure 4.1.11. The effect of Fat Colour on price ($/kg)

Table 4.1.18. Points defining the grid relationship between Price and Fat Colour

Fat Colour (score)	Price ($/kg)	Distance from 'ideal' (units)
9	2.71	
3	2.71	3.08
3	3.76	
2	3.76	0.38
2	3.81	
1	3.81	0.26
1	3.91	
0	3.91	0.00

The discontinuities in the prices may be considered to be cliff faces, as used by the Australian Wheat Board as a descriptor for grain marketing. Alternatively the discontinuities could be considered as steps. The bottom of the cliff (inside of the step would define a lower limit to a continuous price function, while the top of the cliff (outside of the step) would define an upper limit to a continuous price function

The continuous price function suggested by Rutley (2006) was of the form

$$\text{Price} = \text{Maximum Price} - \text{Distance from 'ideal' specification} \times \text{Discount per unit}$$

However, it was found that this simple function creates extremely high premiums and discounts that were considered to be unrealistic in their representation of the value of various carcases. Consequently it was decided to use a price function of the form

$$\text{Price} = \text{Maximum Price} - (\text{Distance from 'ideal' specification})^2 \times \text{Discount per unit}.$$

Such a quadratic function can be defined either from three points, or the vertex and one other point.

The first requirement for a price function based on 'distance to 'ideal' specification' is to define the 'ideal' specification, in this case the most preferred carcase. Cargill Beef's Procurement Manager defined their 'ideal' carcase as weighing 350 kg, with 14 mm fat at the P8 site and a fat colour score of 0.

The second requirement of such a price function is to define the discount rate, the amount of discount for a defined deviation from the 'ideal'. For this study the amount of discount was taken as the smallest price deviation from the maximum price in the grid and the edge of the specification. In this case this discount was 39 cents, the difference between an 'ideal' 350 kg carcase ($3.91/kg) and an over weight carcase greater than 420kg ($3.52/kg). The distance between 350kg and 420kg was defined as 1 unit distance from 'ideal'. These values define the price function as

$$\text{Price}\left(\$/\text{kg}\right) = 3.91 - \left(\text{Distance from 'ideal' specification}\right)^2 \times 0.39$$

This price function can be rearranged to calculate the distance to 'ideal' of each of the points at the bottom of the cliff (inside of the steps). These distances have also been presented in Tables 4.1.16 to 4.1.18.

$$\text{Distance} = \sqrt{\frac{3.91 - \text{Price}}{0.39}}$$

Once the distance to 'ideal' for these defined points of the market specification has been calculated the distance of any other value for all traits in the specification can be calculated using linear interpolation. Thus the uni -variate distances to 'ideal' specification can be calculated for any carcase for each trait in the specification.

Having calculated all uni-variate distances to 'ideal' specification for each trait for a carcase the overall distance to 'ideal' specification can be calculated by combining the separate distances using the method described by Rutley (2006). The overall distance to 'ideal' specification can then be inserted into the price function to calculate the price ($/kg) of the carcase. However, at this stage the price function transects the points at the bottom of the cliff so defining the lower limit of an acceptable price function.

For such a pricing mechanism to be adopted it must be accepted by both the vendors and buyers. To be acceptable to both transacting parties the price mechanism must not favour one party over the other. Therefore to develop an acceptable price function it is necessary to ensure that the average price of carcases traded using the continuous price function is equal to the average price of the carcases calculated using the grid. This was achieved by scaling both the maximum price and the discount rate for the continuous pricing system. When equating the average prices it was necessary to ensure that the minimum acceptable price did not vary. For the 100 day grain fed specification defined above the minimum price was $2.71/kg. This equation produced the following price function.

$$\text{Price}\left(\$/\text{kg}\right) = 3.98466 - \left(\text{Distance from 'ideal' specification}\right)^2 \times 0.39745$$

This scaled price function will allow carcase prices to be calculated as a continuous function of 'distance to 'ideal' specification'. The carcase price can in turn be multiplied by the carcase weight (kg) to calculate the value of the carcase ($).

The measure of overall compliance is given by the parameter 'customer satisfaction'. This is calculated using the combination of the individual distances to the 'ideal' specification for each trait, giving an overall distance from optimal specifications and is expressed as a percentage. The maximum 'customer satisfaction' is 100%, which is given for the ideal carcase. Zero 'customer satisfaction' is given for a carcase which is on the limit of acceptable for all specifications and negative percentages are given to carcases which fall outside overall specifications.

Application of 'distance from specification' (Dfs) technique

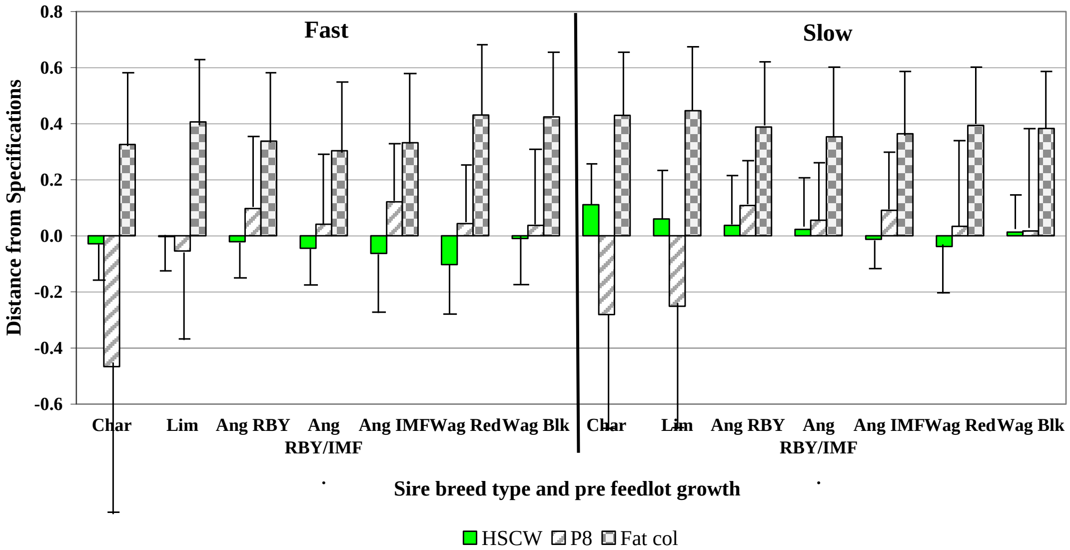


Figure 4.1.12. Comparison of sire breed types within pre-feedlot growth paths for their compliance to specifications as assessed using the 'distance from specification' analysis. The figure shows the mean distance (and standard errors) from optimum for each of the traits – HSCW, P8 and fat colour.

Figure 4.1.12 shows where the various breed types misaligned with optimum carcase specifications using the 'distance from specification' analysis. Clearly the Charolais types in both Fast and Slow growth struggled to meet P8 fat depth requirements. The Limousin type also struggled under Slow growth situations. The same effect of breed type on overall optimum specifications is borne out by the 'customer satisfaction % index' generated by the 'distance from specification' analysis shown in Figure 4.1.13.

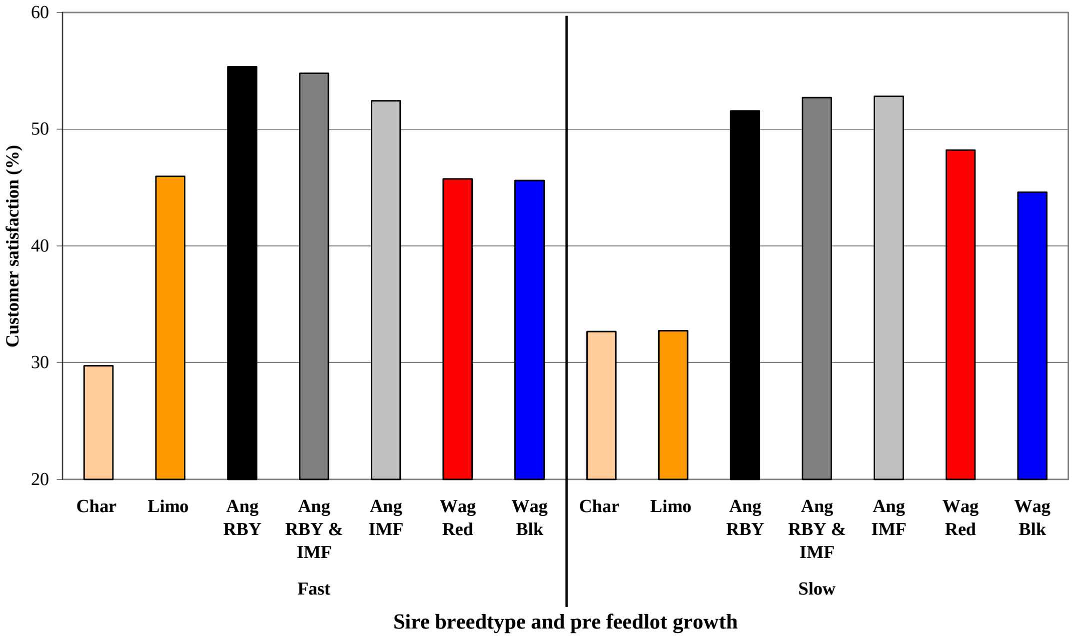


Figure 4.1.13. Comparison of sire breed types within pre-feedlot treatment groups for customer satisfaction index (%) generated by the 'distance from specification' analysis

Table 4.1.19. Comparison of breed types within Slow growth treatment using adjusted mean feedlot entry weights and the distance from specification technique (Dfs) – average carcase price (Dfs $/kg), carcase value (Dfs value $) and $ differences from the highest value breed type plus compliance assessed as customer satisfaction

	Lim	Char	Ang RBY	Ang RBY &IMF	Ang IMF	Red Wag	Blk Wag
Slow growth							
Dfs $/kg	3.75	3.76	3.85	3.85	3.86	3.82	3.84
Dfs value ($)	1355	1379	1370	1364	1353	1330	1355
Value diff ($)	-24	0	-9	-15	-26	-49	-24
Customer satisfaction (%)	**48**	**47**	**60**	**64**	**62**	**60**	**62**
Fast growth							
Dfs $/kg	3.82	3.68	3.86	3.87	3.87	3.83	3.83
Dfs value ($)	1340	1280	1342	1335	1329	1297	1336
Value diff ($)	-2	-62	0	-7	-13	-45	-6
Customer satisfaction (%)	**59**	**43**	**65**	**69**	**64**	**56**	**57**

The Dfs analysis appears to more clearly reward those carcases which fall within the specifications (Table 4.1.19) better than the standard grid system (Table 4.1.11) which showed little difference between breed types in $/kg despite considerable differences in compliance levels (Table 4.1.13). For example the Charolais breed types were clearly leaner than other types and had high proportions (27% and 35% in Slow and Fast growth groups respectively) which did not meet P8 fat specifications and yet financially they were only slightly penalised under the grid system (2 c/kg and 3c/kg respectively). In contrast under the Dfs system the Charolais types were penalised 10 and 20 c/kg respectively. It could therefore be argued that the Dfs system gives a clearer and more precise message in targeting market specifications. The customer satisfaction % (Figure 4.1.13) is an attempt to clearly indicate the ability of the various treatments to achieve market specifications. Figure 4.1.12 graphically demonstrates the areas where the treatments have most effect on the optimum specification traits.

Comparison of pricing systems

It can be seen from Table 4.1.20 that the mean value of carcases were equivalent under the 2 pricing systems and therefore total amount paid by the processor was the same. However there were considerable differences between the pricing systems in the range (and thus the standard deviations) for both $/kg and individual carcase values. Using the Dfs pricing system, carcases closer to optimum specifications receive higher prices/kg while those further away attract more severe discounts than the same carcases valued under the grid system. Thus stronger market signals are conveyed.

Table 4.1.20. Comparison of 'grid' pricing system with 'distance from specification' pricing system for all steers showing the mean, range and standard deviation of the c/kg and $/head (n = 558)

	Grid Price $/kg	Dist. Price $/kg	Grid Value $	Dist Value $
Mean	3.83	3.83	1340.85	1341.25
Range	3.71 – 3.91	3.08 – 3.99	1075.75 – 1536.05	955.00 – 1547.74
s.d.	0.05	0.13	84.59	96.72

4.1.4.5.3 Discussion and implications of meeting specifications

There was a trend for better compliance of the Fast growth treatment to both standard and preferred specifications for almost all traits. The Fast growth path carcases better met both P8 fat and fat colour specifications, resulting in an overall increase in compliance to specifications of about 10%.

The 3 Angus carcase types performed the best in meeting all standard specifications in both Fast and Slow growth treatments whereas types with higher growth potential (particularly the Charolais) had lower compliance levels due to lower P8 fatness and often being overweight even after adjustment for feedlot entry weight.

Due to the financial emphasis placed on weight inherent in grid pricing systems, high growth breed types have much to offer in terms of overall profitability because their extra weight at sale.

The reward for meeting carcase quality specifications is overshadowed by the dominant effect of carcase weight on total carcase value and under current payment systems price signals are too weak to encourage major changes in production systems to better meet these quality specifications. If pricing systems change to increase the emphasis on carcase quality and /or yield traits then price incentives will need to be sufficient to justify changes in breeding and production systems.

These data suggest that in the case of feedlot finished animals, the combination of feedlot entry weight with time on feed will determine the compliance to particular carcase specifications. Breed types with high growth potential need to be treated differently to other types to optimise their advantage. Manipulation of growth paths to suit breed types is warranted.

Grid specifications are a gross method of relaying market signal messages and these messages are often masked by total product value rather than preferred specifications. Distance from specifications analysis may offer a good alternative to pricing carcases with the aim of conveying clearer and more precise market messages.

Processors should consider offering alternative pricing mechanisms if they wish to promote change in carcases being offered to them and also need to fully examine the reliability of the assessment of fat colour and its current impact on carcase value.

4.1.4.6 Economic analyses

4.1.4.6.1 Background methodology

The Beef-N-Omics (BNO) PC software package (Dobos *et al.* 1997, 2006) was used for economic evaluation of the phase of production prior to feedlot finishing (subsequently referred to as “on farm” analyses). This procedure is designed to generate the effects on profitability of a beef herd as a result of changes in management inputs. The program integrates feed budgets and financial gross margin calculations for beef cattle breeding enterprises.

User inputs are required on aspects such as herd size, live weight, calving times, age and weight at turn off, market prices, seasonal pasture growth, and variable costs. The package calculates gross margin per cow, per $100 of livestock capital, per hectare and per tonne dry matter (DM), as well as the monthly feed surplus or deficit.

Adjustments to herd size, monthly pasture growth, months of calving, age and weight of turn off, sale prices, variable costs, cow size, weaning percentage, or other aspects of herd management can be made to assess their impact on feed requirements and herd gross margins. Adjustments to any of those parameters will be reflected in changes in monthly feed consumption and herd gross margin from which principles of beef management can be reinforced. Feedlot induction weights were used for the final weights in the inputs, and these were determined by the “spline analysis” of the growth data, as described above in the “Additional methods” for this site (4.1.3)

Two types of analysis were conducted:-
“Actual” analysis were conducted where the only adjustment made was for differences in age of the weaners at the start of growth treatment – these analyses will be referred to as using “actual” or “unadjusted data”.

Analyses were also conducted where adjustments were made to ensure that each breed type had an average induction weight of approximately 380kg. This adjustment was considered necessary because different breed types had different growth rates but had to be placed in the feedlot on the same day. As a result, some types were too heavy and others too light which consequently resulted in some types receiving price penalties because they were outside of weight specifications at slaughter. The analysis adjusted the average induction weight for each type/growth path combination to an average of 380 kg by adjusting the induction age (time of induction). For slower growing types this analysis calculated the number of additional days to attain induction weight and a daily agistment rate was charged to cover the costs to hold types for additional periods - these analyses will be referred to as using “adjusted data”.

Assumptions used in the input data

Cow weaning percentage:	90%
Bulls per 100 cows	3
Bull life	4 years
Cost of bull	$5,000
Average weight of cows	470kg
Weaning	April
Death rates	1% for adults and weaners
% Cows calving/month	Aug 60%, Sep 30%, Oct 10%.
Cows last joined before culling	9 years of age
% of drys sold	100%
% of other culls	1.5% of herd
Month when drys sold	April
Month when other culls sold	April
Heifers joined	15 months
All replacements purchased @	$1,000 with a calf at foot.
Age of replacements	3 years
Heifer progeny sold at 8 months @	95% of steer weaning weight
Prices for steers	180 ¢/kg (induction weight)
Prices for heifers	165 ¢/kg (weaning weight)
Cull cow weight and price	470kg @ $1.50 ¢/kg
Cull bull weight and price	800kg @ $1.55 ¢/kg
Selling Costs :	
Freight	$8/head
Yard dues & fees	$5/head
Commission	4%
Transaction levy	$3.50/head
Freight costs of buying bulls	$20/head
Health Costs:	
Bulls	$10/head
Cows and calves	$13/head
Weaners $6/head	
Pasture costs for Fast growth rate	$12,000 (includes some irrigation costs)
Pasture costs for Slow growth rate	$2000
Forage oat costs (Fast growth)	$140/hectare

Pastures required to achieve growth rates

Local knowledge was used to determine the proportions of pastures required to finish the steers at the desired rates, as shown in Table 4.1.21.

Table 4.1.21. Areas of pastures required to achieve desired growth rates

	Fast	Slow
Native pasture	40 ha	100 ha
Dryland lucerne/sub clover	50 ha	50 ha
Irrigated lucerne	20 ha	
Forage oats	10 ha	
Total	**120 ha**	**150 ha**

Pasture growth rates were based on data collected in the Riverina for each pasture type, as shown in Table 4.1.22.

Table 4.1.22. Growth rates for various pasture species used in the model (kg/ha/day)

Month	Irrigated Lucerne (Winter active)	Lucerne/sub clover	Native	Forage oats
Jan	94	3	0	0
Feb	83	3	0	0
Mar	62	6	0	0
Apr	44	17	1	0
May	27	16	10	8
Jun	22	14	18	27
Jul	22	14	19	24
Aug	29	19	32	32
Sep	43	31	46	46
Oct	55	48	40	60
Nov	68	21	0	0
Dec	81	4	0	0

"On farm" analyses using unadjusted data

In these analyses, the age at final weight (ready for feedlot entry) was 16 months for the Fast growth treatment groups and 21 months for the Slow.

Stocking rate

It is common practice in southern NSW to give supplementary feed to beef cattle in the late summer/early autumn period. Following consultation with local advisory officers, a maximum monthly pasture deficit of 100 kg per hectare* in the case of the Fast growth enterprises and up to 300 kg per hectare for the Slow growth enterprise was used in the model. The Angus RBY breed type was chosen as a representative breed type and the numbers were progressively increased in BNO until the feed budget showed a deficit of 100kg per hectare for the Fast growth and 300 kg per hectare for the Slow growth analysis*. The resultant stocking rates used were 116 and 67 breeders for the Fast and Slow growth treatments respectively.

Determination of supplementary feed requirements

As the cows were relatively small framed and averaged less than 480 kg in live weight throughout the study period, a loss of 10kg in live weight during the one month (March) was considered normal practice for the Fast growth treatment while a loss of 10kg per month for 2 months was considered normal practice in the Slow growth scenario for cows of this size. In both circumstances the spring flush is considered sufficient to return cows to their original weight. Using the Droughtpack module from StockPlan® (McPhee et al., 2001), feeding at 1.3kg/head/day below maintenance resulted in a loss in weight of 0.33 kg per day or 10kg for the month. Supplementary feed was fed in the Fast growth scenario until the feed deficit in March was -38 kg/ ha for the month*. For the Slow growth scenario, a 10kg/hd/month weight loss allowed in February and March converts to a monthly feed deficit of -18 kg/ ha. Supplementation in other months was made where necessary to reduce the deficit to zero. Supplementary feed was assumed to be 10MJ/kgDM, cost $150/t and 90% DM.

The stocking rates generated by the model were as follows:-

Fast growth treatment - 116 breeders including female progeny till 8 months of age (weaning) and male progeny to 16 months of age.
Slow growth treatment - 67 breeders including female progeny till 8 months of age (weaning) and male progeny to 21 months of age.

*(The Slow growth enterprise allowed for greater deficits because, with lower growth rates required for the steers and the fact that there is no irrigated summer pastures assumed for this enterprise).

Feed deficits for Fast growth options were calculated as follows. 116 head x 1.3kg deficit per day x 30.4 days per month = 4584 kg of allowable feed deficit ÷ 120 hectares = 38 kg per hectare deficit allowed for March.

Deficits for Slow growth options were 67 head x 1.3kg deficit per day x 30.4 days per month = 2648 kg ÷ 150 hectares = 18 kg/ha allowed for February and March.)

“On farm” analyses using “adjusted data”
In these analyses, the most critical variable is the time taken to reach the common weight ready for feedlot induction (380 kg). Slower growing animals and Slow growth treatments take longer, and as a consequence have higher overall maintenance requirements.

As Beef-N-Omics works as a monthly model, the calculated age at induction was rounded to the nearest month for the fastest growing types (Charolais). For the slower growing non-Charolais steer types an additional cost was determined by calculating the additional days required to get to the induction weight, and applying a daily rate for “agistment” (50 cents per head). In Beef-N-Omics this total per head cost was added as an “other cost” against the yearlings. Induction weight means used for all types were generated by the spline analysis and were very close to the targeted 380 kg (range 379 to 382 kg).

It should be noted that because of the differences in pastures and turnoff times we are comparing substantially different grazing systems and it may not be a feasible proposition for some commercial farmers to change from one system to the other. The Fast growth scenario relies on access to 20 hectares of highly productive irrigated pastures to help fill the late summer, autumn feed gap and also on 10 hectares of fodder crop to help fill the autumn, early winter deficit.

While the calculated gross margins account for the annual maintenance costs of managing these different types of pastures, they do not account for the capital investments required to set up the different pastures. Thus, differences in gross margins such as those reported in Table 4.1.25 below (an advantage of $65/cow or $187/ha for the fast versus slow treatment averaged across all breed types) provide an upper bound for the level of investment that could be made in the types of pastures that result in fast growth rather than slow. So for example, if a southern NSW cattle producer could develop 20 hectares of highly productive irrigated pastures to help fill the late summer, autumn feed gap and also 10 hectares of fodder crop to help fill the autumn, early winter deficit, for less than $187/ha, then it is a profitable investment to make. If it would cost more than $187/ha, then it is not a profitable investment to make. However, an investment in an improved pasture system could also be considered in the light of a general increase in the productive capacity and value of the property.

Stocking rate
A total of 67 breeders were run on the low carrying capacity pastures (Slow growth treatment) and 116 breeders on the pastures for the Fast growth treatment, as for the scenarios above.

Cost adjustments for slower growing breeds

Breed combinations that take additional time to achieve market weight incur costs. These include a) interest on sales proceeds that would occur if the fastest growing breed was selected and b) the costs of tying up land for additional periods. A charge of 50 cents per head per day for the additional days (compared to the Charolais groups) that breed X growth combinations required to achieve a 380kg induction weight was considered a fair charge for this activity.

Analyses of production in the feedlot phase (unadjusted and adjusted data)

A spreadsheet model was used to calculate the gross margin outputs for these sections of the analysis. Scenarios using both unadjusted and adjusted data were examined.

Feedlot entry/induction weights were those applicable to the scenario, with price/value of the steers at entry set at a constant $1.80/kg. Feed consumed was based on 2.6% of average bodyweight. This calculation aligned closely with actual feed usage from feedlot information.

Live and carcase weights used were from actual data or those predicted from the spline analysis, in the case of the adjusted scenario.

The following formulae applied:-

Average body weight = (induction weight + (carcase weight ÷ carcase yield) ÷ 2
Dressing percentage was calculated as carcase weight ÷ exit weight x 100
A price of $300 per tonne was assigned for feed prices.
Costs include:

Medicine	$12/head
Labour	$10/head
Interest on steers and feed	8% p.a.
Transaction levy	$3.60/head
Freight	$10.00/head

The value of carcases was based on the Cargill 100 day grain fed grid for July 2005 (Appendix Table 9.1.1). The effect on the gross margin of using a constant price based on the average grid price for all carcase types was also examined. This was $3.81/kg HSCW for carcases based on the actual carcase weights, and $3.83/kg HSCW for the “adjusted analyses”.

Analyses using tightened grid specifications

It is considered likely if not inevitable that abattoir grid specifications will be tightened to provide a stronger signal for producers to supply the desired carcase. In the near future the two most likely traits to undergo tightening of their acceptable ranges will be fat and weight specifications. Yield of retail beef and marbling are also currently under consideration by processors for inclusion in payment systems, but these are not investigated here.

Calculations have been made using projected changes in grid prices for fat and weight specifications, as shown in Table 4.1.23.

Table 4.1.23. Current and projected changes in grid prices for fat and weight specifications.

	Current	Projected
P8 fat depth (mm)		
0-5.5	-$1.20	-$1.20
6-9.5	-$0.15	-$0.15
10-18.5	$0.00	$0.00
19-32.5	$0.00	-$0.10
33-42	-$0.20	-$0.20
Carcase weight (kg)		
420+	$3.52	$3.52
400-419.5	$3.82	$3.82
380-399.5	$3.90	$3.90
360-379.5	$3.91	$3.90
330-359.5	$3.91	$3.91
300-329.5	$3.91	$3.86
280-299.5	$3.86	$3.81
260-279.5	$3.42	$3.42
<259.5	$3.22	$3.22

4.1.4.6.2 Results of analyses using actual/unadjusted data

Charolais steers were the fastest growing animals in both growth treatments, as shown by the feedlot induction and carcase weights in Table 4.1.24.

Angus and Limousin groups performed similarly up to the feedlot stage, but the Limousins produced heavier carcases than the Angus on finishing. Wagyu groups (both Black and Red) generally had the lowest weight, except for the Fast treatment Black Wagyu having similar carcase weight to the Angus types (Table 4.1.24).

Table 4.1.24. Mean feedlot induction and carcase weights for breed types within growth treatment - unadjusted data.

	Induction weight (kg)		Carcase Weight (kg)	
Type\Growth treatment	**Slow**	**Fast**	**Slow**	**Fast**
Angus RBY	380	376	365	352
Angus IMF	394	373	367	347
Angus RBY&IMF	384	376	365	350
Charolais	408	403	392	370
Limousin	389	375	372	356
Wagyu Black	368	372	354	350
Wagyu Red	362	361	346	338
Average	**383**	**376**	**364**	**351**

Gross margins "on farm" - (unadjusted data)

Gross margins for the various treatments are shown in Table 4.1.25. The gross margin returns for the "on farm" production phase was highest for the Charolais steers for both the Fast and the Slow growth treatments (Table 4.1.25).

Table 4.1.25. On farm gross margins per cow and per hectare for breed types within growth treatments – unadjusted data.

	Slow		Fast		Differences Fast vs Slow	
Carcase Type	**Gross margin/ cow**	**Gross margin/ hectare**	**Gross margin/ cow**	**Gross margin/ hectare**	**$/cow**	**$/ha**
Angus RBY	$235	$105	$298	$288	$63	$183
Angus IMF	$249	$111	$300	$290	$51	$179
Angus RBY&IMF	$242	$108	$303	$293	$61	$185
Charolais	$262	$117	$337	$326	$75	$209
Limousin	$245	$109	$308	$298	$64	$189
Wagyu Black	$222	$99	$293	$283	$71	$184
Wagyu Red	$218	$97	$287	$278	$70	$181
Average	**$239**	**$107**	**$304**	**$294**	**$65**	**$187**

Gross margins for feedlot phase - (unadjusted data)

Grid prices paid

Table 4.1.26 shows the weighted average prices ($/kg) that would have been paid for carcases based on the carcase weight, P8 fat depth, fat colour and meat colour. Compared to the other types there was a considerable price penalty for Charolais which was primarily due to a higher proportion of the carcases being overweight. None of the groups achieved the maximum grid price of $3.91, with all having considerable proportions of carcases penalised due to fat colour.

Table 4.1.26. Carcase prices according to Cargill Grid (July 2005) – unadjusted data.

Type	**Slow growth**	**Fast Growth**
Angus RBY	$3.822	$3.816
Angus IMF	$3.832	$3.831
Angus RBY&IMF	$3.819	$3.837
Charolais	$3.738	$3.761
Limousin	$3.803	$3.823
Wagyu Black	$3.826	$3.801
Wagyu Red	$3.819	$3.801
Average	**$3.813**	**$3.813**

Applying the prices paid from Table 4.1.26, gave the carcase values shown in Table 4.1.27. Gross margins were higher for all types in the Slow growth compared to Fast, with returns approximately 14% better on average, due to their compensatory growth (Table 4.1.27). The Charolais steers had the largest difference between growth treatments and fell to the equal poorest returns among the Fast treatment groups.

Table 4.1.27. Feedlot gross margins (per steer) for breed types within growth treatments in the feedlot phase. Actual (variable) prices based on the grid – unadjusted data.

Type	Slow growth	Fast Growth	Difference Slow vs Fast
Angus RBY	$227.03	$195.03	**$32.00**
Angus IMF	$198.60	$186.14	**$12.46**
Angus RBY&IMF	$215.73	$192.98	**$22.75**
Charolais	$228.54	$168.46	**$60.08**
Limousin	$228.52	$217.31	**$11.21**
Wagyu Black	$223.00	$195.26	**$27.74**
Wagyu Red	$206.71	$178.29	**$28.42**
Average	**$218.30**	**$190.50**	**$27.81**

Whilst their growth rates in the feedlot stage were as high as for other breeds, there were additional feeding costs due to their higher average body weight. The higher induction weight also caused a higher initial "purchase" price (hence interest bill) for the Charolais steers, but their outcome was also largely affected by their lower grid value (per kg) due to the proportion having carcase weights over 380 kg.

Outcome using a constant carcase grid value

A "what if" scenario was examined to see the effect of applying a constant grid value to all treatment groups, with the outcome of this exercise shown in Table 4.1.28. This showed a similar outcome to the above, but in this scenario the Charolais did not suffer such a dramatic change in the ranking of gross margins among the Fast groups, although they still had by far the largest difference between Fast and Slow treatment groups.

Table 4.1.28. Feedlot gross margins (per steer) for breed types within growth treatments in the feedlot phase. Constant price of $3.81/kg applied – unadjusted data.

Carcase Type	Slow growth	Fast growth	Difference
Angus RBY	$224.12	$194.33	**$29.79**
Angus IMF	$192.01	$180.25	**$11.76**
Angus RBY&IMF	$213.91	$184.93	**$28.98**
Charolais	$258.34	$188.08	**$70.26**
Limousin	$232.62	$214.10	**$18.52**
Wagyu Black	$218.76	$199.81	**$18.95**
Wagyu Red	$204.98	$182.68	**$22.30**
Average	**$220.68**	**$192.03**	**$28.65**

4.1.4.6.3 ***Results of analyses using "adjusted" data***

Calculation of additional days and costs

As seen above, price penalties were incurred due to over and under weight of carcases of the fastest and slowest growing breed types as a result of the variation in feedlot entry weights. In commercial practice, where individual producers would not have the large range in carcase types examined here, the weight of the animals presented to the feedlot would be much less variable and could be targeted to an optimal average. As discussed in the section on additional methods for this site (4.1.3), the number of days that each breed type required to attain group mean feedlot induction weights of 380kg. (approx. 400 kg final paddock weight) was generated by the "spline analysis" of growth data. The time taken for the Charolais, the fastest growing breed type, to attain the targeted feedlot induction mean was 15 months and 21 months for the Fast and Slow growth treatments respectively. The additional times taken for other breeds to achieve the same target, compared to the Charolais, are shown in Table 4.1.29, which also shows the "agistment" costs charged in the gross margin calculations as a result of this extra time required.

The average additional cost added to cover the retention of livestock beyond 15 and 21 months was $15.89 for Fast treatments and $25.73 for Slow treatments. As discussed in the methodology section, the 50 cents agistment charge represents a charge for the rental value of the land plus an allowance for the opportunity interest on the delay in receiving money for the steers.

Table 4.1.29. Additional time (days) and agistment charges for breed types within growth treatments to attain a feedlot induction weight of 380kg compared to Charolais.

	Additional days to attain 380 kg induction weight		Agistment charged per head at 50¢ per additional day	
Carcase Type	**Slow growth**	**Fast Growth**	**Slow growth**	**Fast Growth**
Angus RBY	53.25	31.75	$26.63	$15.88
Angus IMF	25	30.5	$12.50	$15.25
Angus RBY&IMF	51.5	29.75	$25.75	$14.88
Charolais	0	0	$0.00	$0.00
Limousin	44	31.75	$22.00	$15.88
Wagyu Black	87.75	43.25	$43.88	$21.63
Wagyu Red	98.75	55.5	$49.38	$27.75
Average	**51**	**32**	**$25.73**	**$15.89**

The induction and carcase weights generated from the “spline analysis” that were used for the gross margin calculations in this section are shown in Table 4.1.30.

Table 4.1.30. Mean feedlot induction and carcase weights for breed types within growth treatments - adjusted data.

	Induction weight (kg)		Carcase Weight (kg)	
Type\Growth treatment	**Slow**	**Fast**	**Slow**	**Fast**
Angus RBY	380	380	356	348
Angus IMF	379	380	350	344
Angus RBY&IMF	380	379	354	345
Charolais	381	379	367	347
Limousin	380	380	361	351
Wagyu Black	381	381	353	349
Wagyu Red	383	383	348	338
Average	**380**	**376**	**355**	**346**

Gross margins “on farm” - (adjusted data)

The on farm gross margins for the various treatment groups are shown in Table 4.1.31. The Charolais groups had higher returns compared to all others, and additional price premiums from 1.4¢ to 10.4¢ per kg would need to be received by the other breed types for the same on farm gross margins to be attained.

Table 4.1.31. On farm gross margins per cow and per hectare for breed types within growth treatments and price premiums required for gross margins to equal Charolais – adjusted data.

	Slow		Fast		Difference Fast vs Slow		Additional premiums required (¢/kg) for equivalent gross margin per hectare to Charolais	
Carcase Type	**Gross margin /Cow**	**Gross margi n /ha**	**Gross margin /Cow**	**Gross margin per ha**	**$/cow**	**$/ha**	**Slow**	**Fast**
Angus RBY	$209	$93	$274	$265	$66	$172	2.7 ¢	6.1 ¢
Angus IMF	$220	$98	$280	$270	$60	$172	1.4 ¢	3.0 ¢
Angus RBY&IMF	$214	$95	$279	$270	$65	$174	2.1 ¢	4.7 ¢
Charolais	$232	$103	$296	$286	$64	$182	0.0 ¢	0.0 ¢
Limousin	$215	$96	$284	$274	$69	$178	2.0 ¢	4.3 ¢
Wagyu Black	$196	$88	$270	$261	$74	$174	4.3 ¢	9.7 ¢
Wagyu Red	$194	$87	$273	$264	$79	$177	4.6 ¢	10.4 ¢
Average	**$211**	**$94**	**$279**	**$270**	**$68**	**$176**		

Gross margins for feedlot phase - (adjusted data)

Table 4.1.32. shows the comparison of grid values using adjusted carcase data compared to the previous calculations using unadjusted. The differences were only just over 1 cent/kg on average. However the most notable feature was in the Charolais groups, where prices improved by 8¢ and 6¢ for the Slow and Fast growth treatments respectively. Table 4.1.33 shows the gross margins for the various groups, using the grid prices for adjusted data.

Table 4.1.32. Comparison of grid values (¢/kg HSCW) using actual (unadjusted) data compared to adjusted.

	Using unadjusted carcase data		Adjusted carcase data	
Carcase Type	**Slow Growth**	**Fast Growth**	**Slow Growth**	**Fast Growth**
Angus RBY	$3.822	$3.816	$3.832	$3.839
Angus IMF	$3.832	$3.831	$3.842	$3.843
Angus RBY&IMF	$3.819	$3.837	$3.834	$3.850
Charolais	$3.738	$3.761	$3.817	$3.821
Limousin	$3.803	$3.823	$3.810	$3.820
Wagyu Black	$3.826	$3.801	$3.827	$3.816
Wagyu Red	$3.819	$3.801	$3.829	$3.825
Average	**$3.813**	**$3.813**	**$3.829**	**$3.834**

Table 4.1.33. Feedlot gross margins (per steer) for breed types within growth treatments in the feedlot phase – adjusted carcase and grid values. Also shown are the price premiums required to match the best performing groups within growth treatments.

Carcase Type	Slow growth	Fast Growth	Difference Slow vs Fast	Price premium to match Charolais Slow Growth	Price premium to match Limousin Fast Growth
Angus RBY	$204.63	$178.35	$26.28	8.2 ¢	3.0 ¢
Angus IMF	$186.37	$165.73	$20.64	13.5 ¢	6.7 ¢
Angus RBY&IMF	$196.99	$175.60	$21.39	10.4 ¢	3.8 ¢
Charolais	$233.61	$173.92	$59.69	0.0 ¢	4.2 ¢
Limousin	$215.02	$188.63	$26.39	5.1 ¢	0.0 ¢
Wagyu Black	$190.99	$175.07	$15.92	12.1 ¢	3.9 ¢
Wagyu Red	$169.48	$139.12	$30.36	18.4 ¢	14.7 ¢
Average	**$199.58**	**$170.92**	**$28.67**		

As found previously in the gross margins using unadjusted data, the Slow growth treatments consistently out performed the Fast. The Charolais groups again showed a difference of $60 per head in favour of the Slow treatment. The differences between treatments for the other types were more consistent than when the unadjusted data were used, but the average was similar, and much lower ($29) compared to the Charolais.

Outcome using a constant carcase grid value

Again a "what if" scenario was examined to see the effect of applying a constant grid value to all treatment groups, with the outcome of this exercise shown in Table 4.1.34. This showed a similar outcome to the same exercise for the unadjusted data in that the gross margins and the ranking of the types were similar using constant or variable grid values.

Table 4.1.34. Feedlot gross margins (per steer) for breed types within growth treatments in the feedlot phase. Constant price of $3.832/kg applied – adjusted data.

Carcase Type	Slow growth	Fast Growth	Difference
Angus RBY	$204.63	$178.35	**$26.28**
Angus IMF	$182.87	$161.95	**$20.92**
Angus RBY&IMF	$196.28	$169.39	**$26.89**
Charolais	$239.11	$177.74	**$61.37**
Limousin	$222.95	$192.84	**$30.11**
Wagyu Black	$192.75	$180.65	**$12.10**
Wagyu Red	$170.52	$141.49	**$29.03**
Average	**$201.30**	**$171.77**	**$29.53**

Impact of tighter grid specifications

As previously discussed, there are likely to be changes in the processing industry through the implementation of more stringent specifications for the traits that affect carcase value. Table 4.1.35 shows the comparison of carcase values using the standard grid specifications (July 2005 Cargill grid), as generally used for the gross margin calculations, against a proposed "tightened" grid as described in the methods above (Table 4.1.23).

Table 4.1.35. Comparison of carcase values based on specifications of the July 2005 grid or on proposed "tightened" specifications (for weight and fat) – adjusted carcase data.

	July 2005 grid		Tightened grid	
Carcase Type	**Slow growth**	**Fast Growth**	**Slow growth**	**Fast Growth**
Angus RBY	$3.832	$3.839	$3.826	$3.831
Angus IMF	$3.842	$3.843	$3.829	$3.834
Angus RBY&IMF	$3.834	$3.850	$3.823	$3.848
Charolais	$3.817	$3.821	$3.814	$3.809
Limousin	$3.810	$3.820	$3.802	$3.808
Wagyu Black	$3.827	$3.816	$3.823	$3.805
Wagyu Red	$3.829	$3.825	$3.817	$3.806
Average	**$3.829**	**$3.834**	**$3.821**	**$3.823**

With tighter specifications for weight and fat, prices were reduced by around 1¢/kg on average, which was fairly consistent across all types. With such minor changes in price, the resultant gross margins (Table 4.1.36) showed little variation from those previously calculated (Table 4.1.34), with almost identical ranking of the types within growth treatments.

Table 4.1.36. Feedlot gross margins (per steer) for types within growth treatments using carcase prices based on tightened grid specifications.

Carcase Type	Slow growth	Fast Growth	Difference
Angus RBY	$202.49	$178.00	**$24.49**
Angus IMF	$181.82	$162.64	**$19.18**
Angus RBY&IMF	$193.06	$171.46	**$21.60**
Charolais	$231.51	$184.42	**$47.09**
Limousin	$212.13	$174.29	**$37.84**
Wagyu Black	$189.58	$171.24	**$18.34**
Wagyu Red	$165.31	$132.69	**$32.62**
Average	**$196.56**	**$167.82**	**$28.74**

4.1.4.6.4 Discussion of economic analyses

Using the unadjusted data, there was a huge difference between the Fast and Slow treatments favouring the Fast grown in the on farm analyses (gross margin of $65/cow and $187/ha advantage over the Slow grown), even after accounting for the higher cost of producing pasture capable of sustaining faster growth. This was primarily due to steers being sold earlier allowing more cows to be run on the pastures for the Fast growth treatment, whilst still maintaining the same annual and monthly pasture deficits. This advantage also shows in the return per $100 of livestock capital because, with faster growth, there is less money tied up in stock on hand.

Although the average difference between Fast and Slow growth treatments was $187/ha, within breed types this difference varied with the Charolais the highest at $209/ha and the Red Wagyu the lowest at $181/ha with the other breed types intermediate . It is postulated that this is a reflection of the growth potential of the various breed types and when a potentially faster growth type is given the opportunity to grow it performs better under those more favourable conditions.

The biggest driver of profitability between breed types was weight and weight gain achieved within treatments. The Charolais breed type, even within the slower growth treatment, outweighed and outperformed all other breed types. The Red Wagyu type, the slowest growing, performed worst.

During the feedlot phase, using the unadjusted data, those steers entering the feedlot at heavier weights also exited at heavier weights and were considerably discounted for being overweight at the end (a function of the research design requiring feedlot entry at the mean target entry averaged over all types). Therefore breed types like Charolais were heavily discounted on exit ($3.738/kg and $3.761/kg in the Slow and Fast treatments compared to the treatment averages of $3.813/kg for both). Despite this the Charolais type in the Slow treatment still had the highest gross margin due to a substantial benefit in overall carcase value where their total weight advantage compensated for the $/kg disadvantage. The Charolais weight advantage was considerably enhanced by the higher than treatment average compensatory effect in feedlot gain in the Slow growth group.

Within the Fast growth group, this growth advantage did not occur, reducing the overall weight advantage of the Charolais, allowing the discounts to have more of an effect, and resulting in them being ranked near last compared with the other breed types.

There was a considerable advantage in weight gain to the Slow growth groups (2.54kg/day) compared to the Fast groups (2.39kg/day), occurring across all breed types and resulting in an average advantage at finish of 13kg of carcase weight and hence $ value. This was the major factor in the higher gross margin of the Slow treatment group compared to the Fast.

As discussed above, adjustments were made to feedlot entry, exit and carcase weights and carcase fatness, to account for differences imposed due to project design. These adjustments help compare animals at closer to real world conditions where they would generally be treated as homogenous groups rather than disparate groups as imposed by the project design.

As in the unadjusted data analysis the Fast group achieved substantially better gross margins per ha and per cow than the Slow group. In this instance an average advantage of $176/ha, slightly lower than the unadjusted result but still sufficient to confirm this advantage and be confident in these results. This clear advantage to Fast growth over Slow (on average and across breed types), and its magnitude, suggest there is considerable margin for even greater costs (supplementary feeding, pasture improvement, etc) to be absorbed to achieve a faster pre-feedlot growth. Again the Charolais type showed the biggest margin between Slow and Fast as well as having the overall best gross margins in both the Fast and Slow groups. Again the Red Wagyu the worst.

Performance at the feedlot within this analysis reflected those results from the unadjusted analysis including the much poorer performance of the Fast grown Charolais type, however the ranking of types was similar.

With tighter specifications for weight and fat, prices were reduced by only 1¢ on average, which was fairly consistent across types.

Irrespective of the method used (adjusted or unadjusted data), when the economic analysis of pre-feedlot and feedlot are considered together they are obviously not complementary. The highest gross margins in the pre-feedlot phase were produced by the Fast growth treatment groups, whereas the Slow growth treatments performed better in the feedlot. However, the magnitude of the economic advantage pre-feedlot, combined with the improvements in carcase traits reported above, certainly favour the Fast growth option.

4.2 Details, Results and Discussion – Vic site (Hamilton)

4.2.1 Summary

At the Victorian site (Hamilton), Fast and Slow growth paths were imposed post weaning on autumn and spring born progeny that were bred from sires chosen for high IMF%, high RBY% or for both traits. The weaners were grown to 550 kg and slaughtered, the Fast treatment path averaging 22.2 months at slaughter, and the Slow growth path averaging 27.9 months. The 645 progeny produced were from cows derived from the Multi-Breed project (Graham *et al.* 2002). These comprised Angus, Angus x Hereford, Hereford x Angus, Angus x Limousin, Hereford x Limousin, Angus x Simmental and Hereford x Simmental.

Growth treatment influenced all fatness traits. Animals given the faster growth treatments, slaughtered at the same liveweight but younger age had greater subcutaneous and intramuscular fat (IMF%). The cattle grown faster also had a higher dressing percentage, but with yield unaffected. Sire carcase type significantly influenced all liveweight and carcase traits. Within the Angus progeny, those of sire types chosen for high RBY% or high IMF% differed in the fat, IMF% and RBY% carcase traits, but differences in live or carcase weights were not significant. This demonstrates that EBV's (as generated by BREEDPLAN) can be used with confidence, and that important carcase traits can be influenced without compromising live or carcase weights. The lack of interactions between growth treatment and sire type indicates that the ranking of progeny for different traits would be similar under different growth regimes.

Most traits in the progeny were influenced by the sire breed of the dam indicating the importance of considering both cow and sire breed when targeting specific markets. There were no dam breed by sire type interactions in the effects on the progeny.. There was little difference in carcase traits due to calving season, however autumn born weaners at the same age were heavier at weaning than those born in spring.

Proportions of carcases meeting the price grid for grass-fed cattle were examined. Whilst the percentages of carcases meeting both fat and HSCW specifications were low overall, the

Limousin sired progeny had the best compliance rates and the Wagyu sired progeny the worst, due largely to carcases failing to meet the weight specifications. Whilst differences were small, there was a trend for the Angus sire types selected for higher RBY% to have more progeny meeting market specifications than those selected for high IMF%. An analysis technique examining “distance from specifications” indicated that the Limousin sired cattle had a larger percentage meeting customer requirements, with little difference between the Angus sire types, particularly on the Fast growth path. The index of customer satisfaction was most affected by growth treatment in the higher IMF% sire types. Both the Wagyu and the high IMF% Angus progeny grown on the Slow growth path tended to have lower ratings of customer satisfaction.

Economic evaluation of the data indicated the importance of finishing cattle on a Fast growth path, which enables faster turnover, and allows more breeders to be run. Whilst the highest gross margin/cow was achieved with a Slow growth group, the highest gross margin per ha was achieved using a Fast growth path post weaning. The economic analysis also showed the importance of heavier slaughter weights, highlighted by the poorer performance of the Wagyu progeny compared to others.

4.2.2 Background

This is part of an overall study which was designed to determine the most appropriate growth pathways for progeny of sires that differ in genetic potential for carcase and/or growth traits, to increase product value and herd productivity in southern Australian herds. This section of the report covers results from the site in south-western Victoria (Hamilton).

The site is situated in a rainfall zone with winter dominance and traditionally has lush pasture growth during spring. This usually allows slaughter animals to be finished off pasture to achieve commercial carcase weights.

4.2.3 Additional methods

The general design and methodology of the Regional Combinations project was described by McKiernan *et al.* (2002). Further details particular to this site now follow.

The choice of sires was similar to other sites. Here sires of high RBY% potential were drawn from Belgian Blue, Limousin and (high yielding) Angus bulls (all classified as high RBY%); those of high IMF% potential were drawn from (high IMF%) Angus and Wagyu (Black) bulls (classified as high IMF%); and those with potential for both high RBY% and high IMF% were drawn from Angus and Red Wagyu bulls (classified as high IMF% & IMF%). These are subsequently referred to as the various “classes” (RBY, IMF, RBY&IMF) and “types” of sires (within classes – Angus RBY, Limousin etc.). EBV’s for the traits of interest were used in selection of the Angus sires. Matings were to cows derived from the Multi-Breed project (Graham *et al.* 2000). These comprised Angus, Angus x Hereford, Hereford x Angus, Angus x Limousin, Hereford x Limousin, Angus x Simmental and Hereford x Simmental genotypes.

The design at the Hamilton site comprised faster and slower growth treatments applied between weaning and finish, and was conducted in both autumn and spring calving herds (mean birth dates 15th March and Sept 7th), with a target slaughter liveweight of 550 kg. The mean weaning date of the autumn calves were was 29th Dec, and the spring calves on 27th April. These growth paths resulted in animals being slaughtered at an average age of 22.2 months for the Fast group and 27.8 months for the Slow group. A total of 645 calves were born.

The different growth paths were achieved by preferential pasture allocation and by supplementary grain feeding (at pasture and in a feedlot) when required to reach finishing weights. Liveweights were monitored and the groups managed so that the autumn low and spring Fast groups were slaughtered together, as near to the target slaughter weight as possible.

Comprehensive carcase data (AUS-MEAT 1996) were collected at the abattoir kill floor and in the chiller. Carcases were also examined with VIAscan imaging equipment in the chiller (Ferguson *et al.* 1995) to estimate retail beef yield as well as other traits. All chiller assessments (except VIAscan yield) reported here are those taken by MSA-accredited technicians. Samples of meat from the striploin (*M. longissimus lumborum*) – (cut 2140 AUS-MEAT 1998; cut "STA" MSA classification) were taken at boning and stored frozen for later analysis of IMF% (Perry *et al.* 2001). MSA feedback data were used for analyses of carcase traits.

Economic evaluation was conducted using gross margin analyses with the aid of the Beef-N-Omics package (Dobos *et al.* 1997;2006).

Carcase data were examined for compliance to specifications using 2 systems. The first of these was for compliance to the abattoir grid as for the usual method of payment. The second used an alternative system of assessing compliance and valuing carcases based on the "distance from specifications" model developed by Rutley (2006), which calculates the distance for each trait from the nominated specifications of an "ideal carcase". The system is more fully described in the analysis of "Meeting Specifications" in the section of this report for the NSW site.

Statistical analysis procedures were similar for all sites, and used the PC software package Genstat 9 (2006), with a linear mixed model REML procedure. The analysis model for each site was modified from that used for NSW as described in the general Methodology section (3.2).

4.2.4 Results and Discussions

4.2.4.1 Growth paths achieved

Figure 4.2.1 shows the growth paths achieved throughout the course of the experiment from the first weaning in January 2002 till the final slaughter in July 2005. These generally met the aims of the design, with a mean of 5.6 months difference in age at slaughter between Fast and Slow growth treatments.

The mean post weaning growth rates of the autumn born Fast and Slow growth paths were 0.60 and 0.47 kg/day respectively, and for the spring born groups, 0.77 and 0.54kg/hd/day respectively, giving and overall mean of 0.67 and 0.49 for the Fast and Slow treatment groups respectively.

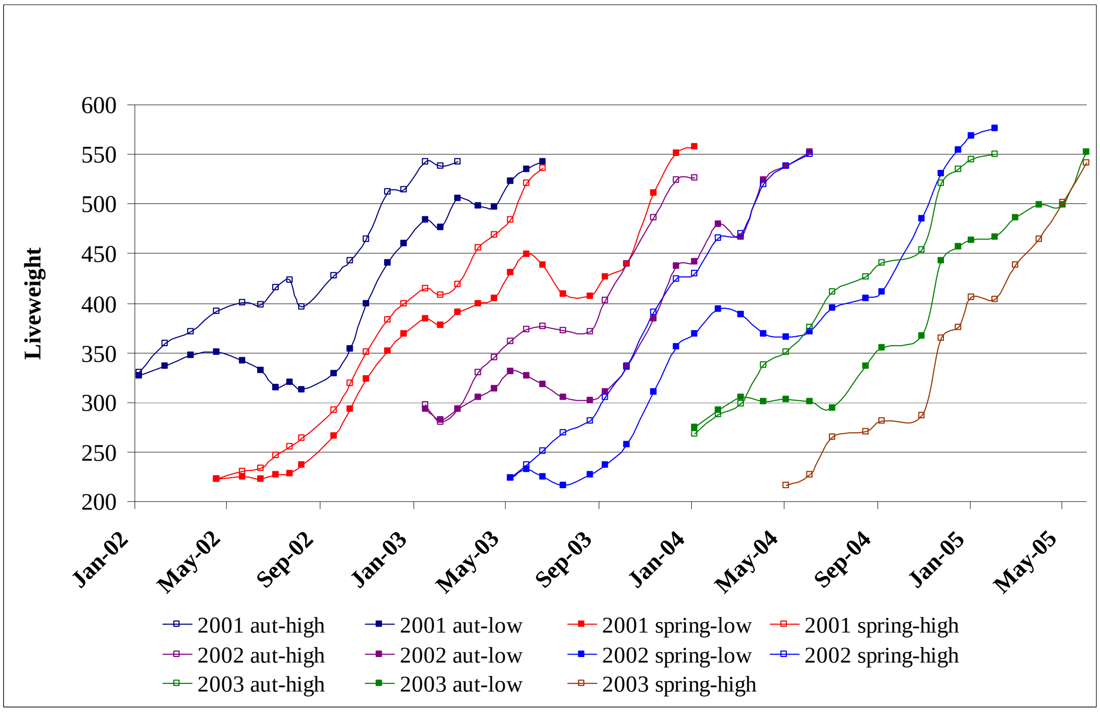


Figure 4.2.1. Liveweight changes from weaning to slaughter for the different growth paths 2002 – 2005.

4.2.4.2 Effect of growth treatment

Growth treatment affected slaughter weight, dressing percentage, P8 Fat depth, marble score, IMF%, and ossification (Table 4.2.1). Whilst the project aimed to have cattle from both growth paths slaughtered at the same liveweight, the cattle given Slow treatment were 11.9 kg heavier at slaughter than those given the Fast. There was no effect of growth path on HSCW, however the Fast growth path had a higher dressing percentage (53.2 vs 52.3%),

Cattle given the Fast growth treatment were fatter at the P8 site (12.8 vs 11.4mm) had higher MSA and US marble scores (1.49.vs 1.25 and 377.9 vs 349.8), as well as higher IMF% (3.1 vs 2.6%). They also had higher scores for predicted eating quality (PEQ) for the striploin cut (53.5 vs 52.1%), as generated by the MSA model (Thompson 2002) . VIAscan carcase yield was not significantly affected by growth treatment. Although the difference between Fast and Slow growth treatments was not significant, eye muscle area (EMA) tended to be higher in the Fast groups of most sire types. However the reverse trend for the Belgian Blue progeny caused a significant interaction effect of growth treatment by sire type (Figure 4.2.3)., When the Belgian Blue progeny were omitted from the analysis, the interaction no longer applied, and the cattle given the Fast growth treatment had significantly higher EMA than those on the Slow (results in brackets for EMA in Table 4.2.1).

Table 4.2.1. Effects of growth treatment on weight and carcase traits. Co-variates of age at start of treatment or HSCW were applied to weight and carcase traits as applicable.

	Fast	Slow	s.e.d	P
N	331	284		
Slaughter liveweight (kg)	538.6	550.5	±4.01	0.016
HSCW (kg)	289.9	293.5	±2.14	= 0.98 ns
Dressing %	53.2	52.3	±0.15	0.031
P8 fat depth (mm)	12.8	11.4	±0.41	<0.001
MSA Rib fat depth (mm)	7.2	6.6	±0.27	0.011
MSA AUS marble score	1.49	1.25	±0.04	<0.001
MSA US marble score	377.9	349.8	±5.99	<0.001
IMF%	3.05	2.64	±0.11	<0.001
MSA EMA (sq cm) #	73.9; (74.8)	73.2; (73.0)	±0.73; (±0.65)	ns; (<0.006)
VIAscan Carcase yield %	68.6	68.7	±0.14	= 0.064 ns
MSA Eating quality	53.5	52.1	±0.2	<0.001
Ossification	158.9	192.3	±1.92	<0.001

 # The difference due to growth treatment was not significant, however there was a growth treatment by sire type interaction (Figure 4.2.3). Figures in brackets apply to analysis excluding Belgian Blue progeny.

4.2.4.3 Effects of sire type

There were significant effects of sire type on all birth, weight and carcase traits (Table 4.2.2). It should be noted that there were considerably fewer progeny of the Belgian Blue and Red Wagyu sires, which requires caution to be taken in using their results.

4.2.4.3.1 Liveweight traits

The Belgian Blue (41.6 kg) and Limousin (41.0 kg) sires had significantly heavier calves at birth and the Wagyu the lightest (34.6kg). This trend followed through to weaning with the Belgian Blue producing heavier calves (266.9) than both Wagyu and Red Wagyu sire types (238.5 and 249.4kg). The Wagyu sires produced lighter calves than all the other types. (Table 4.2.2). Just prior to slaughter, the progeny of the 2 Wagyu sire types were significantly lighter (502.1 and 514.6kg) than all the other types. Differences between the liveweights of the progeny of the other sire types were not significant.

4.2.4.3.2 Carcase Traits

HSCW – This followed a similar pattern to the sire progeny differences in pre-slaughter liveweight, progeny of both the Wagyu and Red Wagyu types had lighter carcases (262.9 and 274.8kg) than the other sire types. There were no significant differences between the Angus sire types.

P8 Fat Depth – Whilst there was a trend for the P8 fat depth of the progeny of the Angus sires chosen for higher IM% to be fatter than those chosen for high RBY%, differences were not significant (Table 4.2.2). The Limousin (9.12mm) and Belgian Blue sired progeny (7.5mm) had lower P8 measurements than the Angus selected for high IMF% (14.4mm) and both Wagyu and Red Wagyu types (13.2 and 14.3mm). There was a sex by sire type interaction with this trait (Figure 4.2.2). While the female progeny of all sire types had greater P8 depths than the males, the ranking of types within sex was different for the Angus IMF% and Wagyu types.

Table 4.2.2. Effects of sire type on gestation, liveweights and carcase traits.

Trait	Belgian Blue	Limousin	Angus RBY	Angus RBY & IMF	Angus IMF	Red Wagyu	Wagyu	s.e.d	P
N	21	108	152	84	169	17	99		
Gestation length (days)	282.9bc	287.7a	282.9bc	281.2b	282.3bc	285.1ac	286ac	±1.38	<0.001
Birth weight (kg)	41.6a	41a	37.7b	37.2b	36.6bc	37.2b	34.6c	±1.16	<0.001
Weaning weight (kg)	266.9a	261.5ab	261.9ab	259.4ab	258.1ab	249.4bc	238.5c	±7.6	<0.008
Slaughter liveweight (kg)	562.7a	552.5a	566.3a	556.6a	561.7a	514.6b	502.1b	±11.47	<0.001
HSCW (kg)	306.8a	298.8ab	295.7ab	294.6b	293.9b	274.8c	262.9d	±5.9	<0.001
Dressing %	54.4a	53.9b	52.2cd	52.3cd	52d	52.5c	51.8d	±0.22	<0.001
P8 fat depth (mm) *	7.5b	9.1b	11.7a	13.1a	14.3a	14.3a	13.2a	±1.39	<0.001
MSA Rib fat depth (mm)	3.9c	5.2c	6.8b	7.5ab	8.5a	8.0ab	8.1ab	±0.8	<0.001
MSA AUS marble score	0.75c	0.91c	1.38b	1.55ab	1.6ab	1.72a	1.5ab	±0.14	<0.001
MSA US marble score	276.5abc	297.4ab	361.8bc	381.6abc	392.9abc	409.3a	373.7bc	±17.5	<0.001
IMF%	1.5c	1.9c	2.8b	3ab	3.5a	3.5a	3.4a	±0.27	<0.001
MSA EMA (sq cm) #	75.7ac	76.5a	71.8b	72.3bc	72.6bc	70.4b	75.2ac	±1.77	<0.001
VIAscan Carcase yield %	70.9b	70a	68.6c	68.3c	67.5d	67.7d	67.8d	±0.38	<0.001
MSA eating quality	50.3d	50.7d	52.8b	53.6bc	53.9ab	54.5ac	53.3b	±0.59	<0.001
Ossification	180	179.1	175.9	177.3	174.2	169.5	173.4	±4.47	0.451

* There was a sex by sire type interaction (P<0.008) (s.e.d. ± 1.67) (Figure 4.2.2)
# There was a growth treatment by sire type interaction (P<0.027) (s.e.d. ± 2.03) (Figure 4.2.3)

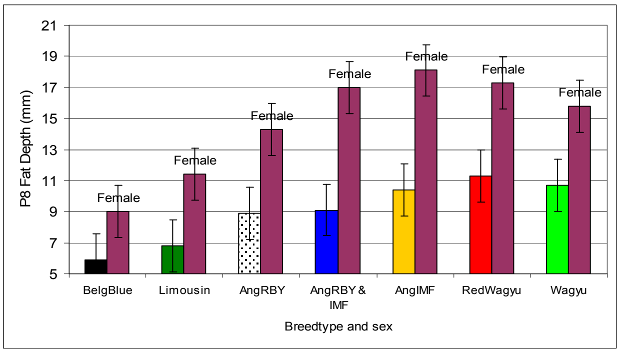


Figure 4.2.2. Effect of sire type and sex on P8 fat depth.

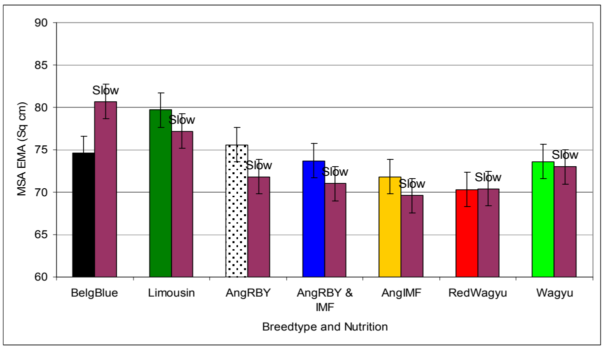


Figure 4.2.3. Effect of sire type and growth treatment on EMA.

Gestation length - Gestation lengths in the progeny of the Limousin (287.7days) and both the Wagyu (286days) and Red Wagyu (285.1 days) were significantly greater than for the progeny of the other 4 sire types (Table 4.2.2).

Rib Fat Depth – Progeny of Angus sires selected for high RBY% had a significantly lower rib fat depth (6.8mm) than those from Angus sires selected for high IMF% (8.5mm) and those from both Wagyu sire types (8.0 and 8.1mm) (Table 4.2.2).

Marble Score – Progeny from high IMF Angus sires had higher marbling (1.6 and 393 – AUS and US marble scores) than progeny of Angus sires selected for high RBY%. (1.3 and 362). There was no significant difference between the progeny of the Angus sires selected for high IMF % and those from Wagyu sires. The Progeny of the Belgian Blue (0.75 and 277) and Limousin sires (0.91 and 297) had lower marble scores than all the other sire types (Table 4.2.2).

IMF% - Progeny of all sires selected for high IMF%, (including the Wagyu sires but excluding the Angus sires selected for both high IMF% and high RBY%) had higher IMF% than those selected for high RBY% (including the Belgian Blue and Limousin) (Table 4.2.2).

EMA – There was no significant difference in the EMA of progeny from the different Angus sire types. The Limousin sired progeny had significantly higher EMA (76.5sq cm) than those from all sires apart from the Belgian Blue (75.7sq cm). The progeny of sires selected for high RBY% and grown on the Fast growth path tended to have larger EMA's, as did the progeny of other sire types apart from the Belgian Blue (Figure 4.2.3).

VIAscan Carcase yield % - The yields for the progeny of the Angus sires selected for high IMF% (67.5%) and from both the Wagyu (67.8 %) and Red Wagyu (67.7%) were significantly lower than those for the Angus selected for high RBY% for both RBY% and IMF% (68.6 and 68.3%%) and the Limousin (70%) or Belgian Blue (70.8%). Both the high yielding sire types, Limousin and Belgian Blue produced progeny that yielded significantly higher than for all other sire types (Table 4.2.2).

Dressing Percentage - Progeny of both the Limousin (53.9%) and Belgian Blue (54.4%) had significantly higher dressing percentages than the other 5 sire types (Table 4.2.2).

4.2.4.4 Effect of sire carcase class

Effects of sire carcase class on liveweight and carcase traits are shown in Table 4.2.3.

Table 4.2.3. Effect of sire class on liveweight and carcase traits.

Trait	Angus RBY	Angus RBY & IMF	High IMF	s.e.d	P
N	281	101	268		
Gestation length (days)	284.8	282.6	284.3	±2.35	= 0.184 ns
Birth weight (kg)	40.9a	36.3b	35.6b	±0.96	<0.001
Weaning weight (kg) *	263	256	249	±8.4	= 0.091
Slaughter liveweight (kg) **	549	540	545	±7.65	<0.001
HSCW (kg)	290.6	289.3	288.5	±6.08	= 0.098 ns
Dressing %	53.4	52.4	52	±0.89	= 0.238 ns
P8 fat depth (mm)	10.7b	12.1a	13.3a	±0.92	<0.001
MSA Rib fat depth (mm)	5.4b	7.6a	8.2a	±0.96	<0.004
MSA AUS marble score	1.2b	1.4a	1.5a	±0.07	<0.001
MSA US marble score	314b	394a	384a	±32.36	<0.001
IMF%	2.09b	3.2a	3.4a	±0.47	<0.005
MSA EMA (sq cm)	75.4a	73.5a	71.6b	±1.34	<0.001
VIAscan Carcase yield %	69.8a	68.0b	67.7b	±0.23	<0.001
MSA Eating quality	52.2b	53	53.3a	±0.4	<0.001
Ossification	178.5	178.4	174.8	±2.3	= 0.149 ns

***** There was a season of calving by sire class interaction (Figure 4.2.4)
** There was a season of calving by sire class interaction (Figure 4.2.5)

4.2.4.4.1 Liveweight traits

Sire class did not significantly affect birth weight, however the weaning weights of the autumn born calves sired by the high RBY bulls (283.3kg) were heavier than the spring born calves sired by all sire classes (Figure 4.2.4) (P<0.027, s.e.d ±16.6). The effect of sire class was not significant for pre slaughter weight, but there was a significant (P<0.023) sire class by calving season interaction (Figure 4.2.5), with the spring born high IMF cattle being significantly heavier (560.9kg) than the autumn born high IMF (528.6kg) and RBY&IMF cattle (531.8kg) (s.e.d . ±16.69.4)

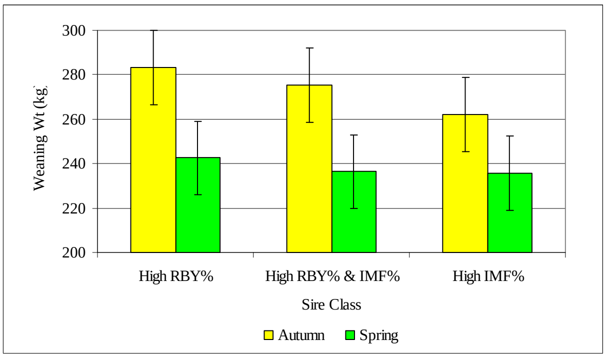


Figure 4.2.4. Effect of sire class and calving season on weaning weight.

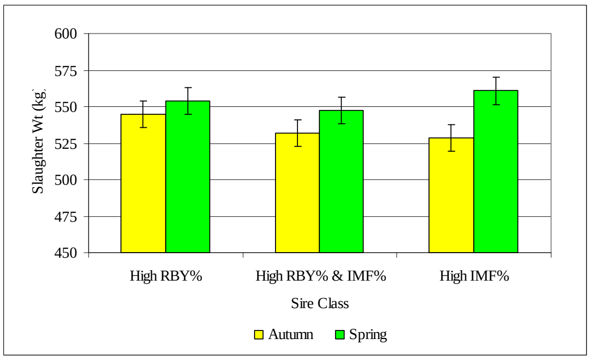


Figure 4.2.5. Effect of sire class and calving season on pre slaughter liveweight.

4.2.4.4.2 Carcase traits

Sire class had a significant effect on most carcase traits; P8 and rib fat depth, marble score, IMF%, eye muscle area (EMA) and VIAscan carcase yield (Table 4.2.3).

P8 and rib fat depth - The progeny of the high RBY sire class bulls had less fat at the P8 site (10.7mm) than those sired by the High IMF bulls (13.3mm) (Table 4.2.3). The animals sired by the high RBY bulls also had less rib fat (5.4mm) than those sired by the high RBY&IMF (7.6mm) , or high IMF bulls (8.2mm) (Table 4.2.3).

Marble scores - MSA AUS Marble score was significantly higher for progeny sired by the high IMF bulls (1.5) than those sired by the high RBY bulls (1.24) (Table 4.2.2). Similarly, the MSA US marble score of progeny sired by both high IMF (383.6) and high RBY&IMF (393.5) sire classes was higher than those sired by the high RBY sire class (314.4) (Table 4.2.3)

Intramuscular fat - The IMF% (Table 4.2.3) was lower in the progeny of the high RBY sires (2.1%) compared to those sired by the high IMF (3.4%) or high RBY&IMF sires (3.2%).

VIAscan Carcase yield. Retail beef yield measured on the carcase by video image analysis (VIAscan) was significantly higher in progeny from high RBY sires (69.8%) than those sired by the high IMF bulls (67.7%) or high RBY&IMF bulls (67.7%) (Table 4.2.3).

MSA eating quality - Predictions from the MSA model (for the anterior striploin cut) indicated better eating quality for carcases from the High IMF sire class (53.3%) compared to the other classes, with those from the High RBY sire class (52.2%) worse than the others.

4.2.4.5 Effect of sex

Sex significantly affected most traits as shown in Table 4.2.4.

4.2.4.5.1 Liveweight traits

Male calves had longer gestation lengths (284.7 vs 283.3 days), higher birthweights (39.4 vs 36.4kg), weaning weights (284.8 vs 262.2kg autumn; 243.7 vs 232.9 spring), liveweights at slaughter (568.5 vs 520.6kg), and heavier carcases (301.1 vs 278.1kg). There was calving season by sex interaction for weaning weight, with the advantage of males over females being greater in the autumn born compared to spring born calves (Table 4.2.4).

4.2.4.5.2 Carcase traits

Female progeny were fatter at both the P8 (12.8 vs 11.4mm) and rib site (7.3 vs 6.6mm), had higher marble scores (AUS – 1.5 vs 1.2; US – 383.4 vs 344.2), and higher IMF% (3.1 vs 2.6%). They also had larger eye muscle area (EMA) when HSCW was used as a covariate (75.0 vs 72sq cm). The eating quality predicted by the MSA model was higher for males than females (53.6 vs 52.1). The difference in dressing percentage was not significant. The females had higher ossification scores than males.

Table 4.2.4. Effect of Sex on liveweight and carcase traits

	Female	Male	s.e.d	P
n	297	365		
Gestation length (days)	283.3	284.7	±0.51	<0.008
Birth weight (kg)	36.4	39.4	±0.37	<0.001
Weaning weight (kg) autumn*	262.2	284.8	±14.7	<0.001
Weaning weight (kg) spring*	232.9	243.7		
Slaughter liveweight (kg)	520.6	568.5	±6.0	<0.001
HSCW (kg)	278.1	301.1	±2.15	<0.001
Dressing %	52.5	52.7	±0.13	=0.080 ns
P8 fat depth (mm)	12.8	11.4	±0.41	<0.001
MSA Rib fat depth (mm)	7.3	6.6	±0.26	<0.001
MSA AUS marble score	1.5	1.2	±0.04	<0.001
MSA US marble score	383.4	344.2	±6.02	<0.001
IMF%	3.05	2.6	±0.1	<0.001
MSA EMA (sq cm) #	75.0	72.0	±0.6	<0.001
VIAscan Carcase yield %	68.1	69.07	±0.1	<0.001
MSA Eating quality	52.1	53.6	±0.2	<0.001
Ossification	192.3	158.9	±2.67	<0.001

* This was a significant season by sex interaction

4.2.4.6 Effect of calving season

The effects of calving season on birth and subsequent liveweights are shown in Table 4.2.5.

4.2.4.6.1 Liveweight traits

Gestation length and birth weight was not significantly affected by calving season. Calving season significantly influenced liveweights at both weaning and slaughter, but there was very little influence on carcase traits. Autumn born steers and heifers were 16.9% and 12.5%

heavier than their spring born counterparts. The spring born progeny (554.1kg) were slightly heavier at slaughter than the autumn (535kg) (Table5).

4.2.4.6.2 Carcase traits

Yield (as estimated by VIAscan) was the only carcase trait significantly influenced by calving season. There was a significant interaction of calving season X sex X growth treatment as shown in Table 4.2.6. Males of the spring born Slow growth treatment and the autumn born Fast treatment males had higher yields compared all other groups.

Table 4.2.5. Effect of calving season on liveweight and carcase traits

	Autumn	Spring	s.e.d	P
n	385	278		
Gestation length (days)	283.6	284.7	±0.62	= 0.058 ns
Birth weight (kg)	36.7	38.5	±0.97	=0.06 ns
Weaning weight (kg) – Female*	262.2	232.9	±14.7	<0.001
Weaning weight (kg) - Male	284.8	243.7		
Slaughter liveweight (kg)	535	554.1	±6.0	<0.001
HSCW (kg)	285.9	297.4	±6.2	0.061 ns
Dressing %	52.4	52.8	±0.53	=0.513 ns
P8 fat depth (mm)	12.3	12.6	±1.117	= 0.773 ns
MSA Rib fat depth (mm)	7.1	7.4	±0.71 ns	= 0.674
MSA AUS marble score	1.4	1.4	±0.51	= 0.171 ns
MSA US marble score	369.4	360.7	±0.19	= 0.193 ns
IMF%	2.9	2.9	±0.3	= 0.882 ns
MSA EMA (sq cm) #	73.8	74.6	±0.65	= 0.232 ns
VIAscan Carcase yield % **	68.7	68.6	±0.14	= 0.064 ns
MSA Eating quality	52.7	52.4	±0.24	= 0.181
Ossification	177.6	173.6	±7.68	= 0.863

* There was a season by sex interaction
** There was a season by sex by growth treatment interaction, see Table 4.2.6

Table 4.2.6 Effect of sex, season and post weaning nutrition on VIAscan carcase yield %

Calving season	Autumn		Spring		s.e.d	P
Growth path	Fast	Slow	Fast	Slow		
Female	68.3b	68.1b	67.9b	68.3b	±0.39	=0.004
Male	69.3a	68.8b	68.4b	69.8a		

4.2.4.7 Effect of dam breed on liveweight and carcase traits

The cows producing the progeny examined here were comprised of various known breed combinations (as shown in Table 4.2.7), and thus effects due to the breed of the dam (grand-sire and grand-dam of the progeny) could be evaluated.

There were significant differences in the progeny due to the breed combinations of the dam for weaning weight, slaughter liveweight and HSCW (Table 4.2.7). These as well as most carcase traits were also affected by the breed of the dams sire (grand-sire of the progeny), as shown in Table 4.2.8. The breed of the grand-dam on the other hand (either Hereford or Angus) affected only gestation length and birth weight (Table 4.2.9), with no significant effects on carcase traits. It was concluded that the effects on carcase traits being restricted to the breed of the grand-sire was due to there being greater differences (both European and British types) compared to the breeds of the grand-dams (British types only).

4.2.4.7.1 Liveweight traits

The highest weaning weights were found in the progeny of the dam breeds Simmental x Hereford (270.8), Simmental x Angus (269.7) and Angus x Hereford (269.0), while the lowest were produced by the Limousin x Hereford (241.6kg) and Hereford (235.8kg) dams (Table 4.2.7). The progeny of the Simmental x Hereford (565.2kg), Simmental x Angus (553.1kg) and Angus x Hereford (560.6kg) dams were the heaviest at slaughter. The progeny from the Hereford (281.2kg) and Angus cows (284.8) had lower HSCW (Table 4.2.7) than those from the Angus x Hereford (297.9kg) and the Simmental cross cows (298.2kg) .

Table 4.2.7. Effects of differing dam breeds on weaning weight, liveweight at slaughter and HSCW.

Dam breed	Ang	Ang x Her	Her	Her x Ang	Lim x Ang	Lim x Her	Sim x Ang	Sim x Her	s.e.d	P
n	198	61	197	49	56	40	40	17		
Weaning weight (kg)	257.2cde	269.0e	235.8a	252.9c	252.9bcd	241.6ab	269.7e	270.8e	±7.15	<0.001
Slaughter liveweight (kg)	538.9ab	560.6c	528.7a	544.9abc	528.2a	536.9ab	553.1cb	565.2c	±10.3	<0.006
HSCW (kg)	284.8a	297.9b	281.2a	288ab	285.3ad	286.2ad	295.5bd	298.2bc	±5.67	<0.010

Examination of the effect of sire of the dam (Table 4.2.8) showed that cows of sire breeds of Angus and Simmental had heavier progeny at weaning (263.1 and 270.2kg), at slaughter (549.7kg and 559.2kg) and had heavier carcases (291.3 and 296.9kg) compared to those of Hereford and Limousin.

4.2.4.7.2 Carcase traits

Sire breed of the dam influenced most carcase traits (Table 4.2.8). The dams sired by the Angus and Hereford bulls produced progeny with fatter carcases, and the dams sired by Limousin produced progeny that had lower marble scores with less intramuscular fat, but higher dressing %. Progeny of dams sired by Limousin and Simmental had carcases with larger eye muscle areas and of higher yield. The predictions of eating quality from the MSA model were higher for progeny of dams with Hereford and Angus sires.

Table 4.2.8. Effect of dam's sire breed (grand-sire of progeny) on liveweight and carcase traits.

Breed of cows sire	Angus	Hereford	Limousin	Simmental	s.e.d	P

n	265	246	95	57		
Gestation length (days)	283.7	284	284.2	284.8	±0.88	= 0.655
Birth weight (kg)	37.5	37.6	37.3	38.6	±0.70	= 0.431 ns
Weaning weight (kg)	263.1a	244.4b	247.2b	270.2a	±5.1	<0.001
Slaughter liveweight (kg)	549.7a	536.8b	532.5b	559.2a	±7.4	<0.001
HSCW (kg)	291.3a	284.6b	285.8b	296.9a	±4.05	<0.004
Dressing %	52.5b	52.6b	53.2a	52.7b	±0.22	<0.023
P8 fat depth (mm)	12.7a	13.0a	11.8b	10.8b	±0.63	<0.005
MSA Rib fat depth (mm)	7.5a	7.5a	6.4b	6.5b	±0.42	<0.004
MSA AUS marble score	1.46a	1.38a	1.21b	1.4a	±0.07	<0.002
MSA US marble score	374a	366a	343b	368a	±9.07	<0.004
IMF%	3.17a	2.94a	2.36b	2.93a	±0.16	<0.001
MSA EMA (sq cm) #	72.8b	72.3b	74.3a	74.7a	±0.92	<0.026
VIAscan Carcase yield %	68.1b	68.1b	68.8a	69a	±0.18	<0.001
MSA Eating quality	53.3a	53.0a	52.2b	52.8ab	±0.31	<0.003
Ossification	176	175.4	175.9	181.7	±2.93	= 0.246 ns

Table 4.2.9. Effect of dams' dam breed (grand-dam of progeny) on birth traits.

Breed of dam's dam	Angus	Hereford	s.e.d	P
Gestation length (days)	283.2	284.9	±0.53	<0.001
Birth weight (kg)	37.3	38.6	±0.4	<0.001

4.2.4.8 Meeting Carcase specifications

4.2.4.8.1 Compliance to the abattoir grid

Cattle were slaughtered at the same abattoir on each occasion (Cargill Beef, Wagga Wagga), with prices received based on a grass fed grid (Appendix Table 9.2.1). In the comparisons below, the rates of compliance to specifications for the major traits in the grid (HSCW and P8 fat depth) are presented for two scenarios. The first is for the specifications in the standard grid – Tables 10 and 12 - HSCW range 300-360kg, and P8 fat 6-17mm; the second for tighter ranges in a "refined" grid - Tables 11 and 13 - HSCW 295-315kg and P8 fat 6-10mm, the latter declared a more "preferred carcase" by the abattoir. Table 4.2.14 gives a summary for the comparison of sire type progeny groups within the Fast and Slow growth treatments of the carcase weights, prices received and carcase values according to compliance to the standard grid specifications :- HSCW range 300-360

The comparisons presented come from the raw carcase data as used by the abattoir for payment. The trends for compliance seen in the following results reflect those reported above for effects on carcase traits. The Belgian Blue progeny had fewer carcases fitting the fat specifications because they were leaner than those of the other sire types, but they had more carcases meet the HSCW specifications. The Red Wagyu progeny had more carcases fit the fat specifications, and less fit the weight specifications. However the results from both these sire types should be treated with caution because of few progeny in those groups (see Table 4.2.14). The percentages of carcases meeting both specifications were low in all groups (Table 4.2.10 and Figure 4.2.6) due to animals being marketed prior to optimum time because of organisational issues relating to aligning kill dates with NSW cohorts to facilitate economical collection and processing of carcase data. Whilst differences between carcase types were small the one notable exception was the Wagyu, whose progeny substantially failed to meet weight specifications and hence performed poorest in compliance level (2%).

Table 4.2.10. Comparison of the percentages of carcases from the various sire types meeting the specifications for HSCW, P8 fat and both, using the standard specifications grid (6-17 mm fat, 300-360 HSCW).

	Belg. Blue	Lim.	Angus RBY	Angus RBY &IMF	Angus IMF	Red Wagyu	Wagyu
Fat	47.6%	59.3%	61.2%	59.5%	56.8%	70.6%	59.6%
HSCW	47.6%	42.6%	36.8%	35.7%	32.5%	29.4%	6.1%
Fat & HSCW	19.0%	27.8%	25.7%	23.8%	21.3%	23.5%	2.0%

Narrowing the fat and HSCW range of specifications halved the number of carcases meeting specifications (Table 4.2.11 and Figure 4.2.7), but the Limousin progeny again had the highest compliance, and the Wagyu the lowest. Of the three Angus sire types, those selected for high IMF%, had the lowest proportion meeting specifications, due to more being over the specified fat range and consistent with the differences in mean P8 seen above (Table 4.2.2).

Table 4.2.11. Comparison of the percentage of carcases from the various sire types meeting the grid for HSCW, P8 fat and both using the refined grid (6-10 mm fat, 290-315 HSCW).

	Belg. Blue	Lim.	Angus RBY	Angus RBY &IMF	Angus IMF	Red Wagyu	Wagyu
Fat	28.6%	38.0%	34.9%	31.0%	21.9%	35.3%	28.3%
HSCW	19.0%	26.9%	32.9%	25.0%	25.4%	17.6%	16.2%
Fat & HSCW	9.5%	13.0%	11.2%	11.9%	6.5%	5.9%	4.0%

When sire classes were compared (Table 4.2.12 and Figure 4.2.8), there was little difference between them in compliance to the fat specifications, but the progeny of the high IMF% class had fewer fitting the weight specification due to the influence of the Wagyu sires in that class. Progeny of the high RBY sires had more carcases meet both specifications than those of the class selected for both high RBY% & IMF%. Narrowing the range of specifications for both fat and HSCW (Table 4.2.13 and Figure 4.2.9) reduced the differences between these sire classes, but increased the relative difference between those and the high IMF% class.

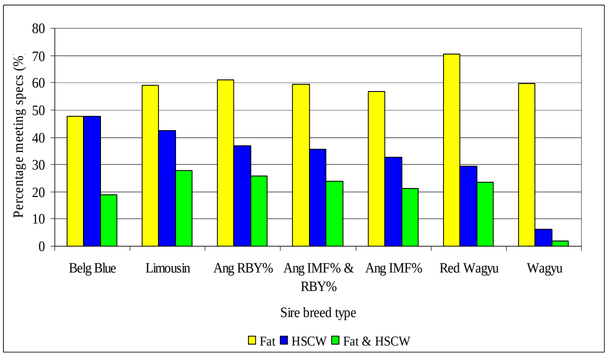


Figure 4.2.6. Percentage of carcases meeting the grid of 300-350 kg HSCW and 6-17mm P8 fat for the various sire types

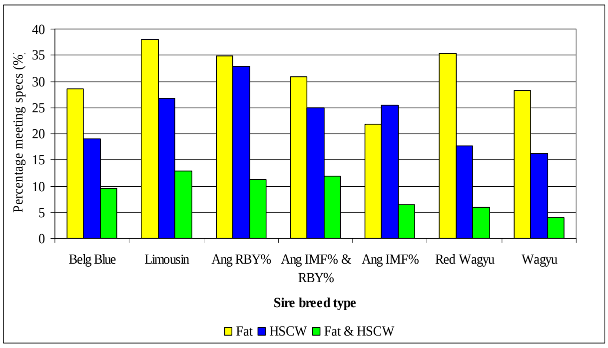


Figure 4.2.7. Percentage of carcases meeting the grid of 295-315 kg HSCW and 6-11 mm P8 fat for the various sire types

Table 4.2.12. Comparison of the percentages of carcases from the various sire classes meeting specifications for HSCW, P8 fat and both, using the standard grid (6-17 mm fat, 300-360 HSCW).

	High RBY	High IMF&RBY	High IMF
Fat	59.4	61.4	57.8
HSCW	39.9	34.7	22.8
Fat & HSCW	26.0	23.8	14.2

Table 4.2.13. Comparison of the percentage of carcases from the various sire classes meeting specifications for HSCW, P8 fat and both using the refined grid (6-10 mm fat, 290-315 HSCW).

	High RBY	High IMF&RBY	High IMF
Fat	35.6	31.7	24.3
HSCW	29.5	23.8	22.0
Fat & HSCW	11.7	10.9	5.6

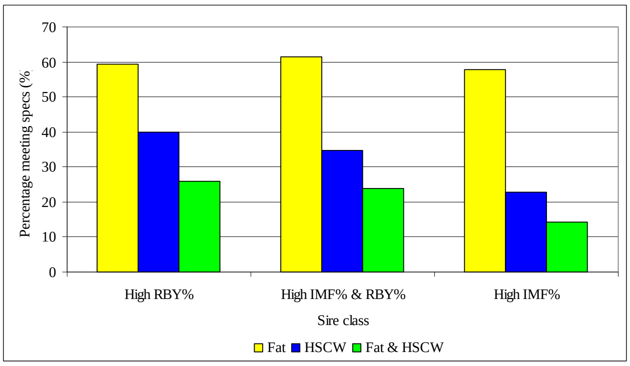


Figure 4.2.8. Percentage of carcases meeting the grid of 300-350 kg HSCW and 6-17mm P8 fat for the various sire classes.

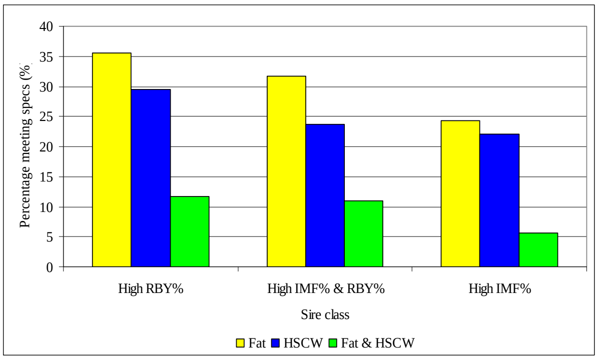


Figure 4.2.9.Percentage of carcases meeting the grid of 295-315 kg HSCW and 6-10mm P8 fat for the various sire classes.

Table 4.2.14. Comparison of progeny groups for sire types within Fast and Slow growth treatments for carcase weight (HSCW), carcase price ($/kg), carcase value (Grid value$) and $ differences from the highest value sire type group.

Growth treatment	Belg. Blue	Lim.	Angus RBY	Angus RBY&IMF	Angus IMF	Red Wagyu	Wagyu
Slow							
n	10	39	66	35	70	8	45
HSCW (kg)	303	300	296	292	293	284	260
Price ($/kg)	1.68	1.81	1.69	1.75	1.70	1.71	1.61
Carcase value($)	944	1014	970	991	964	942	821
Value diff. ($)	-70	0	-44	-23	-51	-72	-193
Fast							
n	9	60	75	43	84	7	47
HSCW (kg)	299	295	290	293	291	274	263
Price ($/kg)	1.78	1.82	1.76	1.79	1.80	1.75	1.68
Carcase value($)	994	1000	989	998	1000	916	855
Value diff ($)	-7	-1	-11	-3	0	-84	-145

Table 4.2.14 shows that steers from the Fast growth treatment received a higher price ($/kg) for all sire types, due to better compliance. This was reflected in higher total carcase value (HSCW x carcase price) in almost all cases, with the 2 exceptions due to lower caracse weight. Progeny of the Limousin sires had a considerable advantage in total carcase value over others in the Slow growth treatment and were practically equivalent to the top performers in the Fast growth groups. The Wagyu progeny were clearly the worst in both growth treatment groups, due to low carcase weights.

4.2.4.8.2 "Distance from specifications" and customer satisfaction

The carcase data were also analysed using an alternative system of assessing compliance and valuing carcases based on the "distance from specifications" model developed by Rutley (2006). The system is more fully described in the analysis of "Meeting Specifications" in the section of this reoprt for the NSW site. The system calculates the distance for each trait from the nominated specifications of an "ideal carcase". Figure 4.2.10 shows the mean differences in distance from specifications for HSCW, P8 fat depth and fat colour, due to sire type and growth treatment (nutrition). The distance from specification is 0 when the carcase meets the value of the ideal for that trait, with a value of ±1 indicating the trait measurement is on either edge of the acceptable range. Progeny of all sire types failed to meet the ideal specification for carcase weight (all below) in both growth treatment groups, with the differences between types being minor except for the Wagyu. The Limousin progeny in the Fast growth treatment had the best compliance to the ideal for P8 fat depth, which was in fact the best result for any group for any of the traits. There was little difference between groups in compliance to the fat clour specification, with all being considerably above the ideal. The rankings among groups were very similar within the growth treatments for all traits.

Figure 4.2.11 shows the overall "customer satisfaction", which is an index of compliance to the ideal when all specifications are considered together (100% when all traits exactly meet the ideal values).

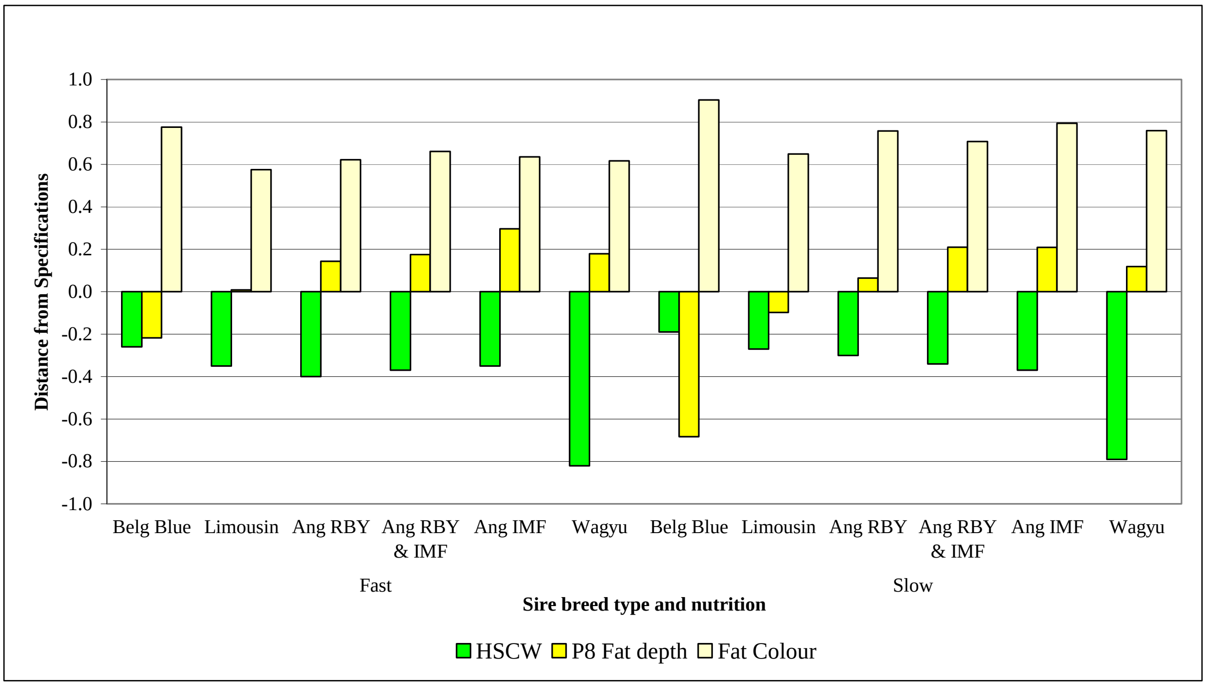


Figure 4.2.10. Effect of sire type and growth treatment on distance from specifications.

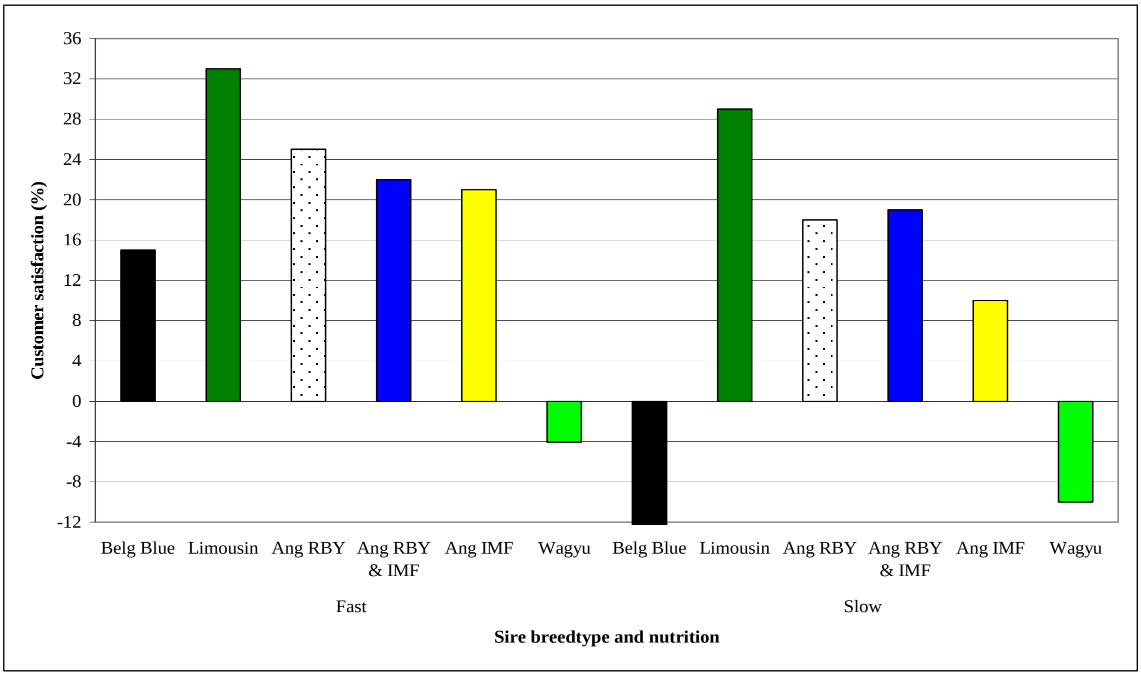


Figure 4.2.11. Effect of sire type and growth treatment on customer satisfaction.

Steers from the Fast growth treatment rated higher than those grown on the Slow, with the Limousin ranking highest in both growth groups. There was little difference in customer satisfaction between the progeny of the Angus sire types grown on the Fast treatment, however those of the high IMF Angus performed the worst of the 3 types grown on the Slow.

The Belgian Blue groups were the only ones with a major change in size or direction of customer satisfaction between growth treatments but again the low numbers of animals precludes confident predictions. Excluding Belgian Blue, satisfaction levels were lowest in the higher IMF% classes (Wagyu and Angus IMF) and lower for both of these sire types in the slower growth groups.

4.2.4.9 Economic evaluation

Economic evaluation was conducted using gross margin analysis with the aid of the Beef-N-Omics package (Dobos *et al.* 1997;2006). The use of this economic model is fully explained in the section of the report for the NSW site. Details of the inputs and assumptions used for the model for this site are shown in Appendix 2. Tables 4.2.15, 4.2.16 and 4.2.17 give summaries of the output from the model which allow comparison of the gross margins per cow and per hectare for the various scenarios of different combinations of growth treatment and season of calving. These results demonstrated the importance of finishing cattle on a Fast growth path to enable faster turnover. This ensures that the period of higher stocking rate when slaughter cattle are being run on the property is as short as possible. The Wagyu progeny had a large effect on the outcomes of these analyses because of their much lower slaughter and carcase weights compared to other groups. Thus scenarios were examined both with and without these animals included. Table 4.2.15 shows that whilst the highest gross margin/cow ($717) was achieved with a Slow growth group (Spring calving, Wagyu excluded), the highest gross margin per ha ($412) was achieved using a Fast growth path post weaning (Autumn calving, Wagyu excluded). The Beef-N-Omics analyses demonstrated the importance of producing cattle with heavier slaughter weights, highlighted when comparing the best outcome ($412/ha, Wagyu excluded), with the same scenario for Wagyu progeny only ($376/ha). Apart from the Wagyu progeny, there were only small and mostly not significant differences between the various sire type groups for carcase weight, and thus the gross margin results for separate scenarios will not be presented.

There was little difference in mean gross margins between autumn and spring calving, (tables 15 and 16) however, comparing the average gross margins for calving season and growth path, it can be seen that for the earlier finishing Fast growth path system autumn calving gave the highest gross margins per hectare ($396), and for the Slow finishing system, spring calving gave the highest gross margin ($354). This would most likely be due to the autumn calving system with earlier finishing cattle being more likely to match feed supply, compared to a spring calving system.

Table 4.2.15. Gross margin (GM) economic evaluation comparing various combinations of growth treatment and season of calving using common weaning weights for all sire types. Table shows a summary of the output from the Beef-N-Omics model having scenarios with and without the inclusion of the Wagyu progeny.

Calving Season	Growth path	Sire type	No cows**	GM Total $	GM $/cow	GM $/ha
Aut	Fast	No Wagyu*	117	$82,472	$705	$412
Aut	Fast	All	118	$80,257	$680	$401
Aut	Fast	Wagyu only	122	$75,235	$617	$376
Spring	Fast	No Wagyu	104	$74,382	$715	$372
Spring	Fast	All	106	$74,084	$699	$370
Spring	Slow	No Wagyu	102	$73,120	$717	$366
Spring	Slow	All	104	$72,934	$701	$365
Spring	Fast	Wagyu only	109	$68,508	$628	$342
Aut	Slow	No Wagyu	99	$68,177	$689	$341
Aut	Slow	All	100	$66,439	$664	$332
Spring	Slow	Wagyu only	105	$66,228	$639	$331
Aut	Slow	Wagyu only	103	$61,274	$595	$306

* All sire types used excluding Wagyu
** Comparative carrying capacity generated by Beef-N-Omics for the various scenarios

Table 4.2.16 Gross margin ($/ha) means from Beef-N-Omics for growth path and season of calving (using figures from Table 4.2.15)

	Growth path		
Calving Season	**Fast**	**Slow**	**Mean**
Autumn	396	326	361
Spring	361	354	358
Mean	379	340	360

Table 4.2.16 Gross margin ($/ha) means from Beef-N-Omics for sire type, growth path and season of calving (using figures from Table 4.2.15)

	Fast	Slow	Aut	Spring	Average
All	386	349	367	368	367
No Wagyu	392	354	377	369	373
Wagyu	359	319	341	337	339
Grand Total	379	340	361	358	360

4.2.4.10 Discussion of Vic results

The aim of this project was to examine the effect of imposing different growth treatments post weaning on animals that were bred to be different in carcase traits. The experiment designed for them to follow the different growth paths to a common finishing weight. Whilst the growth treatments chosen were not extreme in terms of weight gain per day achieved, they resulted in a mean difference of 5.3 months in age at slaughter. There was a mean difference of 12 kg in slaughter weight, but no difference in HSCW, because of a compensating effect of a higher dressing % in the Fast growth treatment groups.

Growth treatment had the greatest influence on fatness traits, with the animals finishing at a younger age being fatter (greater P8 and rib fat depths) and having higher IMF% for the same liveweight. Although differences were small, the animals younger at slaughter (Fast growth treatment) had significantly better predicted eating quality, which was likely due to the effect of higher marble scores on the MSA model predictions. Apart from the Belgian Blue progeny, of which there were few numbers, growth treatment had no significant effect on muscle traits or yield, nor were there any significant interactions between growth path and sire class. The lack of interactions between growth treatment and sire type found here indicates that the ranking of progeny for different traits would be similar under different growth regimes. These results are in agreement with the outcome of previous experiments of the Beef CRC, where it was found that progeny of sires of varying growth and carcase potential having different feed regimes ranked similarly for end product characteristics. (Robinson *et al.* 2001b)

Sire type influenced most traits, however it was usually the types considered extreme for the selected traits (IMF% or RBY%), that had most significant influence. In most cases there was little difference between the progeny of the 3 Angus types, apart from VIAscan carcase yield, EMA, Rib fat and IMF%. Marble score, liveweight traits and predicted eating quality were not affected. This indicates that the important carcase traits can be selected for and influenced within breed without compromising weaning weight, carcase weight or eating quality. There was little difference in fatness traits between the Wagyu progeny and those of the Angus selected for high IMF%, which indicates that there is enough selection potential within the Angus breed to increase IMF%, and without risking the compromise in liveweight or HSCW that was found in the Wagyu progeny. Using sire types extreme for RBY% certainly increased EMA and RBY% in the progeny. However the data indicated that carcases of these sire types had significantly lower predicted eating quality.

The sire breed of the dam influenced most traits, indicating the importance of examining both cow breed and sire breed when targeting specific markets. Dams from Simmental and Angus sires produced heavier carcases in their progeny, and those from Limousin and Simmental sires had progeny with larger EMA and higher yield. Progeny of dams from Hereford and Angus sires were fatter than others. These results demonstrate the value of using specific cow breeds to pass on their advantage for different traits to their progeny. There were no dam breed by sire breed interactions in the effects on the progeny. indicating that the cow breed effects were complementary to those of the sire.

There was little difference in carcase traits due to calving season, however autumn born calves were heavier at weaning than those born in spring when adjusted for age differences.

The proportions of carcases meeting the relevant price grid provided by the abattoirs were examined to assess compliance. The percentages of carcases meeting both of the major specifications (HSCW and P8 fat) were low in all groups. The Wagyu sired progeny had the lowest compliance, due to the majority of carcases failing to meet the weight specification. Whilst differences were small, there was a trend for the Angus sire types selected for higher RBY% to have more progeny meeting market specifications than those selected for high IMF%. Compliance to the grid applicable to the carcases in this study was dependent mainly on variation in liveweight and fat. Since there is no consideration of carcase yield in the grid, there was no advantage in payment for higher yielding animals, and this will remain the case until changed by the processors.

The “distance from specification” analysis technique was used as an alternative method of assessment of compliance. Progeny of all sire types failed to meet the ideal specification for carcase weight (means all below ideal) in both growth treatment groups. The Limousin progeny in the Fast growth treatment had the best compliance to ideal for P8 fat depth. Compliance to fat colour specification was poor overall, with all carcases being considerably above the ideal. The rankings among sire type groups were very similar within the growth treatments for all traits. Results indicated that steers from the Fast growth treatment rated higher in customer satisfaction than those grown on the Slow, with the Limousin progeny ranking highest in both growth groups. Satisfaction levels were lowest in the higher IMF% classes (Wagyu and Angus IMF) and lower for both of these sire types in the slower growth groups. The “distance from specification” analysis technique showed essentially very similar outcomes to the rates of compliance to the standard abattoir grid, and it offers a possibly better method of sending price signals to the supplier of the carcase, whether feedlotter or grass finisher.

Economic evaluation was conducted using gross margin analysis (GM/cow and GM/ha), with the aid of the Beef-N-Omics package, to compare the profitability of different scenarios of growth treatment and season of calving. These results demonstrated the importance of finishing cattle on a Fast growth path to enable faster turnover. Although the highest gross margin/cow ($717) was achieved with a Slow growth group (with Spring calving), the highest gross margin per ha ($412) was produced by a Fast growth path post weaning and Autumn calving. The economic analyses also highlighted the importance of producing cattle with heavier slaughter weights. These results allow the results of responses in carcase traits to be evaluated for their impact in a production situation by the effect on herd carrying capacity and profitability. Thus the effects of carcase weight and faster growth have emerged as the main drivers of profitability.

Thus the results here have demonstrated the effect of using BREEDPLAN EBV's for selection of the most appropriate sires to produce carcases with the best compliance to the targeted market. Selection for individual carcase traits had significant effects in one generation, without detriment to liveweight, and responses were quite consistent under different growth regimes. Growth path influenced all fat traits, and animals reaching slaughter weight at a younger age were fatter and had a higher IMF%, regardless of sire type. Analyses also indicated an economic advantage in maintaining fast growth rates post weaning, and that cattle grown faster should have better eating quality. Despite diverse sire carcase types, there were no interactions of type with environment (Fast or Slow growth) for effects on any trait, indicating the robustness of BREEDPLAN EBV's. The importance of breed of dam was also well demonstrated, particularly the breed of the dam’s sire, with its implications in changing carcase traits in cross breeding. Analyses of compliance to nominated carcase trait specifications, either by fit to the standard abattoir grid or by using the alternative “distance from specification” technique, demonstrated the importance of the treatment effects on the traits in the end product as affecting price/kg for the carcase. Penalties due to poor compliance are compounded by low carcase weight, as was often the case here, and give a low “customer satisfaction” rating, and this was reflected in the returns.

4.3 Details, Results and Discussion – SA site (Struan)

4.3.1 Summary

For the South Australian (SA) site (Struan), Angus sires were selected on EBVs for high IMF, high RBY or for both traits. Belgian Blue and Limousin sires were also included in the high RBY% class, and (Black) Wagyu sires in the high IMF% class, with the Red Wagyu type contributing to the class for both traits. There were no imposed growth treatments at this site. The weaners were grown to achieve European Union (EU) or heavy domestic carcase specifications on a perennial pasture based system. High grain rations were fed to finish calves for commercial slaughter by 24 months of age when pastures failed. In the first two years, the progeny produced were from cows derived from the Multi-Breed project, as described in the report for the Vic site. In subsequent years additional cows from commercial and crossbred trial groups on Struan Research Centre were used. Cow breed types were Angus, Angus x Hereford, Hereford x Angus, Angus x Limousin, Hereford x Limousin, Angus x Simmental, Hereford x Simmental and composite dairy-beef crossbred types.

Calf growth varied considerably between years as a consequence of seasonal rainfall and pasture conditions. In the first year, grain feeding was not necessary as rainfall was sufficient to enable calves to achieve target weights without the need for supplements.

Sire type, considered across the total range, significantly influenced all liveweight and carcase traits. However, within the Angus progeny, those from sires chosen for high RBY% or high IMF% differed in carcase fatness without any difference in the live or carcase weight. This demonstrated that selection of sires using BREEDPLAN EBVs would produce expected responses in carcase traits without compromising important live weight traits. There were no interactions between year and sire type which indicates that the ranking of sires for different traits based on their progeny's performance should be similar in seasons that produce variation in growth rate.

The sire breed of the dam influenced many traits, demonstrating the importance of examining both cow and sire breed when targeting specific markets. Raw data were used to examine the proportions of carcases meeting a price grid that was provided by the abattoirs for grass fed cattle.

4.3.2 Background

This section of the report covers results from the experiment in south-eastern SA (Struan). The overall study was designed to determine the most appropriate growth pathways for progeny of sires that differ in genetic potential for carcase and/or growth traits. However no growth treatments were imposed at this site. Common sires were used at this and the Victorian (Vic) site, and the breeds of dams used were also similar, being cows derived from the Multi-Breed project (Graham *et al.* 2000) for some of the progeny, and similar crossbred genotypes for the rest. Thus the results from this site, in conjunction with those from Vic, will be extremely useful when the combined data from all 4 sites is examined later.

The experiment at this site was designed to provide regionally relevant information for beef producers to enable them to consistently achieve high compliance to targeted market specifications. Production in this area has traditionally been from pasture finished animals aimed at SA domestic trade. However, in recent years, production of cattle for the Japanese grass-fed and EU markets has now become more important.

4.3.3 Additional methods

The general design and methodology of the Regional Combinations project was described by McKiernan *et al.* (2002).

Further details particular to this site now follow.

The diverse genetic potential represented in the sire carcase types used was similar to other sites. All sires used at SA (Struan) were also used at the Vic (Hamilton) site. Sires with high potential for retail beef yield (RBY%) were chosen from Belgian Blue and Limousin, and high yielding Angus bulls; those with high potential for intramuscular fat (IMF%) were chosen from high IMF Angus and Black Wagyu bulls. Those with high potential for both traits were selected from high yielding and high intramuscular fat (IMF%) Angus and Red Wagyu bulls. These are subsequently referred to as the various “classes” (RBY, IMF) and “types” of sires within classes. EBVs for the traits of interest were used in selection of the Angus sires. Also similar to Hamilton, matings were to cows derived from the Multi-Breed project (Graham *et al.* 2000), as well as commercial Angus, Hereford and composite dairy X beef breed cows. These comprised Angus, Angus x Hereford, Hereford x Angus, Angus x Limousin, Hereford x Limousin, Angus x Simmental and Hereford x Simmental and dairy crosses. There were progeny from 115 Angus, 119 Hereford, 55 Simmental and 51 Limousin dam sire breeds with others having 13 or less per group.

At the SA (Struan) site, autumn calving (March-April) was used for 3 calf crops (2000, 2001 and 2003) and additional spring calving (August-September) in the final year, with the initial target a slaughter live weight of 550 kg. Additional data from calves born in 2000 which had the same sires and dam breeds, but were run at the Vic (Hamilton) site, have been included. No nutritional treatments were imposed on any of the calf crops.

Comprehensive carcase data (AUS-MEAT 1996) were collected at the abattoir kill floor and in the chiller. All chiller assessments reported here are those taken by MSA-accredited technicians. Samples of meat from the strip loin *(M. longissimus lumborum)* – (cut 2140 AUS-MEAT 1998; cut “STA” MSA classification) were taken at boning and stored frozen for later analysis of IMF% (Perry *et al.* 2001). MSA feedback data were used for analyses of carcase traits.

Although production in south–eastern SA is traditionally based on pasture finished cattle aimed at the Japanese trade, it became obvious that the seasonal conditions prevailing after the first year of the experiment would not allow high carcase weights to be achieved, without considerable supplementation. Thus cattle management was directed towards the more practical endpoint of the SA domestic trade / EU markets where lower carcase weights were preferred. Carcase data were examined for compliance to specifications using 2 systems. The first of these was for compliance to the abattoir grid as for the usual method of payment (the grid showing specifications applicable to the various markets is provided as Appendix Table 9.3.1). The second used an alternative system of assessing compliance and valuing carcases based on the “distance from specifications” model developed by Rutley (2006), which calculates the distance for each trait from the nominated specifications of an “ideal carcase”. The system is more fully described in the analysis of “Meeting Specifications” in the report for the NSW site.

Statistical analysis procedures were similar for all sites, and used the PC software package Genstat 9 (2006), with a linear mixed model REML procedure. The statistical model for each site was modified from that used for NSW as described in the General Methodology section (3.2). There were no nutritional treatments, autumn calvings in each year and an extra spring calving in the final year only. Thus effects due to calving season could not be estimated by the model.

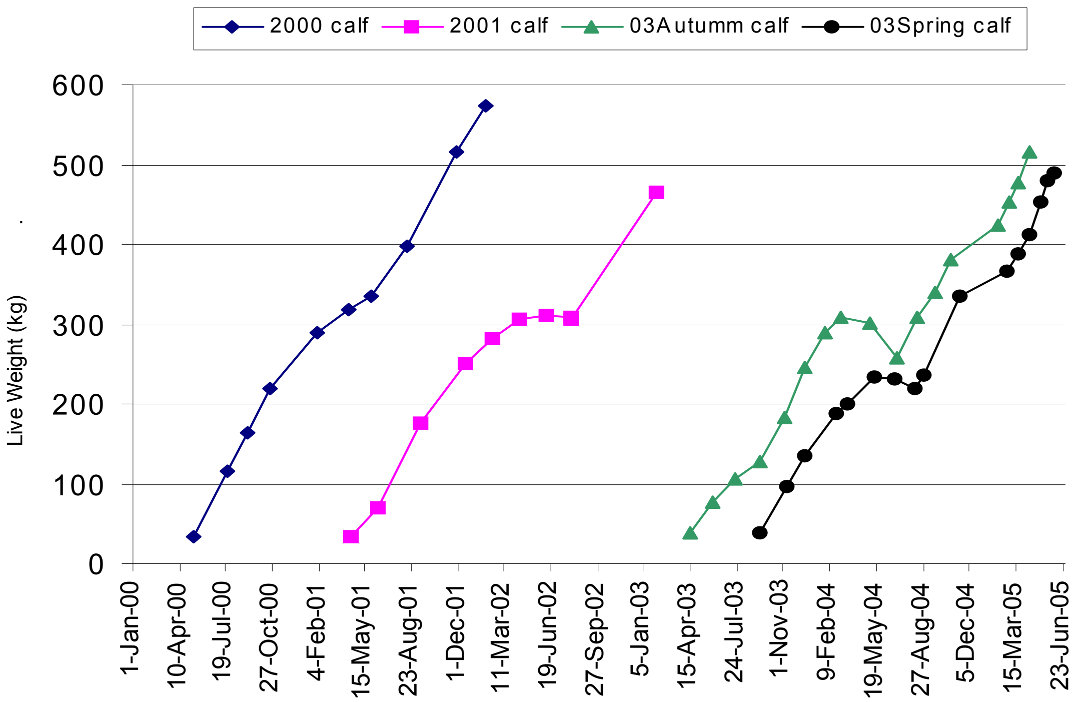


Figure 4.3.1. Growth paths for calves born from 2000 to 2003 at SA (Struan) site.

4.3.4 Results and Discussions

4.3.4.1 Growth paths achieved

Good seasonal conditions followed the 2000 calving, which allowed these animals to maintain desired growth rates and reach the heavy Japanese export market target while grazing perennial pastures. Calves born in 2001 experienced dry conditions and were slaughtered at heavy SA domestic / light EU market specifications whereas the calves born in 2003 were subjected to adverse seasonal conditions resulting in periods of weight loss in winter and were finished on a grain based ration to avoid being carried for another year, having achieved EU market specifications.

4.3.4.2 Effects of sire type

4.3.4.2.1 Live weight traits

Breed type affected all live weight and carcase traits and gestation length. These results are shown in Table 4.3.1. Some caution should be used when examining the results for the Belgian Blue and Red Wagyu, as there were relatively fewer sires and progeny in the experiment.

The Belgian Blue (39.0 kg) and Limousin (37.2 kg) progeny were significantly heavier at birth and the Wagyu lightest (32.6 kg). This trend followed through to weaning with the Belgian Blue producing heavier calves (273 kg) than both Wagyu and Red Wagyu sire breeds (235 and 262kg respectively). The Wagyu sired calves were lighter (425 kg) than all the others at slaughter. (Table 4.3.1). There were no significant differences between the Angus sired calves among those selected for different carcase traits.

4.3.4.2.2 Carcase Traits

HSCW - Wagyu sired calves had lighter carcases (228kg) than the other breed types. There were no differences between the Angus sire types.

P8 Fat Depth – Angus sires chosen for higher IMF had fatter (13.1mm) progeny than those chosen for high RBY (11.0mm), (Table 4.3.1). The Limousin (9.4mm) and Belgian Blue sired progeny (8.2mm) had lower P8 measurements than the Angus selected for high IMF and both Wagyu and Red Wagyu types (12.6 and 16.3mm).

Table 4.3.1. Effect of sire type on gestation, live weights and carcase traits.

Trait	Belgian Blue	Limousin	Angus RBY	Angus RBY&IMF	Angus IMF	Red Wagyu	Wagyu	s.e.d	P
n	33	43	104	48	118	11	35		
Gestation length (days)	284.6bc	288.9a	282.9cd	280.0d	280.9cd	288.1ab	283.7cd	±1.91	<0.001
Birth weight (kg)	39.0a	37.2a	35.4b	35.1b	34.3bc	31.9b	32.6c	±1.16	<0.001
Weaning weight (kg)	262a	256ab	263ab	258ab	253ab	261bc	235c	±7.6	<0.05
Pre-slaughter live weight (kg)	456b	469b	480a	476a	469b	457b	425c	±9.0	<0.001
HSCW (kg)	261b	260b	260b	260b	254b	253b	228a	±5.3	<0.001
Dressing %	55.3c	54.1bc	52.5ab	52.8ab	52.3a	53.3b	52.1a	±0.47	<0.001
P8 fat depth (mm)	8.2a	9.4ab	11.0b	12.4c	13.1c	16.3d	12.6c	±1.2	<0.001
IMF%	3.00a	3.32a	4.48	5.47	4.95	4.95	4.95	±1.1	<0.001
MSA EMA (sq cm)	69.6a	69.6a	64.5b	65.80b	63.4b	63.0b	64.2b	±1.77	<0.001
AUS Marble score	1.20	1.20	1.20	1.30	1.28	1.31	1.21	±0.06	NS

4.3.4.3 Effect of sire carcase class

4.3.4.3.1 Weight traits

Sire class affected birth weight and weaning weight, with IMF sires resulting in lighter calves than RBY calves and RBY&IMF calves intermediate. Sire class had no significant effect on pre slaughter weight or carcase weight.

Table 4.3.2. Effect of sire class on gestation , weights and carcase traits.

	RBY	RBY&IMF	IMF	s.e.d	P
n	180	59	153		
Gestation length (days)	285bc	284b	282bc	±3.6	NS
Birth weight (kg)	37.1b	33.7ab	33.5a	±1.16	<0.001
Weaning weight (kg)	259a	257ab	246b	±7.6	<0.01
Slaughter live weight (kg)	467	467	448	±18.2	NS
HSCW (kg)	260	256	242	±8.8	0.087
Dressing %	53.9	53.0	52.2	±0.22	NS
P8 fat depth (mm)	9.64a	13.8b	12.9ab	±1.47	<0.01
IMF%	3.67a	4.95b	4.95b	±0.27	<0.01
EMA (sq cm)	67.8	64.6	63.8	±2.3	NS
AUS Marble score	1.20	1.30a	1.26a	±0.03	<0.01

4.3.4.3.2 Carcase traits

Sire class had a significant effect on P8 and rib fat depth, marble score and IMF%.

P8 and rib fat depth - The progeny of the high RBY sire class bulls had less fat at the P8 site (9.6mm) than those sired by the High IMF&RBY bulls (13.8mm) (Table 4.3.2).

Marble score s. MSA AUS Marble score was significantly lower in progeny sired by the high RBY (1.20) bulls than those sired by the RBY&IMF and IMF bulls (1.26 and 1.30) (Table 4.3.2).

Intra-muscular fat. The IMF% (Table 4.3.2) was lower in the progeny from the high RBY sires (3.7%) compared to those sired by the high IMF (4.95%) or high RBY&MF sires (4.95%).

4.3.4.4 Effect of sex

Sex significantly affected most traits (Table 4.3.3).

4.3.4.4.1 Live weight traits

Male calves had higher liveweights at birth (36.0 versus 33.54kg), weaning (263 versus 245 kg), slaughter (500 versus 466kg), and a heavier carcase (265 versus 240kg).

4.3.4.4.2 Carcase traits

Female progeny were fatter at the P8 (12.7 versus 9.3 mm), had higher marble scores (AUS – 1.8 vs 1.6 and tended P=0.2) to have higher IMF% (4.99 versus 4.09%).

Table 4.3.3. Effect of Sex on liveweight and carcase traits

	Female	Male	s.e.d	P
n	176	217		
Birth weight (kg)	33.5	36.0	±0.44	<0.001
Weaning weight (kg)	245.2	263.0	±11.37	<0.001
Slaughter live weight (kg)	466.4	499.5	±4.0	<0.001
HSCW (kg)	240.2	265.0	±4.46	<0.001
P8 fat depth (mm)	12.72	9.27	±0.42	<0.001
MSA AUS marble score	1.8	1.6	±0.05	<0.001
IMF%	4.99	4.09	±1.12	NS

4.3.4.5 Effect of breed of dam on liveweight and carcase traits

There were no significant differences in weights attributed to the breed of the cows at the SA (Struan) site. However, it is proposed to combine these data with those from Vic (Hamilton) to further analyse the effects of the breed of the dam, since there were progeny across sites that had identical sires and common dam breeds. Limousin sired cows had progeny with significantly less (1.4) marbling than Angus sired cows (1.7).The breed of the cow's dam on the other hand (either Hereford or Angus) did not have a significant effect on any carcase trait.

4.3.4.6 Meeting Carcase specifications

The cattle were slaughtered at a commercial abattoir in Murray Bridge (T&R) See comment near beginning, with prices being based on a grass fed price grid (see Appendix Table 9.3.1). The cattle produced at this site were eligible for the EU market, which offers a premium over prices paid for non-compliant cattle.

The specifications for EU are as follows: HSCW (240-337kg); P8 fat (8-22mm); Dentition (0-4teeth). The works uses a combined grid in which domestic trade specifications (140-280kg HSCW), EU and Japanese specifications (280-400kg; 8-22mm fat) are used to price carcases which fall within a carcase weight range from a minimum of 140kg to a maximum of 400kg. For the purposes of comparing sire types, proportions of carcases meeting requirements for alternative markets, using the raw data for HSCW and P8 fat depths, are shown in Table 4.4.4.

The Wagyu sired carcases had the lowest rate of compliance to export market requirements, but highest compliance for the domestic trade due to the lighter weights.

Table 4.4.4. Percentages of carcases from the different sire types meeting specifications for weight (HSCW) and fat (P8) for the EU, Japanese grass fed and SA trade grids.

	Belg. Blue	Limousin	Angus RBY	Angus IMF&RBY	Angus IMF	Wagyu
EU Grid						
HSCW (240-337)	82.4	83.7	78.8	81.3	72.0	57.1
P8 fat (8-22mm)	79.4	90.7	87.5	89.6	91.5	94.3
Fat and weight	64.7	76.7	73.1	72.9	65.3	54.3
Jap. grass fed Grid						
HSCW(280-400)	38.2	48.8	42.3	35.4	33.1	28.6
P8 fat (8-22mm)	79.4	90.7	87.5	89.6	91.5	94.3
Fat and weight	29.4	46.5	38.5	31.3	29.7	25.7
SA Trade Grid						
HSCW(140-280)	61.8	53.5	57.7	64.6	66.9	71.4
P8 fat(7-12mm)	61.8	58.1	50.0	37.5	38.1	71.4
Fat and weight	38.2	27.9	28.8	31.3	26.3	60.0

Figure 4.3.2 shows the compliance of carcases to weight and fat specifications for different markets (SA trade or Japanese), using the alternative "distance from specifications" technique of evaluation. The positive or negative deviation from the zero mid-point shows how far, and in what direction, the means for different groups were distant from the "ideal" value (zero midpoints). It is thus shown that most carcases were above the specifications for both weight and fat for the SA trade market, and the reverse for the Japanese market. This demonstrates graphically the poor levels of compliance evident in the proportions shown in Table 4.4.4.

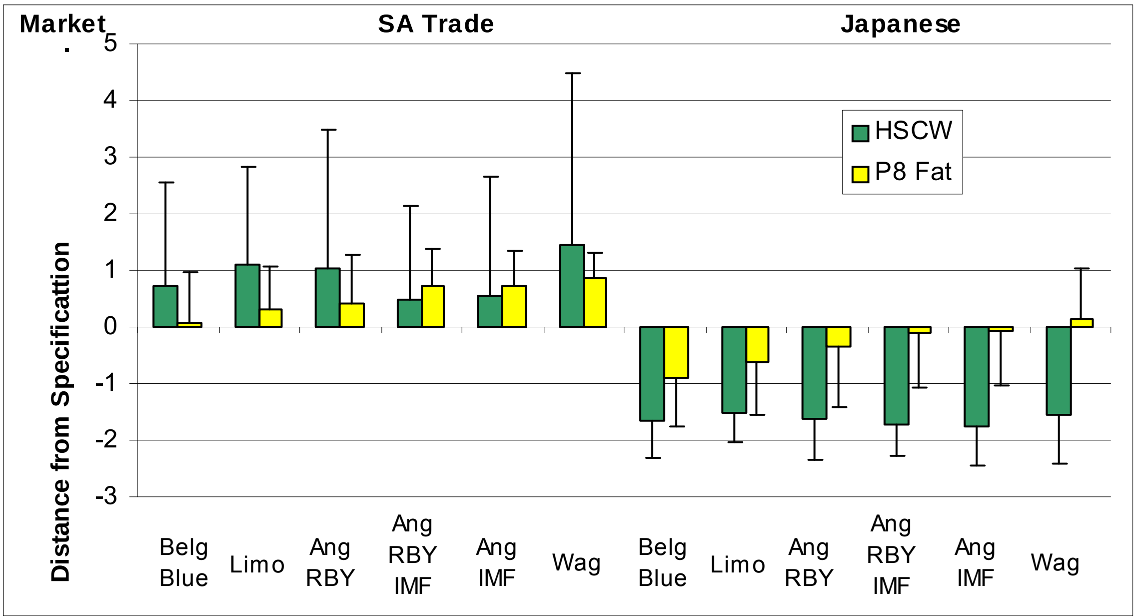


Figure 4.3.2. Comparison of the compliance to weight and fat specifications for different markets (SA trade or Japanese) using the "distance from specifications" technique.

4.3.4.7 Discussion of SA results

The responses seen at the SA (Struan) site are consistent with those at other sites particularly the results from Victoria where both the sires and the dam breeds were almost identical. Thus most of the conclusions regarding the expression of carcase potential in the progeny as affected by the parental genotypes are the same as for the Vic (Hamilton) site. Again there was a good demonstration of the responses in yield and fatness traits that was clearly related to the sire EBVs or breed characteristics. This reinforces confidence in the use of sires selected on BREEDPLAN data, providing sound bull selection guidelines for producers.

Effects due to the breed of the dam were evident, with the progeny of Limousin sired cows having significantly less marbling than those from Angus sired cows (1.4 compared to 1.7). The breed of the maternal parent of the dam on the other hand (either Hereford or Angus) did not significantly affect any carcase trait. When the data from the SA (Struan) site are combined with those from Victoria in a later analysis, the relative contributions of the parental genotypes to responses in the progeny can be further examined.

Although there were no growth treatments applied as such, there were no interactions between year and sire type in the data, which suggests that the ranking of sires based on their progeny for various traits should be similar in different seasons.

As for many, if not most beef producing areas, variation between years in pasture quantity and quality causes large variation in cattle growth rates, thereby affecting finished and carcase weights and the suitability of animals for alternative markets. Although production in this area of SA is traditionally based on pasture finished animals aimed at the Japanese trade, it became obvious that seasonal conditions prevailing after the first year of the experiment would not allow high carcase weights to be achieved without considerable supplementation. Thus the management of the cattle was directed towards the more practical endpoint of the SA domestic/EU markets where lower carcase weights were preferred. This situation is illustrated by the examination of compliance rates, showing those from Wagyu sires with the lowest compliance for export market requirements, but highest for the domestic trade due to their lighter carcase weights.

4.4 Details, Results and Discussion – WA site

4.4.1 Summary

In this Regional Combinations experiment the effects of calving time, sire type and finishing growth path on herd productivity and profitability were investigated in the agricultural area of the south-west of Western Australia. Cows were mated to calve in either autumn (AC; March – April) or winter (WC; June – July) using sires selected with high estimated breeding values (EBV) for either retail beef yield (RBY%) or intramuscular fat (IMF%).

The progeny from the AC and WC groups were weaned in January and grown out on 3 different growth paths to an average live weight at slaughter (for steers) of 500kg.

There was no apparent difference between the two calving times in the reproductive performance of cows, with pregnancy test results, calf mortality and the weaning rates similar for both groups. However the energy requirement for WC cows and their calves was estimated to be approximately 17% less than for their AC counterparts because the winter born calves were weaned at 6, compared with 9 months of age. Actual pasture measurements indicated that consumption by the WC cows and calves was 13% less. This difference in feed requirement was reflected in the stocking rate which was maintained at about 20% higher for the WC system. In addition the amount of hay that was fed to AC cows during the autumn “feed gap” was 639 kg/hd while that fed to WC cows was 133 kg/hd. As a result of the 3 month difference in age, the predicted mean weaning weight of the AC progeny of 354kg was approximately 81 kg higher than that of the WC progeny (273 kg). Economic analysis of production to weaning indicated that changing calving from autumn to winter at an equivalent stocking rate increased the gross margin/ha by 9%, and by 53% when the stocking rate was increased by 10%. This outcome resulted from lower cost of supplementary feeding and more stock for sale in the WC system.

Following weaning, the progeny from the AC and WC groups were finished on 3 different regimes:- Fast – 1.1 – 1.3 kg/d on high concentrate feedlot diet; Slow - 0.5 – 0.6 kg/d to 400 kg liveweight then over 1 kg/d on high quality green pasture or Compensatory (Comp) - loss of approx 10% liveweight over autumn, then grown at over 1 kg/d on high quality green pasture after the opening rains. Finishing growth path had a number of important effects on carcase characteristics. Animals on the Fast growth treatment generally had higher P8 and rib fat thickness than those on the Slow or Comp growth treatments. Animals on the Fast growth treatment had the highest levels of intramuscular fat % while the Comp growth treatment had the lowest. Trends were similar for both AUS-MEAT and US marbling scores. There was also a significant effect of growth path on retail beef yield (RBY%) with the Fast growth treatment having the lowest yield, while the Comp growth treatment had the highest yield. Growth path also had an influence on the proportion of carcases that met abattoir specifications for hot standard carcase weight (HSCW), P8 fat and meat and fat colour. Fast growth treatment animals had the lowest compliance level with only 34.5% meeting all specifications while Slow and Comp growth treatments had compliance rates of 43 and 50% respectively. The Fast growth treatment had the best compliance for meat and fat colour. Gross margin analysis for the weaning to finish period showed that the Slow and Comp growth treatment were more profitable than the Fast growth treatment in WC calves. However in the AC calves the Fast growth treatment was more profitable.

The progeny of RBY sires had higher final live weight and HSCW than either RBY&IMF or IMF sired animals. There was also a strong tendency for RBY sired animals to have lower levels of fat cover but the effects were not always significant. IMF sired animals had higher AUS-MEAT marbling scores, US marbling scores and levels of IMF% than the RBY sires. RBY sired animals also had higher estimated RBY% than those from the IMF sires while RBY&IMF sired animals were intermediate and not significantly different from either. Over 20 % of the progeny of RBY&IMF sires did not meet specifications for meat colour compared with less than 10% for the RBY and IMF sired animals.

Calving time had very little influence on most carcase characteristics. However, there was a consistent trend for WC progeny to have higher marbling and IMF% than their AC counterparts, although the differences were significant for IMF% only.

Heifers grew slower and had lighter carcase weights than steers. Heifers were also fatter and tended to have slightly higher marbling scores than the steers. Heifers had lower RBY% than the steers. Ossification scores for heifers were approximately 30 units higher than steers in AC calves and about 20 units higher in WC calves. Steers were slightly more successful than heifers at meeting carcase specifications and received less discounts and higher prices than heifers.

4.4.2 Background

The work reported in this section is from the Western Australian component (WA site)) of the Regional Combinations project as described by McKiernan *et al.* (2005). The primary aim of the overall project was to examine the effects of treatments causing differences in growth pathways between weaning and finish on meeting market specifications in animals with diverse genetic potential for carcase traits. However, the various sites involved were also able to address concurrently aspects of management, compatible with the design, that provided additional industry relevant information from the experiments. At the WA site, time of calving was considered a major local management issue which has a large effect on profitability of beef production; in fact time of calving impacts on breeding enterprises in any region. Thus a considerable part of this WA site report is devoted to the effects of time of calving in conjunction with the responses to growth treatments and to a lesser extent effects of the sire on production and carcase traits. Detailed measurements of pasture availability and estimated intake were also made at this site and related to animal requirements and live body measurements, so these aspects have also assumed an importance in this section of the report.

The Mediterranean climate of south-western Australia involves a dry summer/autumn period with generally a late autumn break, followed by a wet winter and spring. This climatic environment results in rapid pasture growth in late winter and spring with associated high cattle growth rates. In these predominantly annual pastures a decline in quantity and quality of dry standing pasture through summer and autumn is associated with poor to negative growth rates in cattle if supplements are not provided.

Traditionally in the south-west of WA calving is between February and April with weaning around December/January. This production pattern means lactating cows can often be at peak of production at a stage when pasture nutrition restricts growth/lactation and supplements are required to optimise milk production or survival. The current traditional system evolved through the demand for increasingly heavy milk-fed vealers slaughtered for the domestic market around 9-10 months of age. However at this time, the majority of weaners are not suitable for slaughter and will be finished either in the feedlot, on high-grain diets or on pasture. Although there is an increasing demand for grain-fed cattle for domestic consumption many cattle are still pasture finished.

Supplementing the lactating cow is a major cost in this traditional calving system. Generally the earlier the calving occurs in the year, the higher the supplementary feeding cost. Calving later will significantly reduce these costs and supplements are likely to be used more efficiently if fed directly to the weaned calf.

In dry land pasture systems there are increasing arguments offered for benefits from calving later (winter/spring) and weaning calves younger, especially if they are destined for growing out in a feedlot. In the whole farm production system this approach may well have economic benefits in the breeder phase, for example: i) higher stocking rates resulting in more calves/ha, ii) need for less conserved feed, iii) joining on a rising plane of nutrition, and iv) the associated earlier weaning allows for a longer period between weaning and calving. Obviously there are some negatives such as: i) likelihood of increased level of dystocia, ii) possible increase in calf scours, iii) wetter conditions and shorter day length during calving, compromising husbandry, and iv) lighter calves at weaning if weaned at the same time.

In the yearling phase calves are likely to be weaned younger and consequently may require better quality feed over summer to perform as well as older weaners at the same time of year on similar pastures. However, if these weaners are destined for growing out in a feedlot they are less likely to exceed domestic target turn-off weights, especially in the case of the later maturing breeds and will be suitable for finishing later in the year.

With estimated breeding values (EBVs) of various live and carcase traits now available to producers, a clearer understanding of the likely carcase outcome from different combinations of the EBVs in different management systems within a range of environments is both possible and desirable. Intra-muscular fat (IMF) and retail beef yield (RBY) are two carcase traits which can significantly influence the profitability of a beef enterprise. Intra-muscular fat is an important trait associated with meat eating quality and can demand a premium price in some export markets.

Thus the aim of this experiment at the WA site was to determine, i) the effect of a better synchronisation of calving with pasture growth on productivity and profitability of the breeder herd and ii) the effect of genetics and growth paths on growth, carcase characteristics, meat quality and the proportion of cattle achieving specifications for the heavy domestic market. Specifically the it examined, i) the effects of different growth paths and feeding regimes in cattle with diverse genetic characteristics for RBY and IMF on meat quality of slaughter cattle and, ii) will provide guidelines to producers to achieve higher compliance with market specifications, meat quality and profitability by using combinations of genetics and appropriate growth paths for steer and heifer production in south-western Australia.

4.4.3 Additional methods

The general design and methodology of the Regional Combinations project was described by McKiernan *et al.* (2005). Details specific to the WA site now follow, with further description also given in Appendix 4. A summary of the main features are:-

Two times of calving - Autumn calving, (AC) and Winter calving (WC):

High accuracy EBV (70% and above) Angus sires in the 1 to 5 percentile bands for either RBY%, IMF% and both RBY% & IMF%. These sire groupings will subsequently be referred to as the 3 “types” of sires, although they are also analogous to “classes” at the other sites, since there were no other breed types used here within the 3 classifications. The types will subsequently be referred to as RBY, IMF and RBY&IMF.

The progeny from both the AC and WC calving period were weaned in early January each year. A total of 150 progeny per time of calving from the selected sire types were chosen for finishing on three different post weaning growth paths over the 3 years.

Three post weaning growth treatments were:

Rapid growth (>1kg/d) from weaning to feedlot entry weight of 400 kg with slaughter at final average live weight of 500 kg (steers);

Slow growth from weaning (~ 0.6 kg/d) to 400 kg live weight then rapid finish on pasture (or feedlot) to final average live weight of 500 kg for steers;

Compensatory (Comp) growth: Weight loss of approximately 10% from weaning, over the next 4-5 months, followed by compensatory growth and finish on pasture to final average live weight of 500 kg for steers. The Slow (2) and Comp (3) cattle were slaughtered on the same day.

Collection of carcase information at slaughter and statistical analysis of data was essentially as described for other sites.

Statistical analysis procedures were similar for all sites and used the PC software package Genstat 9 (2006), with a linear mixed model REML procedure. The analysis model for each site was modified from that used for NSW as described in the general Methodology section (3.2). HSCW was included as a co-variate for all other carcase traits and was significant in most cases. Weaning live weight was included as a covariate in analysis of slaughter live weight and HSCW, while P8 fat scan was included as a covariate for the analysis of P8 fat depth at slaughter. Log transformations were found necessary for analysis of some traits at the WA site.

Economic evaluation was conducted at two stages by comparing gross margins. The first compared the profitability of production to weaning for the WC compared to the AC production systems. The second examined the effect on profitability of production from weaning to finish of the growth treatments within the WC and AC systems.

4.4.4 Results and Discussions

4.4.4.1 Reproductive phase

4.4.4.1.1 Reproductive performance

Table 4.4.1 shows the numbers of calves sired by RBY, RBY&IMF and IMF sires as a result of the artificial insemination (AI) program in AC and WC cows in each of the three years of the experiment. The success rate of the AI program generally ranged between 50 and 60%, except for the WC cows in 2002 where the success rate was only 38%. The relatively small number of calves produced by RBY&IMF bulls was due to the fact that semen was available from only 2 sires of that type.

Table 4.4.1. Number of cows artificially inseminated (AI) and the number of calves weaned that were sired by RBY, RBY&IMF and IMF sires in autumn and winter calving groups in each the three years.

Season& Year	Cows AI	RBY	RBY&IMF	IMF	Total AI	% Calves
			Number of Calves			
Autumn 2002	274	58	9	78	145	52.9
Winter 2002	233	42	5	41	88	37.8
Autumn 2003	275	70	11	78	159	57.8
Winter 2003	283	70	7	74	151	53.4
Autumn 2004	260	55	11	56	122	46.9
Winter 2004	232	48	12	57	117	50.4

The average live weights for AC and WC cows at mating and weaning and reproductive performance indicators are shown in Table 4.4.2. Of the cattle available in the different herds the proportions submitting to AI varied from 70.6% in WC cows in 2002 to 91.7% for AC cows in 2004. Submission to AI of cows in the first year of the experiment tended to be lower than in the second and third years, particularly in the WC cows. Pregnancy tested in calf performances of all the groups were over 90% except for the WC cows in the first year.

Table 4.4.2. The average (+ s.e.) live weight (LW) and reproductive performance of autumn and winter calving cows.

Autumn	LW at mating (kg) June	Submissions to AI (%)	PTIC† (%)	LW at weaning (kg) January
2002	428.5 (2.36)	82.0 (4.64)	91.3 (0.69)	609.8 (3.57)
2003	518.6 (3.00)	86.0 (3.51)	90.5 (0.74)	643.2 (3.40)
2004	532.7 (3.17)	91.7 (2.03)	96.5 (1.79)	664.9 (2.94)
Winter	**September**			**January**
2002	420.3 (2.32)	70.6 (2.40)	77.8 (4.38)	510.8 (3.34)
2003	509.9 (2.93)	83.7 (1.80)	95.0 (1.31)	587.9 (3.47)
2004	579.1 (3.57)	80.1 (3.30)	96.4 (0.43)	641.8 (3.39)

† Pregnancy tested in calf

The live weight measurements for the AC and WC cows over the period of the experiment are shown in Figures 4.4.1 and 4.4.2. Both groups were less than 450 kg at the commencement of the experiment. This was partly due to the young age of some of the cows and relatively poor seasonal conditions. Thereafter their live weights showed a similar cyclical pattern for both calving groups, with weights peaking at the end of spring and troughs at the end of autumn. After the first year, the live weight of AC cows increased by almost 100 kg at mating from the first to the second year and remained relatively stable in the third year. In WC cows there was a tendency for live weight at mating to continue to increase after the second year. The fluctuations in weight and fatness in the AC cows were greater in the AC cows than in the WC cows. In particular the decrease in live weight in WC cows between calving and the next mating was much reduced.

Fat thickness patterns followed very closely with live weight changes and were used as an indicator of condition of the animal.

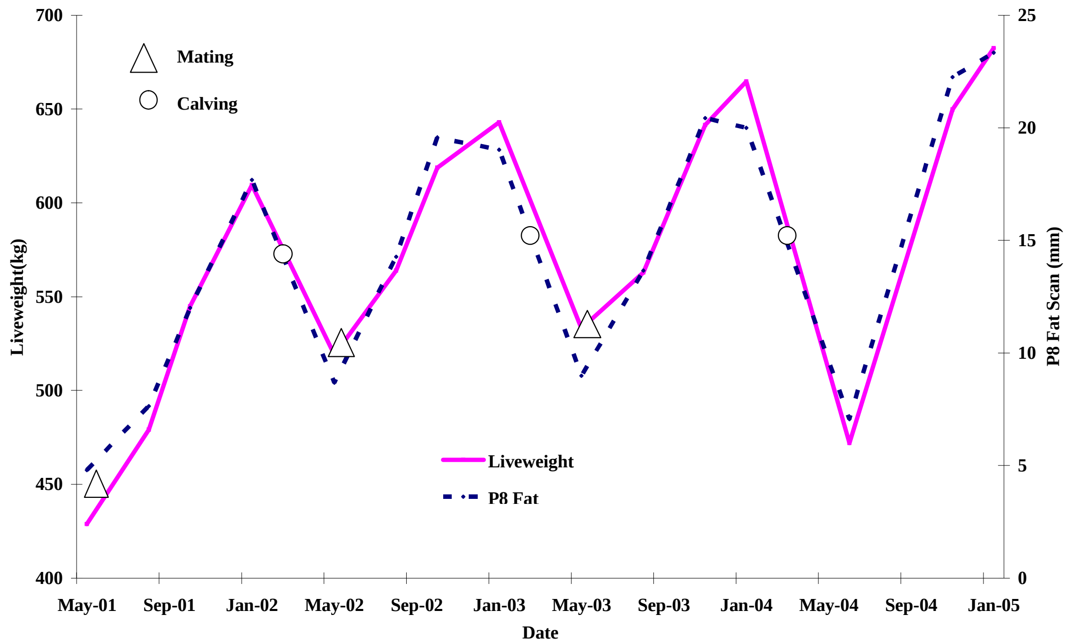


Figure 4.4.1. Live weight and P8 fat scan of autumn calving cows during the experiment.

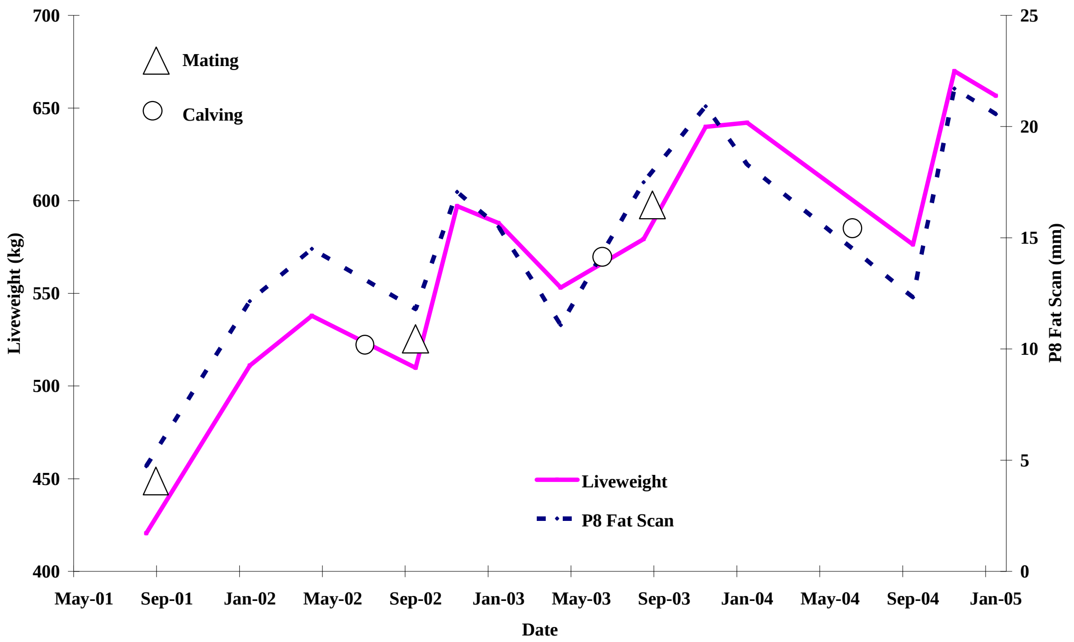


Figure 4.4.2. Live weight and P8 fat scan of winter calving cows during the experiment.

4.4.4.1.2 Pasture production and breeding herd requirements

The average green feed on offer to AC and WC cows over the pasture growing season is shown in Figure 4.4.3. From May onwards approximately 1000kg DM /ha were available to both groups. Feed available remained at about this level until late winter to early spring when growth rates begin to increase and provide a peak in pasture availability in late spring to early summer. There was a decline in both groups in late spring coinciding with the end of the seasonal rains. The seasonal pattern and feed on offer levels were similar for AC and WC groups.

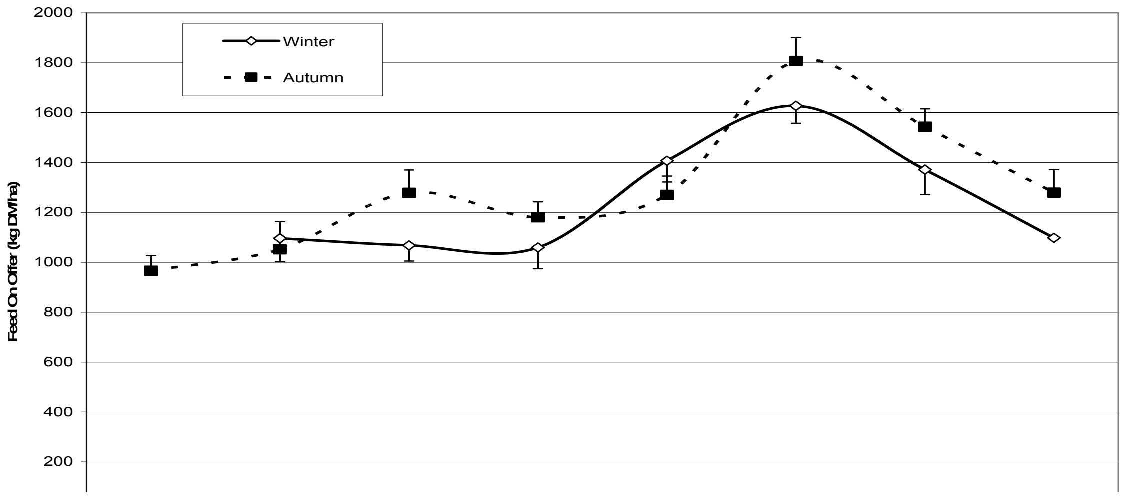


Figure 4.4.3. Average (and s.e.) green feed on offer (FOO) for the autumn and winter calving cows.

The change in stocking rate of the breeder herds over the period of the experiment is shown in Table 4.4.3. Stocking rate increased by an average of 0.15 cow-calf units/ha (14%) from 2001 to 2002. This coincided with the change to rotational grazing, allowing flexible grazing management and reducing the area grazed. This trend continued (6% increase) from 2002 to 2003 as livestock managers became familiar with and confident in rotational grazing. The WC herd commenced at a higher stocking rate than the AC herd and the difference has continued throughout the experiment.

Table 4.4.3 also shows the estimated feed requirements for AC and WC herds and the measured feed disappearance from June to November 2002 & 2003. Feed requirement was predicted using actual live weight changes and the measured pasture feed quality using GrazFeed. Feed disappearance was calculated by measuring the amount of feed that disappeared from the paddock during grazing. This consists of both the amount eaten and losses through trampling and decay. Calculated feed requirement for the WC cows averaged 17% less than for AC cows, while feed disappearance from paddocks grazed by WC cows averaged 13% less than for AC cows.

Table 4.4.3. Stocking rate, feed requirements and pasture disappearance of the autumn and winter calving cows and calves over 3 years.

Year	Stocking rate cow-calf/ha			Feed requirements kg DM/head/day		Feed disappearance† kg DM/head/day	
	Overall	Autumn	Winter	Autumn	Winter	Autumn	Winter
2001	0.89	0.77	1.07				
2002	1.04	0.97	1.10				
2003	1.11	1.01	1.22	16.7	13.2	22.4 (2.12)	19.6 (2.88)
2004	1.17	1.07	1.28	18.3	15.9	20.0 (1.03)	17.3 (1.26)

† Feed disappearance was only recorded in the last 2 years when the cattle were being rotationally grazed.

In all years, growing season rainfall was below average, with the Wagerup site receiving ~ 86 % of the average rainfall while the Pinjarra farm received between 78 and 88% of average.

Figure 4.4.4 shows the seasonal feed energy requirements of the AC and WC herds (including cow, calf and foetus) compared with the energy supplied by the pasture. Green feed is generally available from May to November/December and dry feed from January to April. This highlights a shortfall in pasture energy available between February and June and a surplus from July to November. The deficit between February and June was filled by supplementing the cows with hay. In our experiment the amounts required for the AC and WC cows were 629 and 133 kg/hd respectively. The surplus during the spring flush was estimated to be 810kg/hd for the AC cows and 1325 kg/hd for the WC cows. Energy consumption again exceeded pasture supply in late lactation (November-December), but cattle were able to meet their energy needs from standing surplus spring feed. It is also clear that the requirements for the WC group are generally much lower for most of the year than for the AC group.

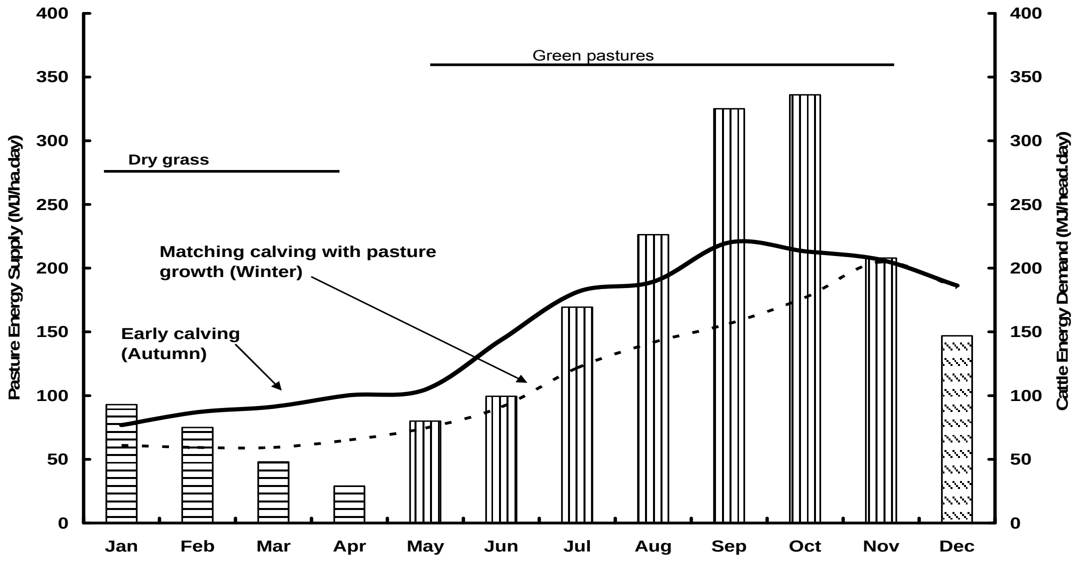


Figure 4.4.4. Estimated daily energy supplied by pasture and energy consumption of cows and calves for autumn and winter calving herds run at 1.0 cow-calves/ha (calculations from GrazFeed). Green feed was available from May to November/December and dry from January to April.

4.4.4.2 Performance of progeny to weaning

The results of the performance of the progeny to weaning are shown in Table 4.4.4.

4.4.4.2.1 Sire type

Table 4.4.4. Predicted means (and LSDs) for growth characteristics to weaning in progeny from sires with high EBVs for retail beef yield (RBY) or intramuscular fat (IMF), for steers and heifers, from either autumn or winter calving.

	Main effect	Weaning Live weight (kg)	Weaning P8 fat scan (log mm)*	(mm)	Live weight gain per day (kg)
Sire type	RBY	319.2[b]	1.490[a]	4.44	1.15[b]
	IMF	308.8[a]	1.699[b]	5.47	1.11[a]
	LSD	5.2	0.070		0.021
Time of calving	Autumn	353.6[b]	1.813[b]	6.13	1.09[a]
	Winter	274.3[a]	1.375[a]	3.96	1.16[b]
	LSD	11.8	0.122		0.057
Sex	Steers	323.6[b]	1.466[a]	4.33	1.16[b]
	Heifers	304.4[a]	1.723[b]	5.60	1.10[a]
	LSD	5.2	0.070		0.021

*log transformed data used in analysis

There was a significant difference due to sire type in weaning weight with RBY sired progeny being about 10 kg heavier (Table 4.4.4).

The progeny of RBY sires also had faster growth rate between the first weighing at between 2-3 months of age and weaning. RBY sired progeny had approximately 1mm lower fat cover as assessed by ultrasound scan at the P8 site than the IMF sired progeny.

4.4.4.2.2 Calving Time

There were significant differences between AC and WC progeny in all characteristics. The 3-month difference in birth date combined with the constant weaning time resulted in a difference of 79.3 kg in weaning weight (Table 4.4.4). The heavier AC calves were also fatter at weaning. WC calves however, grew at a faster rate than autumn calves between 2-3 months of age and weaning.

4.4.4.2.3 Sex

Steers were significantly heavier at weaning, had higher growth rate and were leaner than heifers

4.4.4.3 Profitability of Autumn versus Winter Calving (AC versus WC)

Results from the economic model (Table 4.4.5) indicate that changing calving from autumn to winter at an equivalent stocking rate increased the gross margin of the enterprise from $88/ha to $96/ha (9.1%). This was further increased to $135/ha, when the stocking rate increased by 10%, an increase of 53.4% over autumn calving. This improvement in financial performance was primarily due to a reduction in the cost of production in the winter calving enterprises by 11 c/kg sold in an equivalent stocking rate scenario and by 19 c/kg sold with the increased stocking rate. Although revenue/head sold was reduced in the winter calving enterprise, this was partly offset by increased numbers of calves, as well as cull cows that were available for sale. One factor largely responsible for lower costs of the winter calving enterprise was the greatly reduced cost of feeding hay.

Table 4.4.5. Economic indicators associated with Autumn and Winter calving

Performance Indicator	Autumn Calves	Winter Calves	Winter Calves + 10% Stocking Rate
Number of cows	284	311	374
Stocking rate (DSE)	9.2	9.2	11.1
Cost of hay fed ($)	8513	1962	2355
No. progeny sold	196	209	249
Gross Margin ($)	30923	33720	47322
Gross Margin/ha ($)	88	96	135
Herd cost per head* ($)	73	46	46
Return per head sold ($)	583	468	468
Beef sold /ha (kg)	235	209	251
Cost of Production /kg sold ($)	1.19	1.08	1.00
Margin /kg sold ($)	0.38	0.46	0.54

* Includes variable costs directly related to the herd; e.g. requisites, hay supplement & selling costs.

4.4.4.4 Post weaning growth phase

4.4.4.4.1 Post Weaning Growth paths

The growth of AC and WC animals from weaning in the Fast, Slow and Comp treatments in each of the three years of the experiment is shown in Figure 4.4.5. Except in the first year, when there was a delay in the allocation of animals to their treatments, the Fast treatment generally grew at a rapid rate once placed onto feed. There was one period in the second year when the WC Fast animals suffered a short period of weight loss. This was due to particularly muddy conditions developing in the feedlot which hampered their performance.

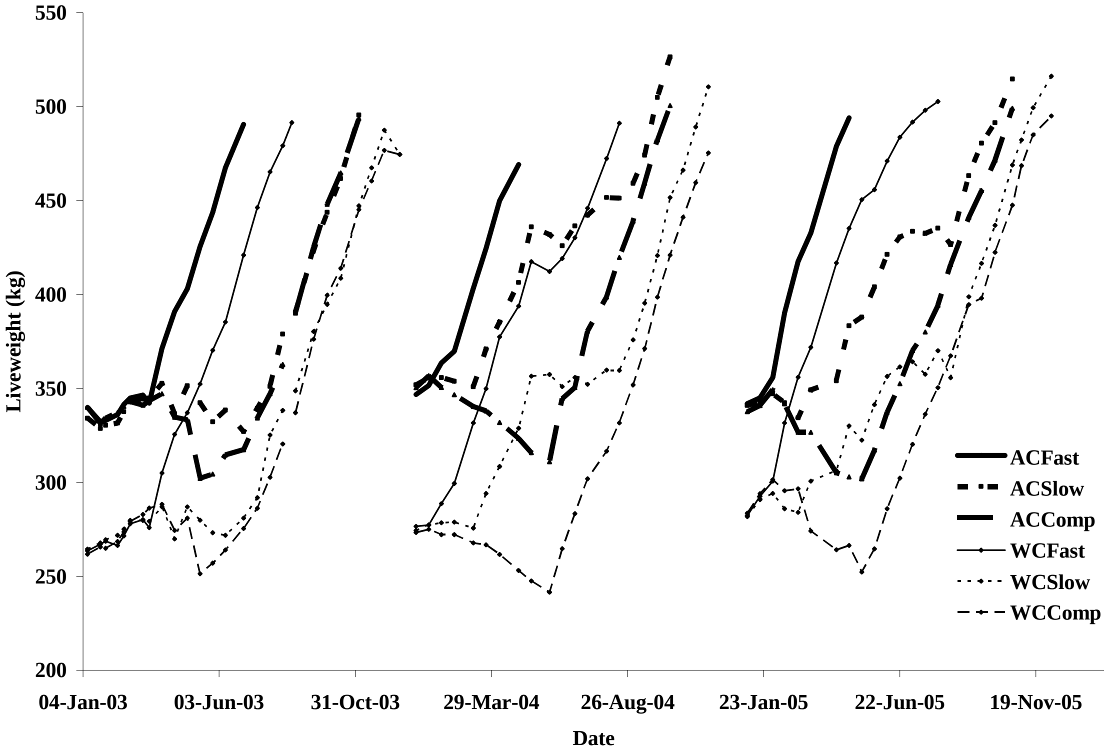


Figure 4.4.5. Live weight change of autumn or winter born calves over three years given Fast, Slow and Comp growth treatments.

In the first year both AC and WC Slow growth animals grew much Slower than anticipated on the pasture and supplementary feed that they were offered and there was a relatively small "gap" between the Slow and Comp growth animals. In the second and third years the difference between these treatments was much more pronounced and the Comp animals did not fully compensate and were slightly lighter when the two groups were slaughtered at the same time.

Table 4.4.6 shows the live weights, gains and feeding periods for AC and WC calves for the different growth treatments. All AC groups were very similar in live weight both at weaning and at the time of allocation to the treatments as were the WC groups. AC calves were on average approximately 70kg heavier at weaning than the WC calves (unadjusted data). A small amount of live weight was lost between weaning and commencement of the treatments. While the loss for AC animals was 4.6 kg it was 9.9kg for the WC animals. The average feedlot feeding period for AC animals was 103 days while WC animals spent 191 days in the feedlot before slaughter. Growth rates over the feedlot period were 1.34 and

1.11 kg/d for the AC and WC animals respectively. While the AC animals in the Slow and Comp treatments were slaughtered after 262 days at growth rates of 0.63 and 0.58 kg/d, the WC animals took 305 days to reach a suitable slaughter weight and grew at 0.71 and 0.65 kg/d respectively. The average period of live weight loss was 103 days after allocation during which time the AC animals lost 41.9 kg (12.1% of their starting weight) at 0.41 kg/d. During the same time the WC animals lost 36.0kg (12.7%) at 0.35 kg/d. Hence the target liveweight loss of approximately 10% was achieved. Following the restriction period the AC Comp animals remained on pasture for 159 days and gained at 1.22 kg/d while the WC animals grazed a further 202 days and gained at an average of 1.16 kg/d.

Table 4.4.6. Live weights at key times, feeding periods and liveweight gains of autumn and winter born calves raised on Fast, Slow and Comp growth paths.

Trait	Autumn			Winter		
	Fast	Slow	Comp	Fast	Slow	Comp
Weaning live weight (kg)	342.9	342.1	342.5	274.9	273.4	272.9
Initial* live weight (kg)	347.7	347.5	346.2	283.3	282.6	284.0
Feeding period (d)	103	262	262	191	305	305
Final live weight (kg)	484.5	511.8	497.7	494.8	499.9	481.5
Growth rate (kg/d)	1.34	0.63	0.58	1.11	0.71	0.65
Minimum live weight(kg)			304.3			248.0
Loss period (d)			103			103
Live weight loss (kg/d)			-0.41			-0.35
Compensatory period (d)			159			202
Comp period gain (kg/d)			1.22			1.16

*Live weight at allocation to the treatments

4.4.4.4.2 Pasture quality

Average quality of pasture available on the experimental areas at Vasse Research Station is shown in Figure 4.4.6 while the FOO during the pasture growing feed season between May and December is shown in Figure 4.4.7. Both crude protein and metabolisable energy levels on this improved grass / clover pasture reached a maximum soon after the onset of seasonal rains, usually in April-May. Thereafter crude protein content was maintained at a high level until the beginning of October when there level fell as the pasture dried off. Energy was maintained at a relatively high level through to the end of November. By the beginning of January, both protein and energy were low and remained so until the start of the new green feed season.

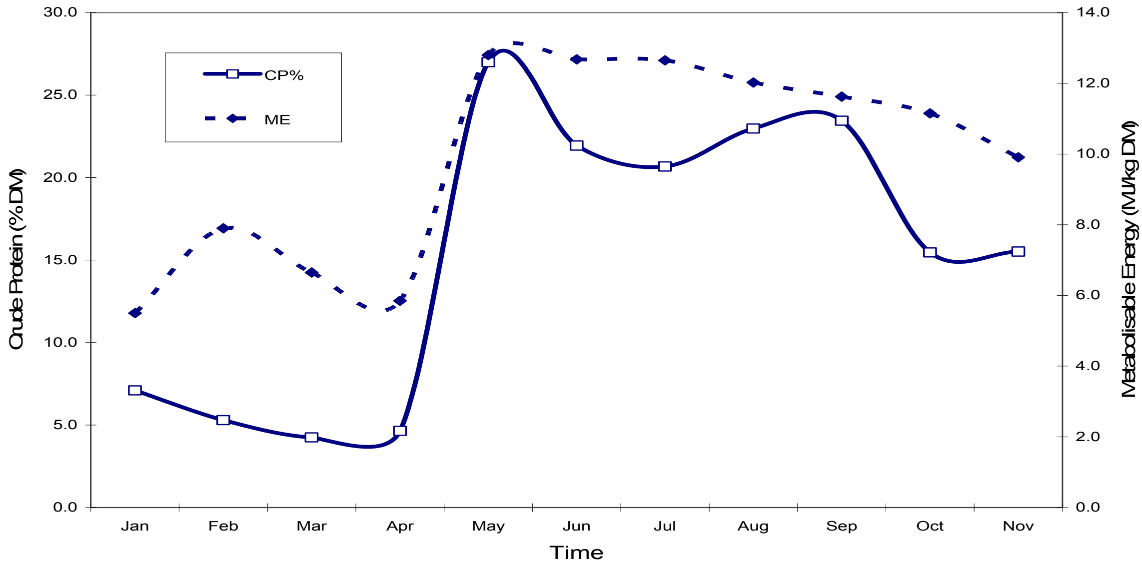


Figure 4.4.6. Average crude protein and metabolisable energy values of the annual pastures grazed by the animals in Slow and Comp treatments

Following opening rains in April / May the available feed supply had reached a level where grazing could commence by the end of May to early June (Figure 4.4.7). Around 1200kg/ha were usually available by the end of May or early June. There was a slight increase in available feed until the middle of June followed by a slight decline. Levels remained between 1000 and 1500 kg/ha until the end of September when levels began to increase. Because of lower stocking rate on the Comp growth treatments, the available pasture was maintained at a slightly higher level than in the Slow growth treatments.

4.4.4.5 Carcase characteristics

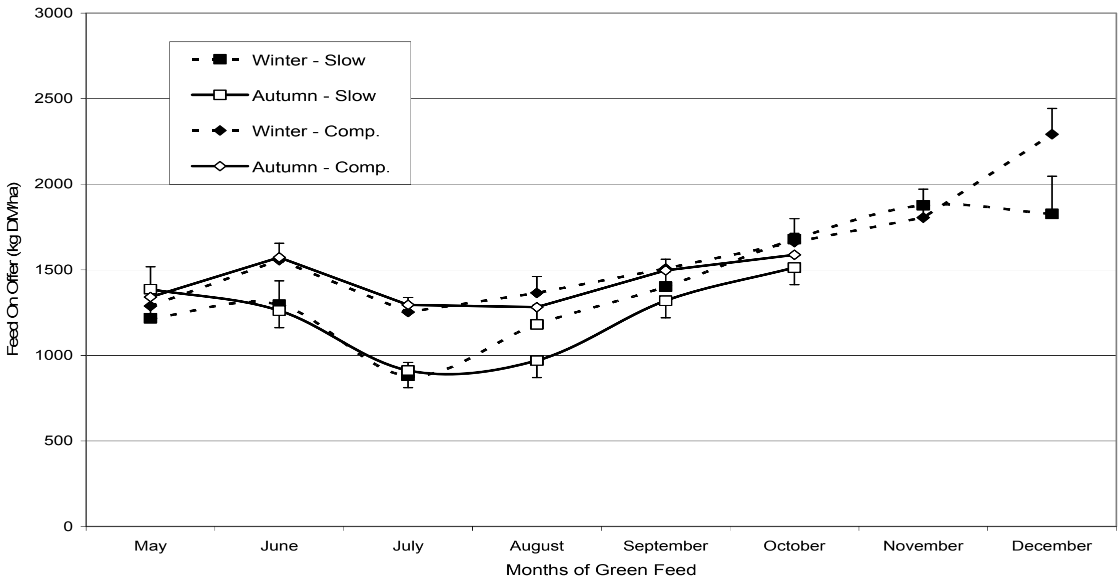


Figure 4.4.7. Average (and s.e.) Feed on Offer (FOO) for the cattle in the Slow and Comp treatment groups during the growing the season.

4.4.4.5.1 Effect of growth treatment

The effects of growth treatment on live and carcase characteristics are shown in Table 4.4.7.

Slaughter live weight
Animals from the Slow growth treatment had higher slaughter live weight than animals from both the Fast and Comp growth treatments. There was no difference between the latter.

Hot Standard Carcase Weight (HSCW)
Animals from the Fast growth treatment post weaning had a higher HSCW than both the Slow and Comp growth treatments. Animals from the Slow growth treatment also had a higher HSCW than the Comp treatment.

P8 Fat Depth
There was a significant growth treatment by sex interaction for P8 Fat depth. After adjustment for differences in HSCW, steers from the Fast growth treatment had higher fat depth than those from the Slow and Comp growth treatments. A similar trend was evident in heifers however in this case the Fast growth animals had higher fat depth than the Slow growth treatment.

Eye Muscle Area

No differences were found in eye muscle area, adjusted for HSCW, between growth treatments.

Marbling scores and IMF%

No differences in either the AUS-MEAT marbling score or the US marbling score were found among growth rate treatments. A log transformation was appropriate for analysis of the AUS-MEAT marbling scores. Growth treatment affected intramuscular fat percentage with animals from the Fast treatment having the highest level. Animals from the Slow growth treatment also had higher levels of IMF% than those in the Comp growth treatment.

Ossification

There was a significant growth treatment x calving time x sex interaction and predicted means are shown in Table 4.4.7. The Fast growth treatment had lower ossification scores than the Slow and Comp treatments in both steers and heifers from the autumn calving. In addition the Comp growth treatment had a lower ossification score than Slow growth treatment in AC heifer calves. There were no differences among growth treatments in either steer or heifer WC calves.

Retail beef yield

RBY as estimated from VIAscan was significantly affected by growth treatment and was highest for the Slow growth treatment and lowest for the Fast growth treatment.

Table 4.4.7. Predicted means (and s.e.d.) for post weaning growth and carcase characteristics of animals from Fast, Slow and Comp growth treatments.

Trait			Growth treatment				
			Fast	**Slow**	**Comp**	**s.e.d.**	**P**
Slaughter live weight (kg)			490.3^{a}	507.6^{b}	490.6^{a}	6.726	<0.01
HSCW (kg)			267.3^{c}	260.1^{b}	248.3^{a}	1.63	<0.001
P8 Fat depth (mm)	Steer		10.92^{c}	7.90^{c}	8.42^{c}	0.3001	<0.001
	Heifer		13.00^{c}	11.80^{b}	12.40^{bc}		
LogRib fat (mm)	Steer		2.2286^{bc}	1.789^{a}	1.890^{a}	0.09403	<0.001
	Heifer		2.404^{c}	2.109^{b}	2.219^{bc}		
MSA EMA (sq cm)			67.60	67.68	67.31		ns
Log* MSA AUS marble score			0.2265	-0.0808	-0.0732		ns
MSA US marble score			348.0	314.2	311.0		ns
Log** IMF %			1.656^{c}	1.505^{b}	1.428^{a}	0.04177	<0.001
Ossification	Male	Autumn	121.0^{a}	129.6^{b}	128.5^{b}	2.520	<0.004
		Winter	125.1^{ab}	128.9^{b}	127.0^{b}		
	Heifer	Autumn	149.1^{c}	167.7^{e}	159.7^{d}		
		Winter	151.8^{c}	152.0^{c}	151.6^{c}		
VIAscan RBY (%)			68.35^{a}	69.67^{c}	69.20^{b}	0.186	<0.001

Means in same row with different superscripts are significantly different at P<0.01 level.
* 0.1 was added to the value before the log transformation
** 1.0 added to the value before the log transformation
Significant interactions
P8Fat depth - Growth treatment x sex
Log Rib fat - Growth treatment x sex
Ossification – Growth treatment x calving time x sex

4.4.4.5.2 Effects of Sire Type

The effects of sire type on live and carcase characteristics are shown in Table 4.4.8.

Slaughter live weight
The progeny of RBY sires had greater slaughter liveweight than either of the other two types. There was no difference between those from IMF and RBY&IMF sire types.

HSCW
The progeny of animals with high EBVs for RBY had approximately 10 kg higher HSCW than either of the other two types. There was no difference between those sired by bulls with high EBV's for IMF and both RBY and IMF.

P8 and Rib Fat Depth
The progeny of RBY bulls had a P8 fat depth of 9.94 mm compared with those of 10.06 mm and 11.19 mm for progeny of RBY and IMF and IMF bulls. However these differences were not significant. For log rib fat depth the progeny of IMF sires had higher rib fat than either RBY or RBY&IMF sires. There was no difference between the latter.

Eye Muscle Area
EMA ranged from 66.52 sq cm for the progeny of IMF sires to 68.18 sq cm for those from RBY and IMF sires. These differences however were not significant.

Marbling and IMF%
A log transformation was required for the analysis of the AUS-MEAT marbling scores. These showed a lower level of marbling in the RBY sired animals than in both the RBY&IMF and IMF sired animals. The latter two were not different. US marbling score showed a very similar pattern with the RBY animals having lower scores than the other two types. For IMF% a log transformation of the data was also required, and there was a significant sire type by calving time interaction. RBY sired progeny had lower IMF levels than both the other two types in the AC group while they had lower IMF level than only the IMF sired progeny in the WC group.

Ossification
Ossification scores did not differ between the three different sire types. The progeny of back up bulls (results not shown) had lower ossification scores than the RBY&IMF sires.

Retail Beef Yield
Retail beef yield for the RBY sired animals was higher than that for the IMF sired progeny. Progeny from bulls with high EBVs for both traits were intermediate between the two and not significantly different from either group.

Table 4.4.8. Predicted means (and s.e.d.) for post weaning growth and carcase characteristics of animals from sires with high estimated breeding values for Retail Beef Yield (RBY), RBY and Intramuscular Fat (RBY&IMF) and IMF.

Trait		Sire type			
	RBY	RBY & IMF	IMF	s.e.d.	P
Slaughter live weight (kg)	512.5 [b]	494.9 [a]	496.3 [a]	4.767	<0.001
HSCW (kg)	267.1[a]	257.9[b]	258.5[b]	2.782	<0.001
P8 fat depth (mm)	9.94	10.06	11.19		ns
Log rib fat	2.036[a]	2.054[a]	2.250[b]	0.07862	<0.01
MSA EMA (sq cm)	67.99	68.18	66.52		ns
Log*AUSmarble score	-0.1044[a]	-0.1502[b]	0.1119[b]	0.07862	<0.01
MSA US marble score	304.6[a]	341.8[b]	340.9[b]	11.39	<0.001
Log**IMF% Autumn	1.317[a]	1.509[b]	1.565[b]	0.062	<0.01
Winter	1.549[b]	1.609[bc]	1.678[c]		
Ossification score	141.8	144.7	140.1	1.993	<0.01
RBY (%)	69.43[b]	69.04[ab]	68.75[a]	0.220	<0.001

Means in same row with different superscripts are significantly different at P<0.01 level.
* 0.1 was added to the value before the log transformation
** 1.0 added to the value before the log transformation
Significant interaction
Log IMF%: Sire type x calving time

4.4.4.5.3 Effect of calving time

Predicted means for post weaning growth and carcase characteristics of animals from AC and WC are shown in Table 4.4.9.

Slaughter liveweight
Slaughter live weights for AC and WC animals were not significantly different.

Hot Slaughter Carcase Weight
Predicted means of HSCW for AC and WC animals were 259.3 kg and 257.7 kg respectively. These were not significantly different.

P8 and Rib Fat Depth
Progeny from WC cows were about 1.3 mm fatter at the P8 site than those for AC, but the difference was not significant. Differences between calving times for rib fat depth in the progeny were not significant.

Eye Muscle Area
WC progeny had slightly higher EMA than their AC counterparts and were 69.50 and 65.61 sq cm respectively. However the difference was not significant.

Marbling score and IMF%
There was no significant difference in AUS Meat marbling score between the progeny of AC and WC cows. For US marbling score there was a significant calving time by sex interaction. WC calves tended to have slightly higher US marbling scores than AC in both heifers and steers calves but the difference was not significant. There was a significant calving time x sire type interaction for Log IMF% (Table 4.4.8). In all sire types, WC had higher IMF% and the differences were significant for both RBY and IMF sired animals.

Ossification
Ossification scores differed between AC and WC calves only in heifers from the Slow and Comp growth treatments (Table 4.4.7).

Retail Beef Yield
Retail beef yield for both AC and WC calves were similar (69.19 and 68.96% respectively) and not significantly different.

Table 4.4.9. Predicted means (and s.e.d.) for post weaning growth and carcase characteristics of animals from autumn and winter calving

Trait		Calving time			
		Autumn	Winter	s.e.d.	P
Slaughter live weight (kg)		498.6	493.4		ns
HSCW (kg)		259.3	257.7		ns
P8 fat depth (mm)		10.07	11.34		ns
Log rib fat depth		1.996	2.235		ns
MSA EMA (sq cm)		65.61	69.50		ns
Log* Marbling (MSA)		-0.1726	0.2179		ns
MSA US Marbling	Steer	293.9[a]	330.1[ab]	14.31	<0.01
	Heifer	330.9[b]	342.6[b]		
Log**IMF%					
RBY (%)		69.19	68.96		ns

Means in same row with different superscripts are significantly different at P<0.01 level.
* 0.1 was added to the value before the log transformation
** 1.0 added to the value before the log transformation
Significant interactions
MSA US Marbling – Calving time x sex
Log IMF% - Sire type x Calving time (Table 4.4.8)
Ossification- Growth treatment X Calving time X sex (Table 4.4.7)

4.4.4.5.4 Effects of sex

Predicted means for post weaning growth and carcase characteristics of steers and heifers are shown in Table 4.4.10.

Slaughter live weight
Slaughter live weights for steers (510.8 kg) were higher than those for heifers (481.0 kg).

Hot Standard Carcase Weight
Steers (268.0kg) had approximately 20kg higher HSCW at slaughter than heifers (248.9kg).

P8 and Rib Fat depth
For P8 fat depth there was a significant growth treatment x sex interaction (see Table 4.4.7). For each growth treatment, steers were significantly leaner than heifers. Similarly for log rib fat depth there was a significant growth treatment x sex interaction (Table 4.4.7). Heifers were fatter than steers in both the Slow and Comp treatments but not in the Fast growth treatment.

Eye Muscle Area
There was no difference in EMA between heifers (67.38 sq cm) and steers (67.72sq cm).

Marbling and IMF%

Heifers had higher AUS-MEAT marbling score than steers. For US marbling score there was a significant calving time x sex interaction (see Table 4.4.9). The results showed a similar pattern as for the AUS-MEAT scores with heifers having higher US marbling scores than steers in both AC and WC. While the difference was significant in AC calves it was not significant in WC calves. Sex had an effect on IMF% with steers having lower content than heifers.

Ossification

Heifers had higher ossification scores than steers regardless of treatment group. Scores for steers ranged between 120 and 130 for steers compared with 150 and 170 for heifers (see Table 4.4.7).

Retail Beef Yield

The estimated yield for steers of 69.41% was significantly greater than that of heifers of 68.74%.

Table 4.4.10. Predicted means (and s.e.d.) for post weaning growth and carcase characteristics of steers and heifers.

Trait	Sex			
	Steer	**Heifer**	**s.e.d**	**P**
Slaughter live weight (kg)	510.8 ^{b}	481.0 ^{a}	1.113	<0.001
HSCW (kg)	268.0^{a}	248.9^{b}	1.022	<0.001
P8 fat depth (mm)				
MSA EMA (sq cm)	67.72	67.38		ns
Log* MSA Marble score)	-0.0642^{a}	0.1126^{b}	0.03175	<0.001
Log** IMF %	1.443^{a}	1.616^{b}	0.018	<0.001
RBY (%)	69.41^{a}	68.74^{b}	0.0689	<0.001

Means in same row with different superscripts are significantly different at P level.
* 0.1 was added to the value before the log transformation
** 1.0 added to the value before the log transformation
Significant interactions
P8 Fat Depth – Growth treatment x sex (Table 4.4.7)
Log Rib fat – Growth treatment x sex (Table 4.4.7)
Ossification – Growth treatment x calving time x sex (Table 4.4.7)
MSA US Marbling – Calving time x sex (Table 4.4.9)

4.4.4.5.5 Incidence of un-graded carcases

The number of carcases that failed to meet the requirements of MSA grading in the AC and WC calves grown on the Fast, Slow and Comp growth treatments is shown in Table 4.4.11. In both AC and WC groups the Slow and Comp growth treatments had many more carcases than the Fast growth that failed to grade. By far the most important reason for failure to grade was meat colour, usually accompanied by high pH (> 5.7). The number and percentage of carcases with high pH is also shown in Table 4.4.11. Animals in the Fast growth treatment had less than half the likelihood of producing dark cutting carcases (high meat colour scores). Of the 70 carcases with high pH, 43 were heifers while 27 were steers. Carcases from RBY and IMF sires produced 7.0 and 6.6% respectively of dark cutting carcases while those sired by the RBY&IMF bulls had an incidence of 17%. The numbers with high pH were very similar in each of the 3 years ranging from 22 to 25.

The feedback data on predictions from the MSA model supported better eating quality from the Fast grown animals compared to those from Slow or Comp growth treatments, as expected from the marbling and IMF% values. The raw means for the predicted eating quality of the strip loin cut were 59.6, 58.3 and 58.3 (palatability units - equivalent to CMQ4 scores) for Fast, Slow and Comp treatments, The higher carcase IMF% in the Fast treatment animals is confounded by the feedlot finish, but the trend in support of higher IMF animals was also apparent with the means of 59.5, 58.3 and 58.2 for IMF, RBY&IMF and RBY progeny.

Table 4.4.11. Comparison of carcases failing to grade MSA and with high pH in AC and WC calves raised on Fast, Slow and Comp growth paths.

	Autumn			Winter		
	Fast	**Slow**	**Comp**	**Fast**	**Slow**	**Comp**
Number Un-graded	9	32	28	4	22	28
Number over pH 5.7	7	19	13	4	10	17
% over pH 5.7	4.4	12.1	8.2	2.6	6.4	10.9

4.4.4.6 Meeting specifications

4.4.4.6.1 Effects of growth treatment

Details of how well carcases met specifications and the discounts and prices for carcases from animals from Fast, Slow and Comp growth treatments are shown in Table 4.4.12. Carcases were examined for compliance to the abattoir grid as used for payment, as well as their outcome from the alternative “distance from specifications” analysis.

Table 4.4.12. Percentages of carcases meeting abattoir grid specifications, average discounts for HSCW, P8 fat depth, fat and meat colours, average carcase prices and values for animals from Fast, Slow and Comp growth treatments. Also shown are the customer satisfaction indices, prices and values from the “distance from specifications” analyses.

Trait	**Growth treatment**		
	Fast	**Slow**	**Comp**
HSCW (kg)	266.0	259.7	247.9
Proportions meeting grid specifications (%)			
HSCW	58.1	68.7	79.0
P8 fat depth	63.6	76.0	78.7
Fat colour	100.0	91.0	91.0
Meat colour	96.8	88.1	88.8
Met all specifications	34.5	43.0	50.0
Average discount (c/kg)			
HSCW	7.19	4.88	2.85
P8 fat depth	4.31	3.45	3.08
Fat colour	0	2.96	2.88
Meat colour	1.6	5.88	5.27
Total	**13.1**	**17.2**	**13.9**
Average price ($/kg)	3.17	3.13	3.16
Total value ($/head)	**840.77**	**811.69**	**784.63**
“Distance from specifications”			
Customer satisfaction index	- 2.91	- 32.05	- 25.96
Average price ($/kg)	3.25	3.01	3.07
Total value ($/head)	**863.61**	**780.95**	**763.75**

Animals from the Fast growth treatment had the lowest percentage of carcases meeting grid specifications for HSCW (58.1%), while those from the Comp growth treatment had the highest (approximately 79.0%). There were 109 of the 131 carcases outside specification from the Fast growth treatment which were over weight. Carcases from the Slow growth treatment also tended to be over weight (75 from 98 outside specification). Average discounts for HSCW reflected the proportions meeting specifications. The Fast growth treatment also had the lowest proportion (63.6%) that met the required P8 fat thickness range while the Comp growth treatment was again the highest (78.7%). In all growth treatment groups, the majority of carcases had P8 fat thickness greater than grid requirement. The Fast growth treatment groups had the best performance in both meat and fat colours and received the lowest average discounts for these characteristics. The Slow and Comp growth treatment groups had similar failure rates at 9% for fat and 11-12 % for meat colours. The net effect of the discounts that were applied resulted in similar prices for the Fast and Comp treatments and slightly lower for the Slow growth treatment. The return for the Fast growth treatment was almost $30 and $56 greater than the Slow and Comp growth treatments respectively. The customer satisfaction scores, as calculated by the distance from specifications method, also favoured the Fast growth treatment and resulted in a substantially greater differential in price /kg and in total price for the Fast growth treatment compared with the Slow and Comp.

4.4.4.6.2 Effects of Sire type

Details of how well carcases met specifications and the discounts and prices for carcases from progeny sired by bulls with high EBVs for RBY, RBY&IMF and IMF are shown in Table 4.4.13.

The progeny of RBY sires had the lowest proportion (65.4%) of carcases meeting the HSCW specification while those by RBY&IMF sires had the highest proportion (75.5%). Most of the progeny of all sire types had HSCW above the upper specified limit, but the highest proportion (97 of 109) was in those of RBY sired animals. The RBY&IMF sired animals had the highest proportion meeting P8 fat (81.1%) and fat colour (98.1%) specifications. However this group performed poorly for meat colour, where the proportion meeting specification was only 79.2 % compared with 92.0 and 92.3 for the RBY and IMF types respectively. This resulted in much greater average discounts being applied for meat colour for this group and lower average grid price for these carcases. The overall effect was that RBY sired progeny received approximately $26 and $33 more per head than the RBY&IMF and IMF sired progeny respectively. The customer satisfaction index, average price and total value from the distance from specifications analysis showed the same ranking of the different sire types. However the price and value of the RBY&IMF sired group received larger discounts for failing specifications than when prices were based on the grid schedule. As mentioned in the methods section the results relating to the RBY&IMF group should be assessed carefully in light of there being only 2 sires.

Table 4.4.13. Percentages of carcases meeting abattoir grid specifications, average discounts for HSCW, P8 fat depth, fat and meat colours, average carcase prices and values for progeny of sires with high estimated breeding values for RBY, RBY and IMF and IMF. Also shown are the customer satisfaction indices, prices and values from the "distance from specifications" analyses.

Trait		**Sire type**	
	RBY	**RBY&IMF**	**IMF**
HSCW (kg)	265.9	258.1	256.9
Proportions meeting specifications (%)			
HSCW	65.4	75.5	69.8
P8 fat depth	76.5	81.1	69.8
Fat colour	93.0	98.1	93.9
Meat colour	92.0	79.2	92.3
Met all specifications	43.0	49.1	42.1
Average discount (c/kg)			
HSCW	6.10	3.58	4.48
P8 fat depth	3.21	2.45	3.85
Fat colour	2.10	0.57	2.11
Meat colour	3.79	12.26	3.76
Total	**15.22**	**18.87**	**14.04**
Average price ($/kg)	3.15	3.11	3.16
Total value ($/head)	**836.30**	**803.00**	**810.92**
"Distance from specifications"			
Customer satisfaction index	- 21.05	- 31.65	- 18.73
Average price ($/kg)	3.11	2.97	3.13
Total value ($/head)	**825.59**	**769.17**	**804.30**

4.4.4.6.3 Effects of Calving time

Details of how well carcases met specifications and the discounts and prices for carcases of progeny from AC and WC cows are shown in Table 4.4.14.

AC and WC calves had similar proportions of the carcases that met specifications for HSCW. WC calves however had a lower proportion (65.1%) than AC calves (80.4%) meeting specifications for fat thickness. In both groups, most were over the maximum of 13 mm. A particularly high proportion of WC calves (98.7%) met the specifications for fat colour compared with AC calves (89.4%). Meat colour was similar for the two groups. Average discounts for AC and WC calves were similar at 16.11 and 13.32 c/kg respectively, as were the average price/head and the average total value /head. The distance from specifications analysis showed a distinct advantage to the WC calves which resulted in an 11c/kg differential in estimated average price/head. The difference in total value between AC and WC carcases was almost $30/head.

Table 4.4.14. Percentages of carcases meeting abattoir grid specifications, average discounts for HSCW, P8 fat depth, fat and meat colours, average carcase prices and values for animals born in autumn and winter calving systems. Also shown are the customer satisfaction indices, prices and values from the "distance from specifications" analyses.

Trait	**Calving time**	
	Autumn	**Winter**
HSCW (kg)	258.5	257.2
Proportions meeting specifications (%)		
HSCW	66.5	70.9
P8 fat depth	80.4	65.1
Fat colour	89.4	98.7
Meat colour	90.3	92.2
Met all specifications	42.5	42.5
Average discount (c/kg)		
HSCW	5.34	4.60
P8 fat depth	2.84	4.39
Fat colour	3.47	0.39
Meat colour	4.60	3.89
Total	**16.11**	**13.32**
Average price ($/kg)	3.14	3.17
Total value ($/head)	**810.59**	**814.23**
"Distance from specifications"		
Customer satisfaction index	- 27.02	- 13.39
Average price ($/kg)	3.06	3.17
Total value ($/head)	**789.19**	**816.83**

4.4.4.6.4 Effects of Sex

Details of how well steer and heifer carcases met specifications and the discounts and prices that were applied are shown in Table 4.4.15. Heifers had a higher proportion (75.3%) of carcases that met the specifications for HSCW than steers (62.5%). While most of the steers that missed specifications had higher HSCW than the upper limit (165 over, 16 under), the numbers of heifers either side of the specification were much more even (47 over, 65 under). While both had poor compliance, heifers were more likely to exceed the specifications for P8 fat thickness (174 over, 1 under) than the steers (72 over, 9 under). The total of the discounts for not meeting HSCW and P8 fat specifications were similar for steers and heifers. Heifers had slightly poorer performance in fat and meat colour than the steers so that the final grid price was $3.17/kg for steers and $3.14/kg for heifers. Because of the higher HSCW, the total value for steers was $846.60, compared to $775.46 for heifers. Heifers were more severely discounted in the distance from specification analysis with a differential of 7 c/kg between steers and heifers. This resulted in approximately $80 difference /head in total carcase value.

Table 4.4.15. Percentages of carcases meeting abattoir grid specifications, average discounts for HSCW, P8 fat depth, fat and meat colours, average carcase prices and values for steers and heifers. Also shown are the customer satisfaction indices, prices and values from the "distance from specifications" analyses.

Trait	**Sex**	
	Steers	**Heifers**
HSCW (kg)	267.6	247.3
Proportions meeting specifications (%)		
HSCW	62.5	75.3
P8 fat depth	83.4	61.4
Fat colour	95.3	92.7
Meat colour	92.0	90.5
Met all specifications	46.9	37.8
Average discount (c/kg)		
HSCW	6.43	3.40
P8 fat depth	2.17	5.17
Fat colour	1.46	2.47
Meat colour	3.15	5.43
Total	**13.25**	**16.33**
Average price ($/kg)	3.17	3.14
Total value ($/head)	**846.60**	**777.46**
Distance from specifications		
Satisfaction index	- 17.13	- 23.67
Average price ($/kg)	3.15	3.08
Total value ($/head)	**841.57**	**761.05**

4.4.4.7 Profitability of weaning to finish

The results of the economic evaluation of AC and WC calves following weaning and finished on different growth paths are shown in Table 4.4.16. The highest gross margin was achieved by the WC Slow ($44.37/hd) and Comp ($42.27) growth treatments. AC Slow and Comp were the least profitable while the two lot-fed groups were intermediate between the two. WC animals were more profitable than their AC counterparts. This was essentially a result of lower purchase costs due to lower initial liveweight, which meant their purchase price was between $5000 - $6000/draft lower than their AC counterparts. While the WC calves had higher feed costs, this did not override the lower purchase costs. Most other costs, such as animal health, labour, selling costs, freight and commission were similar for all groups.

Table 4.4.16. Costs, income and gross margins from autumn and winter born calves finished on Fast, Slow and Comp growth paths.

Trait	Autumn			Winter		
	Fast	Slow	Comp	Fast	Slow	Comp
Stock purchase						
Number of head	52	51	51	52	51	51
Purchase cost ($)	29,815	29,242	29,132	24,307	23,780	23,898
Freight ($) – (purchase)	260	255	255	260	255	255
Variable costs						
Animal health tags ($)	138	135	135	138	135	135
Feed ($)	9,229	9,925	8,622	14,591	10,575	9,348
Labour ($)	156	102	102	156	102	102
Interest – steers ($)	673	1,679	1,550	1,018	1,595	1,463
Interest – feed ($)	208	570	264	610	709	362
Sale costs ($)	239	235	235	239	234	235
Freight ($) – (sale)	520	510	510	520	510	510
Commission ($)	1,723	1,660	1614	1,781	1,652	1,581
Total variable						
Cost ($)	12,886	14,816	13,043	19,054	15,513	13,971
Sale price ($/kg HSCW)	3.19	3.08	3.15	3.15	3.18	3.17
Income sales ($)	43,082	41,502	40,358	44,530	41,302	39,536
Gross margin ($)	640	-(2,302)*	-(1552)	1,430	2,263	2,156
Gross margin ($/head)	12.30	-(45.14)	-(30.43)	27.49	44.37	42.27
Break–even $/kg LW	1.68	1.68	1.65	1.67	1.53	1.52
Break- even $/kg HSCW	3.14	3.25	3.27	3.05	3.01	3.00

Gross margin = Income sales - Purchase cost + Freight cost -Total variable
* Numbers in brackets are negative values

4.4.4.8 Discussion of WA results

The results clearly demonstrate the advantages of the WC system over the traditional AC system in the higher rainfall agricultural area of the south west of Western Australia. There were no indications of any differences between AC and WC treatments in calf survival or in losses from scours or dystocia. The pregnancy rates as evidenced by the PTIC results in Table 4.4.2 were all at an acceptable level except for the WC cows in the first year. The poor performance of this group was likely to be a result of the low live weight and fatness at the first mating, since the performance reached an acceptable level in the second and third years. Although the AC cows had a similarly low live weight and fatness at first mating, their PTIC levels were considerably higher. Improved live weight and fatness after the first year resulted in acceptable levels of reproduction in all groups. The lighter weights at weaning in January of the WC cows is likely to be due to higher nutritional demands of their younger, suckling calves compared with AC born calves. Although the WC cows were lighter at weaning they had similar mating weight to AC cows as a result of the additional time between weaning and mating. As shown in Figures 4.4.1 and 4.4.2 WC cows were generally increasing in weight at mating while the AC cows were mated after a long period of weight loss. The increase in live weight and fatness in both groups between the first and second years is attributed to the increasing average age of the cows and to poor seasonal conditions prior to the start of the experiment. As shown in Figures 4.4.1 and 4.4.2 there was less variation in live weight and fatness in WC cows. The weight loss in autumn calving cows between weaning and mating varied from 91kg in the first year to 192 kg in the third year. In the corresponding period for winter calving cows the losses ranged between 2 kg in the first year and 66 kg in the third year. While the losses in weight accounted for by bigger foetuses in the autumn calving cows would be greater than in the winter calving cows (6 months compared with 3 months) there would still be substantial differences in the loss of body reserves. Perhaps this is best indicated by the differences in fat thickness which ranged between losses of 9.0 and 12.9 mm in AC cows compared with loss of 5.9 to a gain of 2.0 mm for WC cows.

One of the great benefits provided by WC is the ability to increase the stocking rate compared with the AC system. As shown in Table 4.4.3 the stocking rate for WC cows was always more than 20% higher than for AC cows. The reason for this is demonstrated in Table 4.4.3, by the comparative feed requirements that have been calculated for the two systems. The energy requirement for WC and their calves was estimated to be between 13 and 21 % less than for their AC counterparts. Also shown in Table 4.4.3 is the feed disappearance that was measured in the AC and WC systems. The WC system had between 12 and 14% less feed disappear than the AC system. These data provide strong support to the theoretical values. Part of this difference is related to the fact that the progeny of WC cows are only fed for 6 months compared with 9 months for the AC progeny and also have a lower average liveweight during the pre weaning period. The difference in feed requirements is clearly illustrated in Figure 4.4.4 where the feed requirements throughout the year are plotted with the actual feed supply. Figure 4.4.4 highlights the difference in the feed deficiency that exists over the summer and autumn in the Mediterranean climate. The AC cows have a much larger deficit over a much longer period than the WC cows. While some of the deficit is made up by the mobilisation of body reserves in the form of body weight and fatness (Figures 4.4.1 and 4.4.2) at least some must be provided by supplementary feed. In this project the requirement for supplementary hay was measured as 629 kg/hd for the AC cows and 133 kg/hd for the WC cows. This hay can be provided by the feed surplus that is generated in winter and spring. The surplus has been estimated at 810 and 1325 kg/hd for the AC and WC systems respectively. The WC system results in a better match of the pasture growth pattern with the nutritional requirements of the animal, particularly during the autumn feed gap.

Table 4.4.4 shows that AC progeny had a predicted weaning weight of 353.6 kg compared with 274.3kg for the WC calves. The 3-month difference in age, combined with the constant weaning time resulted in this difference of 79.3 kg in weaning weight. The heavier weight of the AC calves also resulted in them being fatter at weaning. WC calves however, grew at a slightly faster rate than AC calves between the time when the calves were first weighed at 2-3 months of age and weaning.

The economic analysis of production to weaning for the AC and WC options (shown in Table 4.4.5) confirms the obvious advantages indicated by the physical measurements. When compared at the same stocking pressure (approx 10% more cows in WC) there is an advantage of almost 10% in the gross margin /ha. When compared using a further 10% increase in the WC system, similar to that in this experiment, the gross margin /ha increased to $135. A major component of the lower costs associated with WC is the reduction in the requirement for supplementary feed and increase in number of progeny available for sale. These two factors more than offset the higher liveweights of the AC progeny.

Another advantage of WC at an industry level is that it provides a supply of animals with different age, weight and fat characteristics from those produced from the traditional AC system. The traditional system probably evolved as a result of a local market preference for milk fed “baby beef”, where suckling calves are slaughtered between October and January at

8-11 months of age. Calving earlier in the year meant that there was more time available for the calf to achieve carcase weight specifications that have increased dramatically over the last 20 years. This production system has resulted in a spike in the supply of high quality beef between October and January. More recently there has been a need to spread the production of high quality beef more evenly throughout the year so that the industry is able to capture year round high quality export and domestic markets.

As shown in Figure 4.4.5 the target live weight patterns of cattle on the different growth treatments proved relatively difficult to achieve, particularly the divergent patterns for the Slow and Comp treatments. However, in the second and third years of the experiment, live weight differences between Slow and Comp treatments of around 100kg were achieved at the beginning of the growing season. While the aim of the experiment was to slaughter the Slow and Comp growth treatments from the same calving time at the same final live weight (500 kg for the steers) this proved to be impossible to achieve. As shown in Table 4.4.7 Slow growth treatments had significantly higher slaughter live weight than either Fast or Comp growth treatments. The difference in live weight among growth rate treatments was determined by a number of factors. Firstly the Comp growth treatments failed to fully compensate by the time the cattle reached the target slaughter live weight. Secondly, they had to be scheduled for slaughter some time in advance of their actual slaughter date. Therefore it was not possible to slaughter them at the exact time they reached their target live weight due to the difficulty in precisely predicting the live weight gain in the intervening period. As a result of their higher dressing %, animals on the Fast growth treatments had the highest HSCW despite having the lightest final live weight. This is consistent with previous experience that lot fed cattle have higher dressing percentages than those grazing pasture , and probably related to high concentrate rations. As noted in discussion of other sites, it is difficult to relate the trend for higher dressing % in faster grown animals with the reduction in gut size in restricted animals found by Ryan (1990). This would therefore appear to be related to other factors like omental fat and/or visceral organs, or simply gut fill. Faster grown animals had more external fat so they would need to have considerably less internal fat if that was the main driver of dressing %.

Finishing growth path had a number of important effects on carcase characteristics. Most of these related to the composition of the animal, particularly fatness. Those on the Fast growth treatment generally had higher P8 and rib fat thickness (Table 4.4.7). Higher IMF% was also favoured by continuous rapid growth with the Fast growth treatment having the highest levels while the Comp growth treatment had the lowest. Trends were similar for both AUS-MEAT and US marbling scores, but differences were not significant. While it might be expected that the levels of marbling would be related to fat content, the Comp growth treatment had higher fat thickness than the Slow growth treatment but had lower marbling levels, suggesting that the interruption to growth had an impact on the development of intramuscular fat. There was also a significant effect of growth path on RBY% with the Fast growth treatment having the lowest yield, while the Comp growth treatment had the highest. These differences in yield were inversely associated with the patterns in both P8 and rib fat which were lowest in the Slow growth treatment and highest in the Fast treatment.

The other effect of post weaning growth path was on ossification (Table 4.4.7). Lower ossification scores were found on the AC Fast growth treatment than on the Slow and Comp treatments in both steers and heifers. This was most likely associated with chronological age at slaughter as animals in the Fast growth treatment were over 150 days younger than those in the Slow and Comp treatments. However the same trend was not apparent in winter calves where there was a similar difference in age between the Fast and Slow and Comp treatments, but little difference in ossification scores.

Growth path also had an influence on the proportion of carcases that met the specifications for HSCW, P8 fat, and meat and fat colour (Table 4.4.12). Fast growth treatment progeny had the lowest compliance level with only 34.5% meeting all specifications. The major reasons for failure to meet specifications were excessive carcase weight and fatness. Fast growth animals achieved very high levels of compliance with fat and meat colour and received very low average discounts while those finished on pasture in the Slow and Comp treatments were much more likely to receive discounts for these characteristics.

The superior performance of the Fast growth rate treatment for fat colour would be expected as a result of the characteristics of their feed in the period leading to slaughter. Both Slow and Comp growth treatments spent at least 6 months leading to slaughter on green pasture that contains high levels of fat soluble carotene pigments that may be absorbed and lead to yellow fat colour. By contrast the high concentrate rations that made up the diet of the Fast growth treatment contain much lower levels of carotene pigments.

Diet almost certainly played a part in the differences in meat colour between the Fast treatment and the Slow and Comp treatments. Meat colour is largely determined by the influence of muscle glycogen level on meat pH, with high levels of glycogen providing a degree of insurance against high pH and dark meat. Fast growth animals are more likely to have high levels of muscle glycogen because of the high energy content of their diet. The grass fed animals were slaughtered when there was a decline in pasture quality so that the muscle glycogen levels were more likely to be lower and provide less insurance against dark cutting. As shown in Table 4.4.11 this trend was clearly evident in our data.

Despite the low overall compliance rate in the Fast growth treatment group, they received the lowest total discount for all factors and therefore the highest price /kg HSCW. The customer satisfaction index also rated Fast growth carcases very highly by comparison with the Slow and Comp animals. The calculated price /kg HSCW using this method was much more in favour of the Fast growth treatment than that based on the standard abattoir grid system.

The response following weaning to growth treatment, within calving time treatment, was variable. The Slow and Comp treatments in the WC management group were more profitable than the Fast growth treatment. However, the reverse was true in the autumn calving system, where the Fast growth treatment was the most profitable alternative. In this case there was little difference in the cost of feed and the animals in the Fast growth treatment received greater income from sales.

The advantage to the grass fed alternatives in the WC group lay chiefly in the lower cost of feed when compared to the cost of the feedlot ration given to the Fast treatment animals. Further investigation needs to be conducted to determine the effect on profitability if these cattle had been slaughtered earlier to better meet market specifications.

The requirement to process all animals at the target slaughter weight of 500 kg for steers made it very difficult to achieve high rates of compliance to grid specifications. The target should have been 450kg, however 500kg was chosen to ensure lighter animals (which would under commercial conditions be held on feed/pasture longer) were available for appraisal within the constraints of this trial design. This was made even more difficult by the requirement to slaughter the Slow and Comp groups at the same time. In normal circumstances where animals could be marketed as they reached the target weight, it should be possible to achieve almost 100% compliance with HSCW specifications. This would also have impact on other characteristics, especially fat thickness. The selection of a lower target slaughter weight would have improved compliance by avoiding the high rates of carcases exceeding the weight and fat specifications found here.

Important differences between sire types were evident by the time their progeny had reached weaning. At this stage the RBY progeny were heavier and had less fat cover than IMF progeny (Table 4.4.4). These trends were continued in the finishing phase where RBY sired animals had higher finishing live weight and HSCW than either RBY&IMF or IMF sired progeny (Table 4.4.8). There was also a tendency for RBY sired animals to have lower levels of fat cover but the effects were not always significant. IMF sired animals had higher AUS-MEAT marbling scores, higher US marbling scores and higher levels of IMF% than the RBY sires. RBY& IMF sired animals had similar marbling characteristics to IMF sires. Therefore the carcase characteristics showed the expected trends indicated by the EBVs for animals sired by the different types. Also in line with expectations, the RBY sired animals had higher estimated RBY% than those from the IMF sires while RBY&IMF sired animals were intermediate and not different from either.

RBY% is known to be determined by fatness and muscling with increases in fatness being accompanied by decreasing yield and increasing muscling leading to increasing yield (Perry *et al.* 1993a, b). Although the differences in EMA (indicator of muscling) and P8 fat depth among the three types were not significant, the higher IMF sired progeny tended to be fatter, have lower EMA and yield lower, while the higher RBY sired progeny tended to be leaner, have higher EMA (compared to IMF sired) and yield higher – following the expectations of above. The stronger inverse relationship between yield and P8 compared to the weaker link with EMA suggests that differences in yield were more likely achieved through variation in fatness rather than muscling.

A notable feature of the results for the different sire types was the poor performance of the RBY&IMF progeny in meeting specifications for meat colour (Table 4.4.13). This group had over 20 % falling outside the required specification compared with less than 10% for the RBY and IMF sired animals. There were only two sires for the 53 progeny that make up this group, 11 of which had unacceptable meat colour. Of these 11 animals, 9 had a pH value of over 5.7, the maximum allowed to be eligible for MSA grading. One sire had 5 progeny represented in this group and the other had 6. Since meat colour is determined to a large extent by muscle pH and this in turn is related to stress it is may indicate that the sires (and their progeny) have a tendency to stress susceptibility.

The proportions of carcases meeting specifications, and consequent discounts and average prices, indicated similar meat quality characteristics in RBY and IMF sired animals. These two groups also rated similarly in customer satisfaction and average price using the distance from specification analyses. However in both payment systems, the RBY sired animals had an advantage in overall value through their greater HSCW.

Calving time had very little influence on most carcase characteristics (Table 4.4.9). However, there was a consistent trend for WC animals to have higher marbling and IMF% than the AC animals although the differences were significant only for IMF%. These animals were slightly younger and fatter (but not significantly so) than the autumn calving animals and this may account for their greater tendency to marbling. There was also a slight tendency for AC calves to have higher ossification scores than WC calves. This is possibly due to the chronological age difference of about 2 months at slaughter. However, this trend was only present in heifers from the Slow and Comp treatments. In all other cases no effects were apparent.

Based on grid prices and values, there was very little difference in the ability of AC or WC animals to meet specifications or in the returns from their sale (Table 4.4.14). The distance from specifications analysis however gave strong support to the WC system where those animals had much higher average price /kg and total value /hd.

The economic analysis of the time of calving and growth path combinations for the finishing phase further supports the advantage of the WC system (Table 4.4.16). Despite the lower live weight at weaning and higher costs of feeding to achieve the required carcase weight and fatness, this was more than offset by their lower initial purchase price. In each of the three growth paths the profitability of the WC calves exceeded that of the AC calves.

The combination of results of economic analyses for both the pre and post weaning phases clearly favours the WC system.

The effects of sex on growth and carcase characteristics showed the expected trends (Table 4.4.10). Heifers grew slower and had lighter carcases than steers. Heifers were also fatter and tended to have slightly higher marbling scores than steers. As a result of their greater fatness, heifers had lower yield of beef compared to steers. The higher ossification scores in heifers, compared to steers at the same age, confirmed previous findings. In this experiment the steers had scores approximately 30 units lower than heifers in AC calves and about 20 units lower in WC calves. Steers were slightly more successful than heifers at meeting carcase specifications and received less discounts and higher prices than heifers (Table 4.4.15).

5 Success in Achieving Objectives

The Regional Combinations project was conducted within the second 7 year term of the Beef CRC (CRC for Cattle and Beef Quality, 1999 – 2006). The first matings to generate experimental progeny occurred in 1999 and the last processing of carcases in early 2006. Experiments within the project were conducted at 4 sites in 4 southern Australian states and involved some 9,000 cows.

The analyses of data within sites were conducted at the end of 2006 using similar 'Genstat' statistical models for each site. Analyses combining data across sites will more clearly address issues of genotype by environment interactions as well as strengthening the predictability of responses due to the designed genetic linkages between sites, and this will be completed by mid-late 2007.

The completion of the within site analyses now reported meets all objectives set for the project. Additional objectives such as the across site analyses, detailed examination of EBV/response relationships across sites and publication of results in scientific journals will be addressed by the end of 2007.

Achievement against overall Objectives

1. *Quantify the effects of post weaning nutrition within and between genotypes varying in propensity for meat quality (yield and/or eating quality) or growth on carcase compliance and meat quality.*

This objective has been fully met with 3 sites comprehensively investigating and reporting on post weaning growth treatment and its effect on market compliance of product as well as effects on carcase traits and both measured and assessed meat quality. There were no interactions of consequence between genotype and post weaning growth path, allowing confident prediction of responses in carcase traits within and between breed and /or sire carcase types regardless of growth regime. Faster growth post weaning was generally more economic and resulted in small increases in compliance to market specifications and higher meat eating quality.

2. *Determine and/or validate the optimum combinations of beef cattle genetics and growth/nutritional pathways to achieve specifications across various environments in Australia.*

Results reported here have validated the responses expected by selecting sires on EBVs or breed characteristics. Clear, practical and economic strategies can be developed based on the results for producers to achieve high compliance to targeted end points through management of growth paths and selection of appropriate maturity/carcase types. This extends to refining growth models, within maturity types , to predict market outcomes using the extensive data sets generated by this multi-state Regional Combinations research . Such models are currently being developed within the CRC for Beef Genetic Technologies, which fortunately will not be confounded by interactions between breed type and growth (as found here). Support of these developments by the current information is the first step in creating an optimisation model applicable across many environments. Within the sites studied an economically optimum combination for each market outcome was reported.

3. *Examine the capability (area specific) and cost (economics) of achieving greater compliance rates.*

This objective has been well met by the substantial economic analyses using gross margins and the examination of compliance rates reported. The effects of the growth and genetic treatments on these outcomes have provided guidelines to choose strategies with the best chance of maximising financial returns by improving output while still adequately satisfying market requirements. The biological responses are integrated with the economics of management costs and value of the end product as determined by market specifications.

4. *Increase beef production technology uptake generated by this and other CRC initiatives throughout regional Australia.*

Throughout the course of the project, there have been numerous occasions of exposure of interim results to the industry through field days, producer meetings, workshop groups etc. There have also been many papers presented in scientific and technical conference proceedings. These communications are listed as Appendix 5. The first of a series of Journal papers (Appendix 6) has been published. Communications have been reported previously in CRC Annual Reports. Additionally, reports have been given in MLA publications – 'Feedback' and 'Prograzier', as well as numerous press articles and industry publications (Appendix 5). Some of the technology developed here has already been adopted by the industry during the course of the project. For example, in WA the time of calving and production system for the co-operating herd of over 4,000 cows has been changed as a direct result of the on-site research results, with influence extending to surrounding producers. Within NSW, associated producers have already implemented breeding and growth path options to take advantage of the economic superiority reported here (e.g. as reported in 'The Land', January 2007).

Future extension of these results combined with producer-friendly tools based on simple growth models are planned to be delivered to industry over the next year.

6 Impact on Meat and Livestock Industry – now & in five years time

The economic calculations reported in Section 4 for each of the state sites are for a representative beef enterprise. In this section, these results are aggregated up to the level of the Australian cattle and beef industry and then projected forward over a number of years into the future. To do this, an existing model of the world beef market is used.

6.1 Choice of Modelling Framework

The DREAM benefit-cost analysis program (Wood *et al*. 2001) was selected as the modelling framework. This program is based on the economic principles developed in the highly regarded text *Science Under Scarcity* (Alston, Norton and Pardey 1995) and has a rigorous theoretical base. It has been widely used in economic impact assessment studies over a number of years by many different national and international institutions. It has been used recently in a number of assessments of the potential value of new CRC proposals (Griffith *et al*. 2006a,b; Jones *et al*. 2006; Vere *et al*. 2005).

DREAM has a number of different sub-models representing different types of market situations. One of these is the "horizontal multi-market" option. This provides a means of assessing the economic impact of a new technology in the context where the product under study is (relatively) freely traded across a number of regions, a situation closely approximated in the Australian beef industry. Different states, and traditional and potential export markets, can all be defined as separate regions. This facility is considered crucial given that the results arising out of this project are specific to the different sites. Unfortunately, choosing to focus on the multi-regional and traded status of the industry means that we cannot simultaneously generate information on the impact of the technologies in the individual vertical market segments of the industry (such as feedlots, processors, retailers, etc.). Thus, the transactions modelled essentially refer to the farm-gate as the point of exchange and the values we choose reflect this market level. “Consumers” in this context means all of the market participants beyond the farm gate.

In our implementation of the DREAM model for this assessment, we define each Australian state as a separate region (where WA is separated into North and South). Four separate export markets are defined - the US, Japan, Korea and an aggregate Rest of World. Australian beef is allowed to be available in all possible regional markets and to compete with beef from all possible regional suppliers.

6.2 Data Required

The economic models underlying the DREAM software require the following data sets:

(1) "equilibrium" prices and quantities produced and consumed, to define the size and structure of the market in each defined region under consideration at a specified point in time;

(2) elasticities of supply and demand, to predict how producers and consumers in each defined region will react to new prices generated by the simulated shocks to the market (the impact of the new technology); and
(3) how the new technology will change either producers' cost structures or consumers' willingness to pay for different quality products in the region(s) where the technology will be

adopted (the so-called K shift, which in this case is essentially a reduction in cost of production).

For this study, the model implemented for the Beef CRC renewal analysis was used (Griffith *et al*. 2006a).The year 2001/02 was chosen as the base year for the price and quantity data. This was the most recent year where the full set of required data was available, prior to the disruptions to markets caused by the recent droughts. The analysis uses "real" (adjusted for inflation) values based on 2001/02 values. This year is considered to be broadly representative of the peaks and troughs of the world beef market during the coming couple of decades, taking into account the inevitable consequences of the US cattle cycle (Griffith and Alford 2002, 2005) and the increasing risks associated with market disruptions caused by droughts and disease outbreaks.

The base price and quantity data for each region are given in Table 6.2.1. Notes explaining calculations relating to these data are given under the table. Although more than two-thirds of Australian beef production is exported, the domestic market remains the largest single market destination.

The base elasticity values are given in Table 6.2.2. These are taken mainly from Zhao *et al*. (2000). We note that the domestic demand elasticities given in Zhao *et al*. (2000) have been reduced by 2/3 to reflect the demand at the farm level modelled here rather than demand at the retail level modelled in that study. The demand elasticities are scaled down to reflect the ratio of the approximate farm price of $3/kg divided by the approximate retail price of $10/kg. The demand elasticities for the Northern states have been set lower than those for the Southern states because of fewer possible substitute products available to consumers. Also, the demand elasticities for US, Japan, Korea and the ROW are export demand elasticities for Australian product, and therefore have been set as being moderately to highly elastic because of the existence of many possible substitutes available to consumers and many possible sources of supply of beef.

Table 6.2.1. Base Price and Quantity Data, Beef and Veal, 2001/02.

Region	Production (ktcw)	Consumption (ktcw)	Beef Exports (ktcw)	Beef Exports (ktsw)	Cattle Exports (ktcw)	Cattle Exports (head)	Price ($AU/tonne)
NSW	474	296	204		0.733	3877	3130
Vic	355	171	144		8.464	44785	3223
Qld	978	129	556		28.507	150829	2634
SA	86	54	37		4.571	24184	2714
WA	96	68	21		62.608	331258	2550
Tas	45	17	21				2773
NT	1	7			50.121	265190	2592
AUSTRALIA	2034	742	1292	984	155.0	820139	
US	11762	12268	(506)				4016
JAPAN	457	1207	(750)				5110
KOREA	190	580	(390)				4295
ROW	35753	35399	354				4016
WORLD	50196	50196	0				

Source: Unless otherwise noted, all data are from *MLA Statistical Review July 2001 - June 2002*
Notes: Consumption in each state is calculated as 35.5 kg/capita times state population for 2001/02 as given in ABS (2003), *Australia at a Glance*, Cat. No.1309.9; live weight of 350kg and an average dressing percentage of 54%. In the model, these equivalents are added to production in each Australian State, to ROW consumption and to both world production and consumption; In the model WA is split into north and south. In the absence of firm data, production is set equal in both halves and demand is set to 50 in the south and to 18 in the north; Domestic prices are for steers 260-300 kg HSCW; NT price is an average of QLD and WA; US price is Australian boneless

cow beef, 90%CL, FAS; Japan price is Australian chilled boneless grass-fed fullset, FAS; Korea price is unit value of all Australian beef and veal exports to Korea, FOB.

Table 6.2.2. Base Supply and Demand Elasticity Values.

Region	Supply Elasticity	Demand Elasticity
NSW	1.00	-0.33
Vic	1.00	-0.33
Qld	0.75	-0.27
SA	1.00	-0.33
WA (north/south)	0.75/1.00	-0.27/-0.33
Tas	1.00	-0.33
NT	0.75	-0.27
US	1.00	-3.00
JAPAN	0.70	-2.00
KOREA	0.70	-2.00
ROW	1.00	-5.00

Source: The base values are taken from Zhao *et al.* (2000)

Finally, the supply elasticities for the extensive Northern states have been set lower than those for the Southern states because of less flexibility in enterprise choices and expansion opportunities. The same reasoning holds for Japan and Korea compared to the US and the ROW.

The relevant measures of K are defined in each of the scenarios that follow. The data in Tables 6.2.1 and 6.2.2 plus the relevant measures of K allow DREAM to calculate the gross annual benefits from a shift in supply brought about by the new technology outcomes generated by this project.

Information is also required on a number of other variables and parameters (Wood *et al*. 2001). Many of these were the same as those used in the Beef CRC renewal analysis:

- the lag before the research results are available to cattle producers (1 year),
- adoption lags (2 years until maximum adoption, to match the Beef CRC accelerated adoption objectives),
- adoption levels (35 per cent, ditto, but discounted back to 15 per cent because many of the better producers will already have adopted this technology),
- dis-adoption if relevant (no),
- probability of success of the technology producing the expected outputs across the target market (80 per cent),
- the time period over which the outcomes are to be assessed (15 years),
- the discount rate (7 per cent real, to approximate the overdraft rate faced by commercial cattle producers),
- the degree to which regions are linked together by prices (fairly closely – parameter value = 0.8 where 1.0 is a completely free market), and
- whether the technology is to be available outside the region where the RD&E occurred (no, with the exception of the spillover of Vic results to SA and Tasmania).

For a discussion of these issues see also Marshall and Brennan (2001).

6.3 Growth Rate Comparisons

The first scenario examined is the comparison between slower and faster growth rates at each site, averaged across breed types and using the "traditional" calving time in those states where this was varied.

For NSW, data from the economics section given in Tables 4.1.25, 4.1.27, 4.1.31 and 4.1.33 (from the Economics section 4.1.4.6) was used to calculate a minimum advantage of $37/head for the Fast treatment over the Slow treatment across all breed types. This had to be done on a per head basis so that the feedlot and pasture phases could be aggregated. Based on the average Slow growth slaughter weight of 360kg, this advantage of $37/head can be converted to 10.3c/kg, or to 3.3 per cent of the NSW equilibrium price of $3130/tonne defined in Table 6.2.1 above. The K value is then 0.033 for NSW. This can be thought of as a 3.3 per cent net reduction in the cost of producing a kg of beef in NSW.

Similarly for Vic, the information in Table 4.2.15 provided an advantage of $16/head for the Fast treatment, autumn calving, all breed types. For a mean carcase weight of 290kg, this gave a K value of 0.017, or a 1.7 per cent reduction in the cost of producing beef in Vic. This value was also used for SA and Tasmania. Finally for WA, the information in Table 4.4.16 was used to calculate a K factor of 0.086, for the Fast treatment across all breed types for autumn calving. This can be thought of as an 8.6 per cent reduction in the cost of producing a kg of beef in WA.

Inputting these K factors into the model together with the other data and parameters described above produced the following results as shown in Table 6.3.1. These values represent the accumulated value in 2000/01 dollars of the individual annual benefits to producers and consumers in each of the specified regions over the specified 15 year time horizon, discounted at 7 per cent.

Table 6.3.1. Present value of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to fast growth paths ($'000).

Region	Producer	Consumer	Total
NSW	43321.4	162.0	43483.4
Vic	18283.9	93.5	18377.5
SA	3851.8	29.5	3881.3
Tas	1946.6	9.3	1955.9
WA - SOUTH	9794.9	27.3	9822.3
Total Southern Australia	**77198.8**	**321.8**	**77520.6**
Total Other Australia	-606.5	79.1	-527.3
Total Rest of World	-18976.7	19732.9	756.2
Total World Market	57615.5	20133.9	77749.4

Therefore, using the model, data and assumptions described above, the aggregate benefits of an additional 15 per cent of Southern Australian beef producers moving from a slow (or conventional) growth path system to a faster growth path system is about $77.7 million over a 15 year time horizon.

These benefits are brought about by increases in the production of beef in the southern Australian states due to the now higher profitability of the cattle enterprises that take up the fast growth technology according to the assumptions specified above about impact on the enterprise and adoption profiles. This increased output causes beef prices to fall everywhere, since we specify a relatively free market structure. Almost all of the benefits accrue to Southern Australian beef producers, as they have access to the new technology that more than compensates for the price fall. Conversely, beef producers in the rest of Australia and the rest of the world lose, as they suffer the consequences of the fall in prices but do not have access to the technology. The other big winners are beef consumers in the rest of the world, who can now access greater quantities of beef at lower prices. However, the positive and negative market impacts outside of Southern Australia essentially cancel out.

In terms of timing, the benefits are calculated to be $2.8 million after one year and $10.3 million after five years.

6.4 Time of Calving Comparisons

The second scenario examined is the comparison between calving time in those states where this was varied, averaged across breed types and using the “conventional” slow growth rates at each site.

For Vic, the information in Table 4.2.15 provided an advantage of $37/head for the Slow treatment, autumn calving, all breed types. For a mean carcase weight of 290kg, this gave a K value of 0.040, or a reduction in cost of production of 4.0 per cent. This value was also used for SA and Tasmania. For WA, the information in Table 4.4.16 was used to calculate a K factor of 0.102 (a cost reduction of 10.2 per cent), for the average across all breed types for autumn calving.

Inputting these K factors into the model together with the other data and parameters described above produced the following results as shown in Table 6.3.2.

Table 6.3.2. Present value of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to winter or spring calving ($'000).

Region	Producer	Consumer	Total
NSW	-234.2	146.0	-88.2
Vic	43367.8	84.3	43452.1
SA	9147.7	26.6	9174.3
Tas	4622.4	8.3	4630.8
WA - SOUTH	11635.5	24.6	11660.2
Total Southern Australia	**68539.2**	**290.0**	**68829.2**
Total Other Australia	-546.6	71.3	-475.2
Total Rest of World	-17102.5	17783.9	681.4
Total World Market	50890.1	18145.3	69035.4

Therefore, the aggregate benefits of an additional 15 per cent of Southern Australian beef producers (except those in NSW) moving from an autumn to a winter or spring calving time is about $69 million in present value terms over a 15 year time horizon. Again, almost all of the benefits accrue to Southern Australian beef producers. In the results shown for this analysis, the NSW beef producers appear to lose, but there were no data available to test the scenario. However, for NSW enterprises where the principles and technology were considered applicable, similar benefits could be assumed to accrue.

In terms of timing, the benefits are calculated to be $2.4 million after one year and $8.9 million after five years.

6.5 Carcase Type Comparisons

The third possible scenario to examine is the comparison between carcase/breed types, averaged across calving time in those states where this was varied and using the "conventional" slow growth rates at each site. However, a formal analysis would require data on the distribution of the various breed types in the different regions, and how these distributions might alter in the future. Further, examination of the results provided in section 4 suggests that in many cases there were no significant differences in gross margins across breeds, even though there were differences in many of the carcase characteristics. All we can do here is highlight some of the breed type results that were different from the average, as a guide for producers who are considering changing breed types.

The NSW data identified weight gain as the biggest driver of profitability of production pre-feedlot, highlighting the differences due to carcase types in gain achieved within growth treatments. The Charolais carcase type, even within the slower growth treatment, outgrew all other / types in the sample of progeny groups in this experiment and was the most profitable on pasture. During feedlot finishing, the results were variable, with the Charolais types achieving the best gross margin following slower pre feedlot growth (due to high compensatory growth), but next to worst following the Fast pre-feedlot phase. Whilst their growth rates in the feedlot stage were as high as for other breeds, there were additional feeding costs due to their higher average body weight. The higher induction weight also caused a higher initial "purchase" price (hence interest bill) for the Charolais steers, but their outcome was also largely affected by their lower grid value (per kg) due to the proportion having carcase weights over 380 kg. High growth breed types have much to offer in terms of overall profitability because of their extra weight at sale, but need to be managed carefully to ensure acceptable compliance for other traits. Further, where change of ownership occurs at the feedlot entry, there would seem to be an argument for feedlots to offer some incentives for producers to supply slower-growing animals within these high-growth breed types.

Conversely, the Red Wagyu type was the slowest growing and performed worst in terms of gross margin. However, as with the Charolais, conclusions are restricted by the small sample of the sire type. The poor result may also be due to the specific post-feedlot specifications, and suggests again that different carcase types are relatively better or less suited to different market specifications.

The WA economic analyses confirmed these findings with the RBY-sired animals having an advantage in overall value through their greater HSCW. The Vic site analyses also showed the importance of producing cattle with heavier slaughter weights, highlighted when comparing the Wagyu ($376/ha) to the other breeds ($412/ha).

6.6 Sensitivity Analysis

One issue related to defining the K value (the impact of the technology on the per kg cost of production) is whether to apply the so-called Davidson and Martin (1965) discount. These authors argued that experimental results should be discounted by a factor of a third when they are applied in a commercial situation to reflect the higher levels of management and operating labour, the more-timely application of inputs, and the overall higher quality of inputs, that are typically used in experimental protocols. In this project, the NSW site was a commercial beef property and a commercial feedlot was used to finish the animals, so no discount is required. In the other states, some or all of the experiment was conducted on agency research stations, so some discount may be required. To check whether this factor makes a difference, a 15 per cent discount rather than a third was applied in Vic, SA, Tas and WA. The results are reported in Table 6.6.1.

Table 6.6.1 Present value of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to fast growth paths, Davidson and Martin discount ($'000).

Region	Producer	Consumer	Total
NSW	43336.7	152.4	43489.2
Vic	16119.3	88.0	16207.4
SA	3395.3	27.8	3423.1
Tas	1716.0	8.7	1724.7
WA - SOUTH	8305.6	5.7	8331.3
Total Southern Australia	**72873.0**	**302.8**	**73175.9**
Total Other Australia	-570.8	74.4	-496.3
Total Rest of World	-17860.6	18572.4	711.7
Total World Market	54441.5	18949.7	73391.3

Compared with the outcomes reported in Table 6.3.1, it is evident that applying a partial Davidson and Martin discount for the lower outcomes expected in commercial relative to experimental situations does not materially impact on the overall benefits of the fast growth path technology.

6.7 Other Considerations, and Conclusions

The economic analyses reported in this Section suggest that both the fast growth rate technology and the time-of-calving technology have the potential to generate significant economic benefits for the Southern Australia cattle and beef industries. The cumulative present values of each technology are around $70 million over a 15-year time horizon at a 7 per cent real discount rate, with benefits in the first year of around $2-3 million and benefits after five years of around $9-10 million. Although not valued formally, it is evident that individual producers running specific breed types could also achieve greater returns by better targeting their cattle to appropriate markets that reflect the growth and carcase types they produce.

As explained previously, these are gross benefits in that they do not take account of the value of the additional investments required to shift into different growth paths, time of calving, or breed types. The values provide an upper bound to the aggregate level of investment in additional resources that could be made by Southern Australian cattle producers. However the general overall profitability of the fast growth alternative provides a level of confidence for producers to invest in pasture improvement, more targeted pasture management or supplementary feeding

Several other summary points that have an economic context are worth making here.

Firstly, animals from slow growth paths still achieved satisfactory meat quality scores. This means that if cattle have been grown slowly prior to finishing, due to adverse seasonal conditions or other reasons, meat eating quality is unlikely to be adversely affected, unless age at slaughter is seriously delayed. This demonstrates a high degree of robustness in cattle growth paths capable of delivering acceptable eating quality.

Secondly, the regional nature of this RD&E program is expected to lead to more rapid adoption of the results. While this is difficult to quantify, there is already evidence that the time-of-calving results have encouraged a shift in breeding season in the south of WA. Similar outcomes should be evident at the other sites as the results are released.

Finally, the gross margin results provide a good guide for producers to select the most profitable combination of genotype, pasture management and market specification for them, and the best combination of inputs that will help them achieve a sustainable level of profit over the longer term.

7 Conclusions and Recommendations

Growth path
Faster growth post weaning impacted favourably on carcase fatness and eating quality.

Faster growth also generally improved compliance rates to end product specifications.

Under current market conditions, faster growth generally produced a more profitable outcome for the breeder/backgrounder.

However, beef cattle grown faster prior to entry did not grow as fast (due to compensation) in the feedlot as those having slower growth previously This made the prior faster growth animals less profitable during the feedlot phase, but this disadvantage was overshadowed by the higher profit in the preceding growth phase. Thus to maximise productivity and profitability and improve meat quality, cattle should be grown as quickly as possible, whilst carefully managing the input costs to achieve that growth. This is consistent with the increasingly demand by the trade for younger animals at targeted slaughter weights.

Carcase Type
Sire carcase type, by virtue of either breed type differences or selection on EBVs had major impacts on all carcase traits.

Sires selected on EBVs for carcase traits produced progeny displaying the expected carcase phenotypes within all environments studied.

There were no genotype by environment interactions within site – an important outcome allowing confidence in the ranking of progeny under varying growth regimes.

There was a clear association of fatness traits with eating quality. However IMF% was a more reliable predictor of sensory eating quality than visually assessed marble scores.

The greater output of the higher yielding sire carcase types produced carcases of acceptable eating quality below however those bred for higher fatness.

Sires can be successfully selected simultaneously for both high IMF% and meat yield%.

Sires selected on EBVs for RBY% resulted, as expected, in progeny higher in RBY% due largely to reduced subcutaneous fatness.
The biggest driver of profitability between sire carcase types was final weight or weight gain and, although the focus of these Regional Combinations experiments was on the effect of sires selected for carcase traits, there were breed type differences favouring those with faster growth potential.

Thus, selection of sires should be made with specific regard to the final carcase outcome required (i.e. high yield or high IMF or both). It is possible to select for both these carcase traits simultaneously, but because of the positive association of fatness with eating quality, care should be taken when selecting sires of high yield potential (or with high RBY% EBVs), not to unduly decrease fatness. It may be worth investigating an alternative method of calculating the EBV for meat yield% whereby it shifts the emphasis from decreasing subcutaneous fatness to increasing proportion of lean.

Breed of dam (particularly the dam's sire breed) influenced all carcase traits (as with progeny sire type) and production decisions and predictions should, where possible, take account of this influence on targeted outcomes.

Sampling of sires from a population has practical limitations as to how well they represent a group, and the experiments here are no exception. This applies particularly to the sires for which no trait EBVs were available and/or were few in number in particular groups.

General

Any strategies to improve beef eating quality are encouraged, since it is likely to become an increasingly important issue for future markets, both domestic and export. Results here have clearly shown the benefits of both growth path management and selection of appropriate breed and/or sire carcase types. The taste panel eating quality results were important in detecting responses and trends not exposed by the less sensitive MSA model predictions.

Major economic benefits can be gained by better matching the animal management aspects of production systems to pasture availability - specifically in timing of calving to minimise the need for supplementary feed inputs and to maximise cow reproductive and lactation performance.

Results from these regionally focussed experiments are twofold in value and effect – they will supply biological and economic input data while clearly highlighting the need for the development of models which can incorporate the complexities of breed/carcase type, cattle growth and carcase end points, to assist producers to optimise their production system for the most profitable outcomes.

Recommendations from the site results, reported here individually, will be expanded with the forthcoming analyses combining data across all sites, which has the designed statistical strength of many common link sires. This will allow a wider examination of interactions, estimation of sire effects and correlations. These will be important for future modelling and to assist beef producers choose regionally specific, profitable options.

Future Scientific Publication plan

Scientific publications resulting from the project currently planned (with suggested topic areas) be submitted or in progress by December 2007 are as follows:-

From the NSW site
(John Wilkins, Bill McKiernan, Bev Orchard, Steve Barwick, John Irwin)

1) Growth/type/carcase traits
2) Eating quality
3) Correlations of body measures and performance
4) Feedlot entry predictions
5) Ossification/dentition, MSA vs. EQ, Flight speed

From the Victoria site
(John Graham)

6) Growth/type/carcase traits – sire (focus)
7) Growth/type/carcase traits – cow breed (includes SA)

From the SA site
(Mick Deland)

8) Breed type comparison + combine with Vic

From the WA site
(Brian McIntyre, Geoff Tudor, Jane Speijers, Tony Della Bosca)

9) Growth/type/carcase traits
10) Economics of Time of Calving

Overall and NSW sites
(Garry Griffith and Lloyd Davies)

11) Overall economic paper (all sites)
12) Industry implications

8 Bibliography and Acknowledgements

8.1 Bibliography

AFRC (1992) Technical Committee on Responses to Nutrients. Energy and protein requirements of ruminants. Ed. G Alderman and BR Cottrill. CABI Publishing, Oxford UK

Alston JM, Norton GW, Pardey PG (1995) 'Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting'. (Cornell University Press: Ithaca and London).

AUS-MEAT (1998) "Handbook of Australian meat" (AUS-MEAT Ltd: Brisbane).

Davidson BR, Martin BR (1965) The relationship between yields on farms and in experiments. *Australian Journal of Agricultural Economics* **9(2),** 129-140.

Dobos RC, Carberry PJ, Vleeskens S, Sangsari E, Johnston B, Oddy VH (1997) An age and herd structure model for beef breeding enterprises. *Proceedings of the International Congress on Modelling and Simulation,* Hobart, Tasmania, December 1997 pp.1080-1085.

Dobos RC, Carberry PJ, Davies L (2006) Beef-N-Omics: Users manual May 2006. (NSW DPI Orange).

Earle DF and McGowan AA (1979) Evaluation and calibration of an automated rising plate meter for estimating dry matter yield of pasture. *Australian Journal of Experimental Agriculture and Animal Husbandry* **19,** 337-343.

Ferguson DM, Thompson JM, Cabassi P (1995) Video Image Analysis. In: 'Proceedings of Meat '95 Australian Meat Industry Research Conference' (Gold Coast, Queensland, Australia, 10-12 Sept., 1995) pp. (7A) 13-16. (CSIRO: Aust).

Genstat 9 (2006) Release 9.1 for Windows XP, Lawes Agricultural Trust, United Kingdom.

Gilmour AR, Cullis BR, Welham SJ, Thompson R (2002) ASREML Reference Manual. NSW Agriculture Biometrics Bulletin, No 3., Agriculture, Orange, NSW, Australia.

Graham JF, Clark AJ, Hayes GA, Kearney GA, Deland MPB (2000) The effect of genotype on growth and fatness when Angus, Hereford, Limousin and Simmental sires are mated to Angus and Hereford cows. *Asian-Australasian Journal of Animal Sciences* **13** (Supplement July 2000), C: 325-328.

GrazFeed (1990) Managing the nutrition of sheep and cattle. Horizons@hzn.com.au

Gregory KE, Cundiff LV, Koch RM, Dikeman ME, Koohmaraie M (1994) Breed effects, retained heterosis, and estimates of genetic and phenotypic parameters for carcase and meat traits of beef cattle. *Journal of Animal Science* **72,** 1174-1183.

Gregory KE, Cundiff LV, Koch RM, Dikeman ME, Koohmaraie M (1994) Breed effects, retained heterosis, and estimates of genetic and phenotypic parameters for carcase and meat traits of beef cattle. *Journal of Animal Science* **72,** 1174-1183.

Griffith GR, Alford AR (2002) The US cattle cycle and its influence on the Australian beef industry. Review Paper No. 2, Volume 10 in *Australian Agribusiness Review,* [Online]. Available: http://www.agribusiness.asn.au/Review/2002v10/Griffith/Griffith.htm

Griffith GR, Alford AR (2005) The US cattle cycle and Australian beef prices – June 2005. In 'Proceedings of Beef School Emerald'. (The CRC for Cattle and Beef Quality, Queensland DPIF and Emerald Agricultural College: Emerald) pp. 15-22.

Griffith GR, Parnell PF, McKiernan W (2006a) 'The Economic, Environmental and Social Benefits to NSW from Investment in the CRC for Beef Genetic Technologies'. Economic Research Report No. 30 (NSW Department of Primary Industries: Armidale).

Griffith GR, Vere DT, Jones RE (2006b) 'The Sheep CRC Renewal Proposal: Economic Evaluation of the Proposed Scientific Themes'. Economic Research Report No. 32 (NSW Department of Primary Industries: Armidale).

Hearnshaw H, Arthur PF, Johnston D, Stephenson PD (1995) Evaluation of Angus, Charolais and Hereford as terminal sire breeds on Hereford and first-cross cows. I. Growth of progeny. *Australian Journal of Agricultural Research* **46(6),** 1231 – 1244.

Hennessy DW, Morris SG (2003) Effect of a preweaning growth restriction on the subsequent growth and meat quality of yearling steers and heifers. *Australian Journal of Experimental Agriculture* **43,** 335-341.

Jones RE, Griffith GR, Vere DT (2006) 'An Economic Evaluation of the Research Benefits and Returns in the Invasive Plants Cooperative Research Centre'. Technical Series Number 12 (CRC for Australian Weed Management: Adelaide).

Marshall GR, Brennan JP (2001) Issues in benefit-cost analysis of agricultural research projects. *Australian Journal of Agricultural and Resource Economics* **45(2),** 195-213.

McKiernan WA (1990) New developments in live animal appraisal of meat quantity in beef cattle. *Proceedings of the Australian Association of Animal Breeding and Genetics* **8,** 447-450.

McKiernan WA, Wilkins JF, Barwick SA, Tudor GD, McIntyre BL, Graham JG, Deland MPD Davies L (2005) CRC "Regional Combinations" Project – effects of genetics and growth paths on beef production and meat quality: experimental design, methods and measurements. *Australian Journal of Experimental Agriculture* **45 (7-8),** 959-969.

McPhee MJ, Meaker G, Graham P, Carberry PM, Davies BL, Whelan MB, Bell AK, Clements B (2001) StockPlan: decision tools for exploring management options for drought. *International Congress on Modelling and Simulation Proceedings, 10-13th December 2001, Canberra*, Vol 4, 1859-1864.

Perry D, Shorthose WR, Ferguson DM, Thompson JM (2001a) Methods used in the CRC program for the determination of carcase yield and beef quality. *Australian Journal of Experimental Agriculture* **41,** 953-957.

Perry D, Thompson JM, Hwang IH, Butchers A, Egan AF (2001b) Relationship between objective measurements and taste panel assessment of beef quality. *Australian Journal of Experimental Agriculture* **41,** 981-989.

Perry Diana (2003) Which are more tender – fast-growing or slow-growing cattle? In: *Proceedings of "The Beef Products Program: Technology - our future"* (JF Wilkins Ed.). Beef Products Conference. pp. 64-66. (NSW DPI: Orange).

Perry D, McKiernan WA, Yeates AP (1993a) Muscle score; its usefulness in describing the potential yield of saleable meat from live steers and their carcases. *Australian Journal of Experimental Agriculture* **33,** 275 – 81.

Perry D, McKiernan WA, Yeates AP (1993b) Meat yield and subjective muscle scores in medium weight steers. *Australian Journal of Experimental Agriculture* **33**, 825 – 31.

Perry D, Thompson JM (2005) The effect of growth rate during backgrounding and finishing on meat quality traits in beef cattle. *Journal of Animal Science* **69,** 691-702.

Pethick DW, Harper GS, Oddy VH (2004) Growth, development and nutritional manipulation of marbling in cattle: a review. *Australian Journal of Experimental Agriculture* **44**, 705-715.

Polkinghorne R, Watson R, Porter M, Gee A, Scott J, Thompson J (1999) Meat Standards Australia, a 'PACCP' based beef grading scheme for consumers. 1. The use of consumer scores to set grade standards. In: *Proceedings of the 45th International Congress of Meat Science and Technology* **45,** 14-15.

Robinson DL, Ferguson DM, Oddy VH, Perry D, Thompson JM (2001a) Genetic and environmental influences on beef tenderness. *Australian Journal of Experimental Agriculture* **41**, 997-1003.

Robinson DL, Oddy VH, Dicker RW, McPhee M (2001b) Post–weaning growth in northern New South Wales. 3. carry-over effects on finishing, carcase characteristics and intramuscular fat. *Australian Journal of Experimental Agriculture* **41**, 1041-1049.

Rutley DL (2006) Implications of size and shape of slaughter cattle in their selection and marketing. PhD Thesis, University of Adelaide, Australia.

Ryan WJ (1990) Compensatory growth in sheep and cattle. *Nutrition Abstracts and Reviews (Series B)* **60,** 653-664.

StockPlan® NSW Department of Primary Industries (2005), Orange, NSW, 2800.

Thompson J (2002) Managing meat tenderness. *Meat Science* **62,** 295-308.

Trenkle A, DeWitt DL, Topel DG (1978) Influence of age, nutrition and genotype on carcase traits and cellular development of the *m.longissimus* of cattle. *Journal of Animal science* **46**, 1597-1603.
Thompson John (2002) Managing meat tenderness. *Meat Science* **62,** 295-308.

Upton W, Burrow HM, Dundon A, Robinson DL, Farrell EB (2001) CRC breeding program design, measurements and database: methods that underpin CRC research results. *Australian Journal of Experimental Agriculture* **41,** 943-952.

Verbyla AP, Cullis BR, Kenward MG, Welham SJ (1999) The analysis of designed experiments and longitudinal data by using smoothing splines. *Applied Statistics* **48,** 269-311.

Vere DT, Griffith GR, Silvester LT (2005) 'Australian Sheep Industry CRC: Economic Evaluations of Scientific Research Programs'. Economics Research Report No. 27 (NSW Department of Primary Industries: Orange).

Wood S, You L, Baitx W (2001) '**D**ynamic **R**esearch **E**valu**A**tion for **M**anagement - DREAM Version 3. A user-friendly system for estimating the magnitude and distribution of the economic benefits of agricultural research and development' (International Food Policy Research Institute: Washington, D.C.).

Zembayashi M (1994) Effects of nutritional planes and breeds on intramuscular-lipid deposition in *m. longissimus* dorsi of steers. *Meat Science* **38**, 367-374.

Zhao X, Mullen JD, Griffith GR, Griffiths WE, Piggott RR (2000) 'An Equilibrium Displacement Model of the Australian Beef Industry'. Economic Research Report No. 4 (NSW Agriculture and the CRC for Cattle and Beef Quality: Orange).

8.2 Acknowledgements

We are pleased to acknowledge the large contribution to the project by the generous support in cash and kind of our commercial co-operators – AgReserves Australia Ltd (NSW site, Tony Abel and Angus Paterson in particular) and Alcoa Farmlands (WA site, Tony Hiscock in particular) – our thanks go to all the field staff and management of those organisations whose efforts made the project successful, as well as providing enjoyable working alliances. We are also grateful for the co-operation and assistance of Cargill Beef Australia at the finishing and processing stages of the experiments – thanks to the many staff and management at both "Jindalee" and the abattoir works at Wagga Wagga (Harry Waddington and Grant Garey in particular) who provided enthusiastic assistance and access to data. Thanks also to Don Robertson, "Skene", Hamilton for the use of his breeding herd and his keen assistance.

This project was heavily supported by funding from Meat and Livestock Australia within the Beef CRC stage 2 programs. All sites were supported by relevant State Departments of Primary Industry and the CRC for Cattle and Beef Quality. We are most grateful for the assistance of the staff of the Meat Science Laboratory at Armidale and the staff of MSA. Many staff of the various State Departments of Primary Industry assisted in field operations, data collection and processing and administrative support – too many to name individually, but thanks go to all.

We acknowledge in particular the important contributions of Jeffrey House, Greg Meaker, Steve Exton, Alan Clark, John Byron, Rick Hartney, (the late) Bill Smart, Donna Read, Tony Della Bosca and Eric Taylor. Thanks go to Gavin Kearney and Jane Speijers for biometrical assistance, and to John Cooper and Brian Clark for management support.

9 Appendices

9.1 Appendix 1 – NSW site – additional data and results

9.1.1 Abattoir price grid

Appendix Table 9.1.1 shows the Cargill Beef price grid applicable to the 100 day grain finished (lotfed) steers presented for processing from the NSW site. Appendix Tables 9.1.2 and 9.1.3 show extra measurements taken at weaning and prior to feedlot entry. Table 9.1.4 shows measurement taken in the chiller with the VIAscan imaging equipment and objective laboratory measurements of meat quality. Table 9.1.5 shows raw correlations between carcase measurements taken in the chiller by MSA assessors and those measured by the VIAscan imaging equipment. Table 9.1.6 shows raw correlations between sensory eating quality, IMF%, fatness measurements taken at the abattoir and eating quality predicted from the MSA model.

Appendix Table 9.1.1. Price grid from Cargill Beef showing specifications and discounts for the traits HSCW, butt shape, P8 fat depth, bruising, dentition, fat and meat colour (100 day grain fed).

CARGILL BEEF AUSTRALIA

P.O. BOX 166, WAGGA WAGGA, N.S.W. 2650

A DEPARTMENT OF CARGILL AUSTRALIA LTD.

A.B.N. 42 004 684 173 Quote Ends

DATE:

	Steers	Heifers
GRID		

BUYER :

VENDOR :

HDW	Steers GRID No.	Heifers GRID No.	Base
420 +	$3.52	$3.47	
400 - 419.5	$3.82	$3.77	
380 - 399.5	$3.90	$3.85	
300 - 379.5	$3.91	$3.86	$3.91
280 - 299.5	$3.86	$3.81	
260 - 279.5	$3.42	$3.37	
< 259.5	$3.22	$3.17	

No. HEAD Expected

CODE	BUTT SHAPE	FAT MM	BRUISE CODE	DENT	FAT COLOUR	MEAT COLOUR	PREM/ DISC
GR1	A - C	10 - 32	NIL	0 - 2	0	1B - 3	0
GR2	A - C	10 - 42	1 - 4	0 - 2	0 - 2	1B - 6	- 10 C
GR3	A - C	6 - 9	1 - 4	0 - 2	0 - 3	1B - 6	- 15 C
GR4	A - C	10 - 32	NIL	4	0	1B - 6	- 15 C
GR5	A - C	33 - 42	1 - 4	4	0 - 2	1B - 6	- 20 C
GR6	A - C	6 - 9	1 - 4	4	0 - 3	1B - 6	- 20 C
GR7	A - D	0 +	1 - 9	0 - 8	0 - 9	1A - 7	-1.20

REQUIREMENTS

A completed National Vendor Declaration, and a completed Johne's Disease form for cattle from Victoria.
Food Safety Requirements - Size 1.5m High (shld) - 2.5m Long (head to tail)
Transaction Levy of $3.50 per head will be deducted.
Grids are subject to change without notice unless confirmed. All prices quoted are exclusive of GST.

9.1.2 Additional data

9.1.2.1 Live body measurements

Appendix Table 9.1.2. Measurements[4] taken at weaning of body dimensions, live body composition and temperament.

Trait	Limousin	Charolais	Angus RBY	Angus RBY&IMF	Angus IMF	Red Wagyu	Black Wagyu
(n)	*59*	*52*	*112*	*113*	*110*	*67*	*70*
Hip width (cm)	35.0	35.8	35.3	35.7	36.0	34.3	34.8
Hip height (cm)	112.8	112.9	110.9	111.7	111.4	111.6	111.2
Stifle width (cm)	35.2	35.4	33.1	33.2	33.4	33.3	32.6
Muscle score[1]	9.2	10.4	7.5	7.4	7.0	7.8	6.0
EMA (sq. cm)[2]	47	48	43	43	42	41	43
P8 fat (mm)[2]	1.6	1.5	2.2	2.5	2.9	2.3	2.4
Rib fat (mm)[2]	1.2	1.3	1.7	1.9	2.2	1.6	1.8
Crush score[3]	2.2	1.6	1.5	1.6	1.6	1.7	1.7
Flight time[3]	72	100	108	94	103	105	98

[1]Muscle score – 15 point numeric scale - equivalent to alpha scale E- to A+ (McKiernan 1990)
[2]Measurements taken by ultrasound imaging
[3]Indicators of temperament – degree of agitation in the crush (high scores worse) and time taken to traverse a standard distance on release from the crush (high scores better)
[4]Means from raw data

Appendix Table 9.1.3. Measurements[4] taken prior to feedlot entry for Slow and Fast growth treatment groups, of body dimensions, live body composition and temperament.

Trait		Lim.	Char.	Angus RBY	Angus RBY&IMF	Angus IMF	Red Wagyu	Black Wagyu	*ALL TYPES*
(n)	*Slow*	*31*	*23*	*50*	*53*	*47*	*36*	*34*	***274***
	Fast	*28*	*29*	*62*	*60*	*63*	*31*	*36*	***309***
Liveweight (kg)	Slow	408	420	404	409	422	399	393	***407***
	Fast	392	427	394	401	397	385	387	***396***
Hip width (cm)	Slow	44.1	44.5	43.7	43.9	44.0	42.9	42.6	***43.6***
	Fast	43.5	43.9	43.2	43.7	42.7	42.5	43.1	***43.2***
Hip height (cm)	Slow	131.1	129.4	127.6	126.9	128.4	128.8	127.9	***128.2***
	Fast	126.8	128.2	125.2	125.0	123.9	124.6	126.3	***125.3***
Stifle width (cm)	Slow	42.2	43.1	41.1	41.3	40.8	39.8	39.5	***40.9***
	Fast	42.6	42.3	40.1	40.9	39.8	40.2	39.9	***40.5***
Muscle score[1]	Slow	8.7	10.3	7.1	7.3	6.7	7.1	5.6	***7.3***
	Fast	9.6	11.2	7.7	7.8	7.3	7.8	5.9	***7.9***
EMA (sq. cm)[2]	Slow	58	60	54	55	52	52	54	***54.4***
	Fast	61	63	56	57	55	56	56	***57.1***
P8 fat (mm)[2]	Slow	2.3	2.3	2.8	3.0	4.1	3.9	4.2	***3.3***
	Fast	4.6	3.2	4.5	5.4	5.7	5.6	5.1	***5.0***
Rib fat (mm)[2]	Slow	1.7	1.7	2.0	2.0	2.8	2.5	2.6	***2.2***
	Fast	2.9	2.4	3.3	3.8	4.0	3.5	3.5	***3.5***
IMF%[2]	Slow	2.33	2.00	2.59	2.85	3.01	3.19	3.32	***2.79***
	Fast	2.64	2.09	2.78	3.17	3.17	2.98	2.93	***2.90***
Crush score[3]	Slow	2.0	1.6	1.0	1.1	1.1	1.3	1.4	***1.3***
	Fast	2.0	1.3	1.1	1.1	1.1	1.5	1.6	***1.3***
Flight time[3]	Slow	74	110	96	101	111	115	102	***101***
	Fast	73	77	102	93	95	103	86	***92***

[1]Muscle score – 15 point numeric scale - equivalent to alpha scale E- to A+ (McKiernan 1990)
[2]Measurements taken by ultrasound imaging
[3]Indicators of temperament – degree of agitation in the crush (high scores worse) and time taken to traverse a standard distance on release from the crush (high scores better)
[4]Means from raw data

9.1.2.2 Additional VIAscan and laboratory data

Appendix Table 9.1.4. Measurements[1] taken with the VIAscan imaging equipment in the chiller and also laboratory measurements of meat quality.

Trait	Lim.	Char.	Angus RBY	Angus RBY&IMF	Angus IMF	Red Wagyu	Black Wagyu	*s.e.d*	*Slow*	*Fast*
(n)	*56*	*52*	*106*	*109*	*106*	*63*	*67*			
VIAscan										
VMble	1.19	1.34	1.52	1.76	1.84	1.46	1.69	*0.105*	1.51	1.58*
VMcol	0.88	0.54	0.89	1.00	0.94	1.08	1.00	*0.113*	0.97	0.84
Vfatcol	0.06	0.08	0.03	0.05	0.05	0.17	0.04	*0.049*	0.07	0.07
Vrib (mm)	9.7	7.9	12.0	11.7	12.8	10.3	12.0	*1.05*	10.8	11.1
VEMA (sq cm)	95	97	86	87	82	85	83	*2.3*	88	88
VRBY%	68.9	69.3	67.9	67.9	67.1	68.1	67.2	*0.31*	68.1	68.0
Laboratory										
Shear force (N)	44	40	39	40	39	44	36	*1.7*	40.0	40.8
Compression (N)	17	16	16	16	16	17	15	*0.4*	16.2	15.8*
Cooking loss (%)	22	22	23	23	23	24	23	*0.6*	22.6	22.8

* Significant difference between growth treatments
VMble – VIAscan marble score
VMcol – VIAscan muscle colour
Vfatcol – VIAscan fat colour
Vrib – VIAscan rib fat depth
VEMA – VIAscan eye muscle area
VRBY% – VIAscan estimated retail beef yield%
[1] Predicted means

9.1.2.3 Chiller and eating data correlations

Appendix Table 9.1.5. Raw correlations between carcase measurements taken in the chiller by MSA assessors and those measured by the VIAscan imaging equipment.

AdjMeatCol	-0.15	-0.09								
FatCol	-0.20	-0.17	0.17							
Rib	0.25	0.21	0.03	0.02						
EMA	0.11	-0.03	-0.12	-0.03	0.05					
VMbl	0.71	0.60	-0.20	-0.20	0.26	0.08				
VAdjMC	-0.08	-0.09	0.56	0.29	0.08	0.00	-0.10			
VFatCol	-0.11	-0.07	0.17	0.10	-0.05	-0.04	-0.14	0.11		
VRib	0.13	0.14	0.03	-0.05	0.55	0.00	0.14	0.00	-0.05	
VEMA	-0.06	-0.15	-0.07	0.00	-0.11	0.60	-0.05	-0.06	0.01	-0.09
	AUSMbl	USMbl	AdjMeatCol	FatCol	Rib	EMA	VMbl	VAdjMC	VFatCol	VRib

AUSMbl – AUS-MEAT marble score (0 – 6)
USMbl – USDA marble score
AdjMeatCol – meat colour score (1A - 7) adjusted to remove alpha components
FatCol – fat colour score (1 – 7)
Rib – rib fat depth (mm)
EMA – eye muscle area (sq cm)
VMbl – VIAscan marble score
Vxxxxx – VAIscan measurements of equivalent chiller assessed trait

Appendix Table 9.1.6. Raw correlations between sensory eating quality, IMF%, fatness measurements taken at the abattoir and eating quality predicted from the MSA model.

CMQ4						
IMF%	0.44					
AUSMbl	0.30	0.59				
USMbl	0.24	0.53	0.90			
P8	0.15	0.39	0.35	0.28		
Rib	0.08	0.30	0.25	0.21	0.50	
PEQ	0.27	0.49	0.72	0.76	0.28	0.24
	CMQ4	IMF%	AUSMbl	USMbl	P8	PEQ

CMQ4 – Palatability score from consumer taste panel results (MSA sensory test protocol)
IMF% - intramuscular fat % measured in the laboratory
AUSMbl – AUS-MEAT marble score (0 – 6)
USMbl – USDA marble score
P8 fat depth measured on the kill floor
Rib – rib fat depth measured in the chiller
PEQ – predicted eating quality (striploin cut) – from MSA eating quality model

9.2 Appendix 2 – Victorian Site – attitional methodology

9.2.1 Abattoir price grid

Appendix Table 9.2.1 shows the Cargill Beef price grid applicable to the grass finished steers and heifers presented for processing from the Vic site.

Appendix Table 9.2.1. Price grid from Cargill Beef showing specifications and discounts for the traits HSCW, butt shape, P8 fat depth, bruising, dentition, fat and meat colour (grass fed).

CARGILL **BEEF** AUSTRALIA DATE:

Camll BOX 166. WAGGA WAGGA, N.S.W. **2650**
A **DEPARTMENT** OF CARGILL AUSTRALM LTD.
A.B.N. 42 004 **684 173**

GRID

BUYER : QUOTE ENDS:

VENDOR: PVI Hamilton

YEARLING	GRID No.			**YEARLING**							
	STEERS	HEIFERS									
HOW				CODE	BUTT **SHAPE**	**FAT** MM	**BRUISE CODE**	**DENT**	**FAT COLOUR**	**MEAT COLOUR**	**PREM.' DISC**
396 +	2.96	2.92									
356 - 395.9	**3.4**	**3.36**	**Base**	**1**	A-C	**6 -17**	NIL	**0-2**	**0-3**	**1A-3**	0.1
300 - 355.9	3.46	3.42		D02	A-C	**6 - 22**	**1-4**	**0-2**	**0-3**	1A-7	0
275 - 299.9	3.4	3.36		D03	A-C	**23 - 32**	**1-4**	0-2	**0-3**	**14 -** 7	-0.05
250 - 274.9	3.32	3.28		D04	A-C	**33 - 42**	**1-4**	0-2	**0-3**	1A-7	-0.15
230 - 249.9	3.16	3.12		**D05**	A-D	**4 - 17**	**1-4**	0-2	0-3	1A-7	-0.05
200 - 229.9	2.36	2.32		D06	A-D	**18 -** 22	**1-5**	0-2	**0-3**	1A-7	-0.2
<199.9				D07	A-D	**0 -** 50	**1-9**	0-2	0-3	1A-7	-0.4
PRIME							**PRIME**				
HOW				M01	A-C	**6-17**	**1 -4**	**4**	**0-3**	1A-4	0.2
396 +	2.5	2.45		M02	A-C	**6 -22**	**1 - 4**	**4**	**0-3**	1A-7	0.1
356-395.9	**2.7**	**2.65**	**Base**	M03	A-C	**6-17**	**1-7**	**4-7**	0-4	1A-4	0.05
300-355.9	2.75	2.7		M04	A-D	**4-22**	**1-7**	**4-7**	0-4	1A-7	0
275-299.9	2.7	2.65		M05	A-D	**23-32**	**1-9**	**4-7**	0-5	1A-7	-0.1
250-274.9	2.6	2.55		M06	A-D	**33-42**	**1 - 9**	**4-7**	**0-6**	1A-7	-0.3
230-249.9	2.45	2.4		**M07**	A-D	**43-49**	**1-9**	**4-7**	0-7	1A-7	-0.4
200-229.9	1.9	1.85		**M08**	**A-E**	**0+**	**1-9**	**4-7**	0-7	1A-7	-0.65
<199.9											
No. HEAD											

9.2.2 Beef-N-Omics input and output data

9.2.2.1 Input data

The following input data were used for the various scenarios examined for the Vic site.

- Beef Breeding Stock Replacement Policy

Age at last joining before cows culled for age	10 years
Month when dry cows sold	Jan
Proportion of dry cows sold	100%
Month when other culls sold	Jan
Proportion of other herd sold as culls	2%
Heifers kept in herd	No
Age at joining heifers (months)	15 months
Replacement heifers (cows) 100% of total replacement as:	Heifers empty & dry
Month of purchase	May
Price	$800/cow
Age at purchase	1 year
Working life of bulls	4 years
Cost of replacement bulls	$5000/bull

- Costs and Income Couple of yellow highlights feral—year , hd

Freight:	Sales	$8/hd
Freight:	Purchases	$20/hd
Yard dues and fees:	Sales	$5/hd
Commission: sales	Sales	4%
Transaction levy:	$3.5/hd	
•	Health Costs	
Bulls	$10/hd	
Cows and calves	$13/hd	
Weaners	$6/hd	
Yearlings	$10/hd	
2 year old +	0	
Trading stock	0	

- Pasture production costs and area grazed

Pasture maintenance	$14000/year
Total area grazed	200 ha

Pasture Carryover and Growth Rate (Hamilton)

•	Feed carried over to following month (%)	Growth rate (kg DM/ha/d)

•	50	2
Feb	75	3
Mar	55	5
Apr	50	13
May	40	20
Jun	10	12
Jul	10	12
Aug	10	22
Sep	30	44
Oct	60	73
Nov	70	65
Dec	80	9

Month when least kg DM available = May

Hamilton Base Data – Autumn Calving, Slow Growth Path

- Beef Breeding Herd Management & Performance.

Cows joined	100
Calves weaned	90%
Number of bulls	3
Weight of mature cows	600 kg
Month when calves weaned	Dec
Minimum age of calves at weaning	8 months
Weight of calves at minimum weaning age	200 kg
Annual death rate: Weaning-18months	2%
Annual death rate: Adults	2%

- Calving Calendar

Calving – Feb:Mar:Apr	22:62:16

Based on actual PVI calving data

- Stock Sales

Steers:	
Age	27 months (27.2 PVI analysed data)
Percent sold	100%
Sale weight	562 kg (PVI analysed data)
Sale price	200 c/kg
Heifers	
Age	27 months (27.2 PVI analysed data)
Percent sold	100%
Sale weight	518 kg (PVI analysed data)
Sale price	195 c/kg

- Stock Sales

Culled cows: weight	600 kg live
Price	150 c/kg live
Culled bulls: weight	800 kg live
Price	155 c/kg live

<u>Hamilton Base Data – Autumn Calving, Fast Growth Path</u>
INPUT DATA same as Autumn Calving, Slow Growth with the following adjustments

Beef Breeding Herd Management & Performance

Weight of mature cows	600 kg

- Stock Sales

Steers:	
Age	23 months (22.8 PVI analysed data)
Sale weight	556 kg (PVI analysed data)
Heifers	
Age	23 months (22.8 PVI analysed data)
Sale weight	506 kg (PVI analysed data)

- Stock Sales

Culled cows: weight	600 kg live
Price	150 c/kg live

<u>Hamilton Base Data – Spring Calving, Slow Growth Path</u>
INPUT DATA same as Autumn Calving, Slow Growth with the following adjustments

Beef Breeding Herd Management & Performance

Weight of mature cows	560 kg
Month when calves weaned	May
Minimum age of calves at weaning	8 months

* Spring cows 40 kg lighter than autumn cows

- Calving Calendar

Calving – Aug: Sep: Oct	41:50:9

*Based on PVI data

Beef Breeding Stock Replacement Policy

Month when dry cows sold	May
Month when other culls sold	May
Month of purchase	Sep

- Stock Sales
-

Steers:	
Age	29 months (28.5 PVI analysed data)
Sale weight	589kg (PVI analysed data)
Heifers	
Age	29 months (28.5 PVI analysed data)
Sale weight	537 kg (PVI analysed data)

- Stock Sales
-

Culled cows: weight	560 kg live
Price	150 c/kg live

<u>Hamilton Base Data – Spring Calving, Fast Growth Path</u>
INPUT DATA same as Spring Calving Slow Growth Treatment with the following changes

Beef Breeding Herd Management & Performance

Weight of mature cows	560 kg

* Spring cows 40 kg lighter than autumn cows

- Stock Sales

Steers:	
Age	22 months (21.5 PVI analysed data)
Sale weight	570 kg (PVI analysed data)
Heifers	
Age	22 months (21.5 PVI analysed data)
Sale weight	530 kg (PVI analysed data)

- Stock Sales

Culled cows: weight	560 kg live *
Price	150 c/kg live

<u>Assumptions</u>

- Stocking rate was determined by adjusting breeding cow numbers until the total feed deficit was 200kg DM/Ha.

9.2.2.2 Beef-N-Omics output

Beef-N-Omic outputs using the overall breed type liveweight means for the different season by growth paths scenarios.

Treatment	Base Aut Calv, Slow Growth	Base Spring Calv, Slow Growth	Base Aut Calv, Fast Growth	Base Spring Calv, Fast Growth
No cows	100	104	118	106
Worst Month*	Mar -114	Apr -138	Jul –90	Mar –133
Deficit (kg DM/Ha)	-201	-192	-193	-205
Feed Utilisation (%)	66.3	62.1	62.2	67.4
GM Total $	$66,439	$72,934	$80,257	$74,084
GM $/cow	$664	$701	$680	$699
GM $/ha	$332	$365	$401	$370

* Note: Worst month is the month that had the largest feed deficit

Beef-N-Omic output using the overall breed type liveweight means for the different season by growth paths.

Treatment	Aut Calv, Slow Growth Wagyu*	Spring Calv, Slow Growth Wagyu	Aut Calv, Fast Growth Wagyu	Spring Calv, Fast Growth Wagyu
No cows	103	105	122	109
Worst Month*	Mar - 92	Mar -124	Jul – 92	Mar –129
Deficit (kg DM/Ha)	-198	-191	-193	-200
Feed Utilisation (%)	62	61	62	67.6
GM Total $	$61,274	$66,228	$75,235	$68,508
GM $/cow	$595	$639	$617	$628
GM $/ha	$306	$331	$376	$342

*The Wagyu cattle were on average 43 kg lighter than the average of the base mean, and all sale liveweight adjusted accordingly Beef-N-Omic output using the overall breed type liveweight means for the different season by growth paths.

Treatment	Aut Calv, Slow Growth No Wagyu	Spring Calv, Slow Growth No Wagyu	Aut Calv, Fast Growth No Wagyu	Spring Calv, Fast Growth No Wagyu
No cows	99	102	117	104
Worst Month*	Mar -116	Mar - 123	Jul –90	Mar –124
Deficit (kg DM/Ha)	-202	-202	-198	-192
Feed Utilisation (%)	66.3	61.4	62.2	67.7
GM Total $	$68,177	$73,120	$82,472	$74,382
GM $/cow	$689	$717	$705	$715
GM $/ha	$341	$366	$412	$372

** No Wagyu are all breeds excluding Wagyu. The live weight at slaughter excluding Wagyu are 15kg more than the base mean, and all live weights were adjusted accordingly

9.3 Appendix 3 – SA site – additional methodology

9.3.1 Abattoir price grid

Appendix Table 9.3.1 shows the abattoir price grid for various markets (T&R Pastoral, Murray Bridge) applicable to the steers and heifers presented for processing from the SA site.

Appendix Table 9.3.1. Abattoir price grid showing specifications and discounts for the traits HSCW, butt shape, P8 fat depth, bruising, dentition and meat colour (grass fed).

	Grass	**Trade**	**USA**	**Manufact.**				**Comb.**
	Japan	**Str/Hfr**	**Str/Hfr**	**Cow/Str/Hfr**	**Bulls**	**EU**	**Veal**	**EU/Trade**
	***	***				***		
Dentition	0 - 2	0 - 2	0 - 8	0 - 8	0 - 8	0 - 4	0	0 - 4
Sex	m	m/f	m/f	m/f		m/f	m/f	m/f
Fat premium	8 - 22	7 - 12	8 - 22	3 - 12	0 - 6	8 - 22	2 - 9	8 - 22
Butt shape	ABC	ABC	ABC	ABC	Any	ABC	ABC	ABC
Colour	0 - 3	0 - 3	0 - 3	0 - 3	Any	0 - 3	0 - 3	0 - 3
Bruise	0 - 4	Nil	0 - 9	0 - 9	0 - 8	Nil	Nil	Nil
Weight	280 - 400	140 - 280	180+	140+	140+	240 - 337	0 - 149.9	140 - 337
300+	$2.75		$2.45	$2.20	$1.70	$3.15		$3.15
280 - 299.9	$2.65		$2.35	$2.15	$1.70	$3.10		$3.10
260 - 279.9		$2.55	$2.20	$2.10	$1.65	$3.05		$3.05
240 - 259.9		$2.60	$2.10	$2.05	$1.60	$2.95		$2.95
220 - 239.9		$2.55	$2.05	$2.00	$1.55			$2.55
200 - 219.9		$2.45	$2.00	$1.95	$1.50			$2.45
160 - 179.9		$2.35		$1.90	$1.25			$2.35
150 - 159.9		$2.25		$1.85	$1.15			$2.25
140 - 149.9		$2.15		$1.80	$1.00			$2.30
100 - 139.9				$1.70	$1.00			

*****Chiller assessed**

Penalties for Jap, Trade, USA, Manufacturing Cow

Bruising	Rate $	Fat	Rate $	Butt	Rate$	Fat	Rate$
1 - 4	-0.05	0 - 2mm	-0.15	A	0	0 - 2	-0.15
5 - 8	-0.10	3 - 6	-0.10	B	0	3 - 6	0
9	-0.15	7 - 12	0	C	0	7 - 12	0
		13 - 17	0	D	0	13 - 17	-0.10
		18 - 22	0	E	-0.15	18 - 22	-0.10
		23 - 32	-0.10	Bulls		23 - 32	-0.20
		33 - 42	-0.35	6+mm fat	-0.10	33 - 42	-0.35
		43 - 50	-0.50	420kg+	-0.40	43 - 50	-0.50
		51+	-0.60			51+	-0.60

Notes

Dentition	**Jap**	4t	-0.02	6t	-0.05	7 - 8	-0.10
	US	4t	0	6t	-0.05	7 - 8	-0.10
Sex	**US&EU**	Hfr	-0.05				
Fat	**Trade**	13 - 22mm	-0.10				

(Rejects on Chiller assessment to USA/Cow, Hfr Steer grid)

9.4 Appendix 4 – WA site - additional methodology

9.4.1 Reproductive Phase

Site

The cows and experimental area for this experiment were provided by Alcoa Farmlands on its properties located at Wagerup (155.55 E, 32.52 S) and Pinjarra (115.52 E, 32.28 S) in the south-west of Western Australia. These properties are approximately 30 km apart.

Animals

In the first year of the experiment, there were 3 groups of cows at Wagerup and 2 at Pinjarra in the Autumn Calving (AC) treatment while there were 2 groups at Wagerup and 4 at Pinjarra in the Winter Calving (WC) group. In the second and third years, the number of groups of AC cows was reduced to 3, (2 at Wagerup; 1 at Pinjarra) while there were 4 WC groups (1 at Wagerup; 3 at Pinjarra). There were between 290 and 370 cows in each seasonal calving group in the three years of the experiment. The cow groups were selected by the management of the Alcoa properties and ranged in size from 40 to 137. Cows were either predominantly of the Angus or Murray Grey breed. Within each group, cows were the same age and most had previously had either 1 or 2 calves.

Mating program

In the AC groups, cows were mated in early June by artificial insemination (AI). Cows were mustered and a CIDR inserted on day one of the AI program. Seven days later the CIDRs were removed and animals were injected with prostaglandin and mounting detection devices (Bulling Beacons®) were attached to the rump region. Over the next three days the cows that had shown signs of sexual activity were inseminated. Two days later bulls were run with the cows for a period of 6 weeks in order to maximize the conception rate. The same procedures were used for WC groups which were mated in September. A total of 23 sires were used in the AI program, 10 with high EBVs for RBY and 11 with high EBVs for IMF and 2 with high EBVs for both RBY & IMF.

Cows were pregnancy tested between 4 and 5 months after mating and in most cases, non-pregnant cows were culled from the herd. Other cows were culled for structural reasons. During the calving period, cows were inspected daily to ear tag newly born calves, record birth date and the dam of the calf. In the second and third years of the experiment, birth weight of some of the calves was also measured. Cows and calves were weighed at selected times during the year to coincide with weaning in January each year, before calving, at mating, and in early and late spring. Fat thickness at the P8 site was measured on all cows at the same time as weighing and on the calves at weaning using a PIE 200 ultrasound scanner.

Because back-up bulls were introduced to each group of cows soon after AI, it was necessary to have a method of determining if calves had been sired by AI or by back-up bulls. Any calves born within 284 days of AI were deemed to have been sired by AI. Calves born between 285 days and 299 days after AI were sampled for confirmatory DNA testing, while all calves born 300 or more days after AI were assumed to have been sired by the back-up bulls. Hair samples were taken from calves in the first year while blood samples were used in the second and third years for DNA testing. Semen samples were used as the source of DNA from the sires.

Pastures & grazing management

Calves were run with their mothers from birth (March for AC or June for WC) until weaned in the following January. In the 1st year , up until the start of the pasture growing season in 2004 cows were set stocked at approximately 0.8 cows/ha for AC and 1.0 cows/ha for WC. After this time, cattle were run in a simple flexible rotational grazing system, based on a four paddock, four week cycle, one week on and three weeks off. Stocking rates were adjusted according to pasture availability as the experiment progressed. Pasture dry matter was monitored during the green feed phase using the calibrated rising plate meter or visual assessments along representative paddock transects to determine feed on offer (FOO) (Earle and McGowan 1979). Pasture quality was measured at the Feed Evaluation Unit, Department of Agriculture Western Australia, Bunbury from samples cut for calibration or purpose collected samples. Livestock requirements were estimated from actual body weight changes and feed test quality data, using relationships from Energy and Protein Requirements of Ruminants (AFRC 1993).

9.4.2 Growth Paths

Animals

Approximately equal numbers of steer and heifer weaners from each of the AC and WC groups were selected for the finishing phase at Vasse Research Station (115.24 E; 33.43 S) and were transported within 2-3 days of weaning. All calves known to be sired by the AI bulls, either because of their gestation period, or as a result of confirmation by DNA test were included. The remainder were selected at random from progeny sired by the back up bulls

On arrival at Vasse the animals were retained in a confined paddock and fed hay and handled in the yards a number of times over the next 10-14 days. This was designed to familiarise the animals with their new environment. They were then allocated to three replicates of their growth treatment groups after being stratified on sex, sire type and liveweight and drafted into their treatment groups as described below and shown in Appendix Figure 9.4.1. Each replicate had approximately equal numbers of steers and heifers and equal average liveweight.

In year 1, following almost 7 weeks on the different finishing growth treatments the animals were reallocated to the treatments. This was due to problems associated with the methods used in the initial allocation.

Fast Growth path ("Fast")

AC Fast and WC Fast groups - These groups were grown rapidly from weaning to feedlot entry weight of 400 kg, with slaughter at final average liveweight of 500 kg for steers.

The Fast growth treatment groups were fed a mixed ration consisting of grains such as wheat, oats, barley, lupins and roughage such as pasture and oaten hay. The proportions contained in the mix varied over the feeding period and from year to year depending on cost and availability. A typical ration is shown in Appendix Table 9.4.1.

AppendixTable 9.4.1. Feed mixes and feeding program for calves finished on a high energy feedlot diet in the Fast growth treatments for autumn and winter born animals.

Component		Feedlot Introduction		Final Ration
	%	%	%	%
Barley	45	50	50	55
Lupin	15	25	30	30
Hay	38	23	18	13
Minerals	2	2	2	2
Virginiamycin†				
Average days	4	4	5	73

† Virginiamycin was added to the grain portion of the diet at the recommended rate to prevent acidosis

Slow Growth path ("Slow")

AC Slow and WC Slow groups -These groups were grown slowly from weaning (~ 0.6 kg/d) to 400 kg liveweight then rapid finish on pasture to final average liveweight of 500 kg for steers;

In the first year of the experiment, the Slow growth groups were allocated to plots where they grazed the available dry pasture and were fed supplementary hay at the rate of approximately 4kg per head per day. However, these animals were not gaining at the required rate so in early April they were fed *ad libitum* silage in an attempt to raise the growth rate to the required level. Two weeks later, following a poor growth result they were also allowed access to *ad libitum* hay. These animals continued on the supplementary feed up to early June but their growth continued to be lower than expected so the animals were moved from their allocated plots to larger paddocks. Supplementary feeding stopped when it was considered the paddocks contained sufficient green pasture to permit the animals to grow.

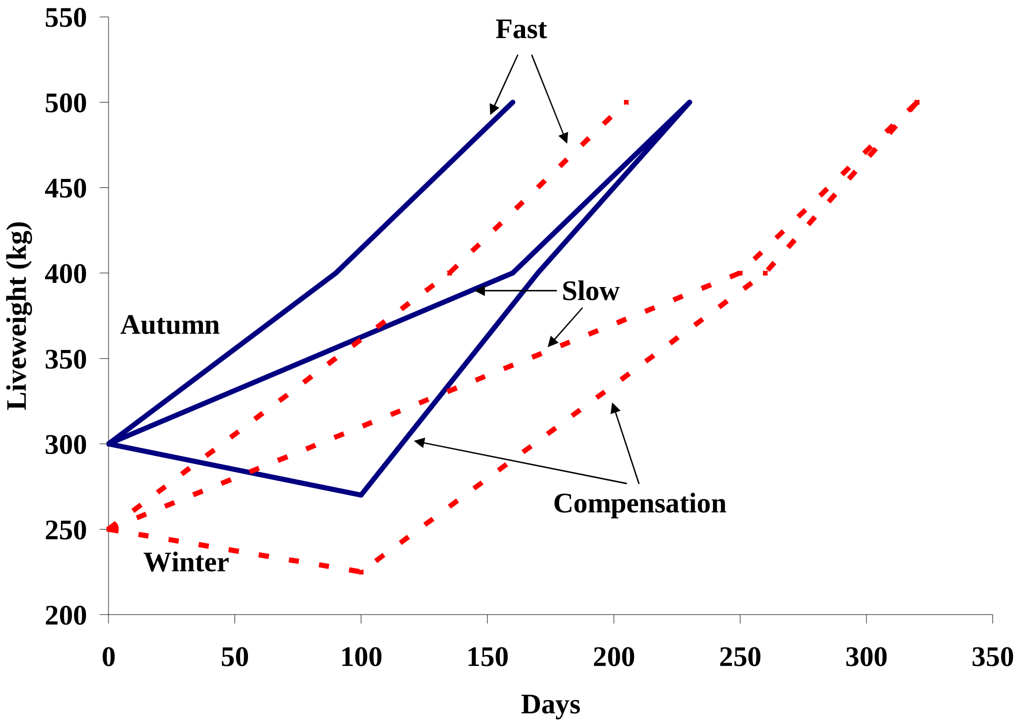
In years 2 and 3, the Slow growth groups were confined to a paddock where they were fed a restricted amount of a mixed ration of barley, lupins and hay and ad libitum hay. This feeding system was adopted to ensure that these animals grew at their target rate of approximately 0.6kg/hd per day. This feeding method continued until the end of May. At this time the opening rains had been sufficient to support strong pasture growth and allow commencement of the grazing period. Feeding of hay was discontinued and the animals were placed onto the grazing areas where they were rotationally grazed at the rate of 0.35 ha/hd until slaughter.

Compensatory Growth path ("Comp")

AC Comp and WC Comp groups -: These groups sustained a weight loss of approximately 10% from weaning, over the next 4-5 months, followed by compensatory growth and finish on pasture to final average liveweight of 500 kg for steers. The Slow and Comp animals were slaughtered at the same time.

In the first year the Comp growth groups were allocated to plots which had been grazed by cows for a few days to reduce the pasture to a level considered appropriate for the subsequent weight loss regime. These animals received supplementary hay at 2 kg per head per day but performed above expectation and had to be grouped into one paddock with severe restriction on feed to achieve the desired liveweight fall. Having achieved this target by the opening rains they were stocked under conditions similar to the Slow growth treatments.

In years 2 and 3, all animals in the Comp treatments were confined to a paddock where they received supplementary hay. This feeding method was adopted to enable better control over the rate at which animals lost weight. These animals reached their minimum weight (loss of around 10% of weaning weight) by about the end of May. At this time they were placed onto pasture and rotationally grazed at approximately 0.70 ha/hd.



Appendix Figure 9.4.1. Projected growth paths for Autumn and Winter calves from weaning to slaughter.

Measurements

Animals were weighed approximately every two weeks to monitor progress against growth targets and back fat at the P8 site was measured approximately monthly using a PIE 200 ultrasound scanner. Pasture FOO was estimated during the pasture growing season with a rising plate meter or visual estimates

All animals were slaughtered when the steers reached the target of approximately 500kg liveweight. They were transported to the abattoir on the day before slaughter according to requirements for MSA grading. Following slaughter, standard AUS-MEAT carcase measurements of hot standard carcase weight (HSCW), P8 fat depth (P8), Sex and dentition were recorded. All carcases were graded by an MSA grader who made measurements and assessments of eye muscle area (EMA), rib fat, ossification, AUS-MEAT marbling score, US marbling score, pH, meat colour and fat colour. Carcases were also assessed by VIAscan the day following slaughter for retail beef yield. IMF was measured on samples of strip loin which were removed from each carcase after boning.

9.4.3 Carcase specifications

Carcase data were examined for compliance to specifications using 2 systems. The first of these was for compliance to the abattoir grid (Appendix Table 9.4.2) as applied for the usual method of payment. The second used an alternative system of assessing compliance and valuing carcases based on the “distance from specifications” model developed by Rutley (2006), which calculates the distance for each trait from the nominated specifications of an "ideal carcase". The system is more fully described in the analysis of "Meeting Specifications" in the section of this report for the NSW site.

As indicated above the target for slaughter in this experiment was when the average weight for steers reached a liveweight of 500 kg. This weight was selected to comply with local market specifications for HSCW. The specific ranges for the relevant carcase specifications that receive the maximum price and the discount grid that is applied outside the ranges is shown in Appendix Table 9.4.2. Carcase discounts and values were calculated using the grid for all carcases.

Appendix Table 9.4.2. Carcase specification grid for cattle for the domestic market in Western Australia and "ideal" carcase specifications.

HSCW		P8 fat depth (mm)		Fat colour score		Meat colour score	
Range	Discount	Range	Discount	Range	Discount	Range	Discount
320+	- 50	0 – 4	- 30	0 – 3	0	1A – 3	0
300 – 320	- 30	4 – 13	0	4	- 30	4	- 30
280 – 300	- 10	14 – 18	- 10	5 – 6	- 50	5+	- 70
220 – 280	0	19 – 21	- 20				
200 – 220	- 10	22 – 25	- 30				
180 - 200	- 20	26+	- 50				
"Ideal"							
270		6		0		1B	

9.4.4 Economic analyses

Calving time

An economic analysis of the breeding enterprise compared AC and WC using the following three scenarios:

- traditional AC enterprise;
- WC enterprise with an equivalent stocking rate as in scenario one;
- WC enterprise with a 10% increase in stocking rate.

Assumptions used in the economic analysis included:-

1) property of 350 ha with a stocking rate of 9.2 DSE/ha with all supplementary feed grown on the property;
2) autumn calving cows fed 5kg/day pasture for 150 days and winter cows 1.75kg/day for 90 days;
3) fodder production 5 tonne/ha at a cost of $40 per tonne;
4) reduction in demand for supplementary feed in winter mob increases the available area for grazing and the number of cattle to maintain an equivalent stocking rate;
5) at weaning in January, autumn calves were approximately 80 kg heavier than the winter calves. In Scenario 3 it was assumed all parameters remain the same except stocking rate was increased by approximately 10% (to 11.1 DSE per hectare),
6) heifer and steer calves are sold at values of 160 and 165 c/kg live weight respectively.

Growth path and calving time

Comparison of the economics of rearing the progeny from the two calving times on the Fast, Slow and Comp growth paths was undertaken using average data for the three years of the experiment. Live weights and dates of commencement of feeding were taken from the date on which the animals were allocated to the different growth treatments. A summary of the data that were used is shown in Table 4.4.4 in the main text of the results.

Because we were unable to gather sufficiently detailed measurements of feed consumed by the various treatment groups, and because non-commercial feedstuffs were used in order to control the liveweight of animals on the different growth treatments, the feed requirements were estimated using the GrazFeed (1990) model. Grain, hay, pasture and feed additives for the feedlot ration were costed at $180, $67, $70 and $200 /t respectively.

The initial purchase price was assumed to be the same per kg liveweight for the autumn and winter born calves ($1.65 /kg liveweight) while the final sale prices for the various treatment groups were used. The average sale prices for AC and WC calves given Fast, Slow and Comp growth treatments were $3.19, $3.08, $3.15, $3.15, $3.18, and $3.17/kg HSCW respectively. Costs of transport, health, labour, interest on animals and feed, and selling costs were included in the gross margin analysis.

9.5 Appendix 5 – Communications throughout the project

The following communications have occurred throughout the course of the project demonstrating the high degree of exposure of this project to industry and the scientific community. There have been many more local newspaper and media articles at the respective sites – a sample only appears below.

9.5.1 Scientific conferences

(In chronological order)

Wilkins, J.F., Irwin, J., McKiernan, W.A., and Barwick, S.A. (2002). Combining genetics and growth rate to produce high quality beef in south eastern Australia. *Animal Production in Australia* **24:** 370**.**

Della Bosca, T.J., McIntyre, B.L., Read, D, Smart, W.L., Taylor, E.G. and Tudor, G.D. (2004). Optimising feed supply, reproductive efficiency and progeny growth to meet market specifications. 5. Economic analysis of Autumn and Winter calving. *Animal Production in Australia* **25:** 228.

House, J., Irwin, J., Wilkins, J.F. and McKiernan, W.A. (2004). Associations of growth rates and meat quality with assessments of temperament in a range of Bos taurus genotypes. *Animal Production in Australia* **25:** 263.

Irwin, J., Wilkins, J.F. and McKiernan, W.A. (2004). Effects of sire genotype and growth rate on the variation in weaning and feedlot entry weights of beef feeder steers. *Animal Production in Australia* **25:** 267.

McIntyre, B.L., Della Bosca, T.J., Read, D, Smart, W.L. and Tudor, G.D. (2204). Optimising feed supply, reproductive efficiency and progeny growth to meet market specifications. 4. Effect of finishing growth paths on carcase quality. *Animal Production in Australia* **25:** 282.

Read, D, Della Bosca, T.J., Hiscock, McIntyre, B.L., Smart, W.L., Taylor, E.G. and Tudor, G.D. (2204). 2. Reproduction in Autumn and Winter calving herds. *Animal Production in Australia* **25:** 304.

Smart, W.L., Della Bosca, T.J., McIntyre, B.L., Read, D, Taylor, E.G. and Tudor, G.D. (2204). Optimising feed supply, reproductive efficiency and progeny growth to meet market specifications. 3. Efficient use of pasture. *Animal Production in Australia* **25:** 316.
Toohey, Edwina, Wilkins, J.F., Irwin, J., McKiernan, W.A. and King Belinda (2004). Genotype and growth rate effects on marbling, intramuscular fat (IMF%) and eating quality in feedlot finished beef carcases. *Animal Production in Australia* **25:** 331.

Tudor, G.D, Della Bosca, T.J, McIntyre, B.L, Read, D, Smart, W.J., Taylor, E.G. and Hiscock, A.J.F. (2004). Optimising feed supply, reproductive efficiency and progeny growth to meet market specifications. 1. Background and experimental design. *Animal Production in Australia* **25:** 334.

Wilkins, J.F., Irwin, J., McKiernan, W.A., and Barwick, S.A. (2004). Effects of altering growth rate on carcase traits in a range of beef genotypes that vary in potential for yield and fat deposition. *Animal Production in Australia* **25:** 337.

Graham, J.F., Byron, J. and Deland, M.P.B. (2005). Effect On Liveweight And Carcase Traits Of Progeny Sired By Bulls Selected For Extremes In Intramuscular Fat And Retail Beef Yield And The Effect Of Post Weaning Growth. *Proc. Assoc. Advan. Anim. Breed. Genet.* **16:** 338-341.

Read, D.M., McIntyre, B.L., Taylor, E.G. and Tudor, G.D. (2005). Effect of time of calving and sire types on growth of progeny to weaning. *Proc. Assoc. Advan. Anim. Breed. Genet.* **16:** 342-345.

Irwin, J., Wilkins, J.F., McKiernan, W.A. and Barwick, S.A. (2006). Relationships between carcase measures and estimates of meat quality traits in steers with diverse genotypes and having different pre-feedlot growth treatments. *Animal Production in Australia* **26:** Short Communication Number 19.

McKiernan, W.A., Wilkins, J.F., Irwin, J. and Barwick, S.A. (2006). Live body composition assessments as predictors of carcase retail beef yield. *Animal Production in Australia* **26:** Short Communication Number 18.

McKiernan, W.A., Wilkins, J.F., Graham, J.F., Tudor, G.D., Deland, M.P.B., McIntyre, B.L., Walkley, J.R.W., Barwick, S.A. and Irwin, J. (2006). CRC 'Regional Combinations' Project – Regional beef systems to improve productivity and profitability. In: Proceedings – "Australian Beef – the leader! – the impact of science on the beef industry." Beef CRC Conference, Armidale, NSW, March, 2006. pp. 127-134.

9.5.2 Technical conferences

(In chronological order)

House, Jeffrey, Wilkins, John and Irwin, John (2003). Give it a whorl – Hair whorls and temperament in cattle. In: "Technology – Our Future", Beef Products Conference (NSW Agriculture), May 2003, pp. 74-76.

Irwin, J., Wilkins, J.F. and House, J. (2003). Assessing temperament in cattle – variation in flight times and crush scores. In: "Technology – Our Future", Beef Products Conference (NSW Agriculture), May 2003, pp. 72-73.

McLennan, Stu, Poppi, Dennis and McKiernan, Bill (2003). Improved supplementation strategies for cattle grazing tropical pastures. In: "Technology – Our Future", Beef Products Conference (NSW Agriculture), May 2003, pp. 67-68.

Wilkins, J.F., Irwin, J., McKiernan, W.A. and Barwick, S.A. (2003). “Regional Combinations” – combining genetics, nutrition and management to produce high quality beef. In: “Technology – Our Future”, Beef Products Conference (NSW Agriculture), May 2003, pp. 69-71.

J.House, J.Irwin and J.F.Wilkins (2003). Temperament in Beef Cattle. In: *Southern Beef Update 2003.* (J.Wilkins Ed.) Wagga Wagga, 6 Nov.2003, (ISBN 0 7347 1548X, NSW Agriculture) pp19-21.

J.Irwin, J.F.Wilkins, W.A.McKiernan, and S.A.Barwick (2003). Combining Genetics and Growth Rate to Produce High Quality Beef in South Eastern Australia. In: *Southern Beef Update 2003.* (J.Wilkins Ed.) Wagga Wagga, 6 Nov.2003, (ISBN 0 7347 1548X, NSW Agriculture) pp10-13.

J.F.Wilkins, J.Irwin, W.A.McKiernan, Edwina Toohey and S.A.Barwick (2003). Early Trends in Weaning and Carcase Data from the CRC “Regional Combinations” High Quality Beef Project. In: *Southern Beef Update 2003.* (J.Wilkins Ed.) Wagga Wagga, 6 Nov.2003, (ISBN 0 7347 1548X, NSW Agriculture) pp14-18.

Wilkins, J.F., McKiernan, W.A., Barwick, S.A. and Irwin, J. (2005). CRC “Regional Combinations” – Genetics and growth paths for high quality beef – Progress report and implications. In: “Moving from Research to Industry Adoption”, NSW Dept Primary Industries/CRC for Cattle and Beef Quality Conference, Coff’s Harbour, May 2005. pp. 44-50. (NSW Agriculture).

Davies, B.L., McKiernan, W.A. and Wilkins, J.F. (2007). Economic results of Regional Beef Systems to Achieve Market Specifications - NSW section. In: “Adapting to the changing environment” (I. Blackwood, Ed.), Beef Products Conference, Hawk’s Nest, March 2007 (NSW Department of Primary Industries).

McKiernan, W.A. and Wilkins, J.F. (2007). Meeting market specifications – (Beef CRC - Regional Combinations). In: “Adapting to the changing environment” (I. Blackwood, Ed.), Beef Products Conference, Hawk’s Nest, March 2007 (NSW Department of Primary Industries).

Wilkins, John, McKiernan, Bill, Irwin, John, House Jeffrey, Barwick, Steve and Orchard, Beverley (2007). Effects of genetics and growth rate on beef production and meat quality – (Beef CRC - Regional Combinations). In: “Adapting to the changing environment” (I. Blackwood, Ed.), Beef Products Conference, Hawk’s Nest, March 2007 (NSW Department of Primary Industries).

9.5.3 Theses completed from the project

Toohey, Edwina (2003). The effect of Genetics and Growth Path on Meat Quality (Intramuscular Fat and Yield) and market compliance. Thesis submitted to Charles Sturt University for the degree of Bachelor of Applied Science (Honours), December 2003.

McGee, Rachel (2004). The Effect on Temperament in Beef Cattle on Meat Quality and Genotype. Thesis submitted to Charles Sturt University for the degree of Bachelor of Applied Science (Honours), November 2004.

9.5.4 Field Days, Public Presentations and Communications

Field Days/Open Days/Workshops

- "The Beef CRC Regional Combinations Project" – Field Day, "Bringagee", Darlington Point, NSW, October 2001.
- Time of Calving Field Walk. ALCOA Fairbridge, WA, June 2002.
- Geoff Tudor & Brian McIntyre (2002) Overview the Beef Quality CRC Projects in WA. The Busselton Weaner Production Workshop. Geograph Bayview Resort, WA, August 2002.
- Time of Calving Field Day. ALCOA Fairbridge, WA, December 2002.
- BIA Field Day, Vasse Research Station, WA, July 2003.
- Midwest Profitable Cattle Workshop. Dongara, WA, August 2003.
- Henty Machinery Field Days, Henty, NSW, September 2003.
- Southern Beef Update 2003, Wagga Wagga Agricultural Institute, November 2003.
- SheepVention and Beef Expo, Hamilton, Vic, 2003.
- Lucindale Field Days, SA, 2003.
- Alcoa Farmlands Field Day, WA, January 2004.
- Drought Recovery Beef Breeding Field Day, ARAS Grafton, NSW, February 2004.
- Glen Innes Autumn Field Day, ARAS Glen Innes, NSW, May 2004.
- Murrumbidgee Farm Fair, Yanco, NSW, May 2004.
- Henty Machinery Field Days, Henty, NSW, September 2004.
- NLIS/Beef Breeding Workshop, Hamilton, Vic, November 2004.
- CRC Regional Combinations Field Day, Vasse Research Station, November 2004.
- SheepVention and Beef Expo, Hamilton, Vic, 2004.
- Lucindale Field Days, SA, 2004.
- Beef-Cheque Groups, (various), Vic, 2004.
- Acme Field Day, Warnambool, Vic, 2005.
- Landmark (WA) Breeding Forum, April 2005.
- Murrumbidgee Farm Fair, Yanco, NSW, May 2005.
- Beef CRC day, Fairbridge, WA, June 2005.
- Beef CRC day, Butterfield, WA, October 2005.
- EH Graham Centre (NSW DPI/CSU alliance) Open Day, Wagga Wagga, NSW, October, 2005.
- Henty Machinery Field Days, Henty, NSW, September 2005.
- SheepVention and Beef Expo, Hamilton, Vic, 2004.
- Lucindale Field Days, SA, 2004.
- Beef-Cheque Groups, (various), Vic, 2004.
- Beef CRC field days. Holbrook, NSW, March 2006.
- Beef CRC field days. Mandurama, NSW, March 2006.

9.5.5 Presentations/seminars

Geoff Tudor (2001) Beef Quality CRC Regional Combinations Project. Meat Research Update. CALM Headquarters, South Perth, October 2001.

Geoff Tudor & Donna Read (2001) Time of Calving. Proc. Meat Research Forum for Agribusiness. Ascot Inn November 2001.

Bill Smart (2002) Monitoring Pasture Feed Supply – Regional Combinations Time of Calving X Growth Paths Experiment Alcoa Farmlands. AgBeef Seminars Dept Agriculture South Perth November 2002.

Wilkins, J.F. and Irwin, J. (2002). "CRC Regional Combinations Project - High quality beef production". Presentations and displays at Wagga Wagga Agricultural Institute Open Day, October 2002.

Graham, J.F. (2002). CRC Regional Combinations Project – Victorian and SA finishing systems. Presentation to Southern Australian Beef Research Committee, November 2002.

Geoff Tudor, Donna Read, Brian McIntyre, Bill Smart, Eric Taylor (2003) Beef Quality CRC Regional Combinations Project3.3. SABRC Meeting –Western Australia April 2003.

John Wilkins and Bill McKiernan. Overview of the CRC Regional Combinations Project. Agricultural Research and Advisory Station, Grafton, July 2003.

Brian McIntyre. Time of calving pasture management systems. A day of information and technology. "Daniel's Well", Borden, September 2003.

CRC Time of calving and growth paths project. AgBeef Meeting, Hanson's Swan Valley, February 2004.

John Wilkins and Bill McKiernan. Progress report and preliminary results from the CRC Regional Combinations Project. Agricultural Research and Advisory Station, Grafton, March 2004.

Wilkins, J.F. Temperament in beef cattle - Implications for management, performance and meat quality. Presentation to BIA, Wagga Wagga, August 2003.

Calving time and year round supply and Producer experience. "Explore the Options" Beef Year Round Supply Information Day. Jurien Bay, March 2004.

Tony Della Bosca. Economics of time of calving. Esperance Beef and Sheep Updates. Civic Centre, Esperance. August 2004.

Livestock updates – Moora, Dongara and Esperance, WA, July/August 2005.
Vasse Research Discussion group - Growthpaths and economics of changing Time of Calving - October 2005.

9.5.6 Miscellaneous Publications and newspaper articles

(Sample only)
Regular contributions to CRC Stakeholder News and CRC Email News (2003 -2006).

Hoffman, Bill (2003). Research herd finds new home. Beef News No 58, August 2003 (ISSN 1322-1493).

Wilkins, John and Hoffman, Bill (2003). Sires help target markets. Beef News No 60, December 2003 (ISSN 1322-1493).

Anon. (2002). Combining genotype and growth rate. In: Agriculture Today, July 25, 2002 (The Land, Supplement) p.15.

Clark, A.J.and Graham, J.F. (2002). CRC Project – milk production from dams. In: Hamilton Spectator, August 2002.

John Wilkins (2004). Fine tuning sire selection to meet quality beef specifications. Australian Farm Journal, July 2004, pp. 47–50.

John Wilkins and John Irwin (2004). High quality beef – the right mix of genetics and growth. Wagga Wagga Agricultural Institute – Update 2004. (NSW Agriculture, ISBN 0 7347 1419) pp. 42-43.

Regional beef systems to achieve market specifications. Feedback magazine (MLA), July 2004, p.7.

Bill McKiernan and Bill Hoffman (2004). Regional combinations trial. Beef News, No. 63, November 2004 (ISSN 1322-1493), NSWDPI, pp. 1-2.

Bill McKiernan (2004). Lift profits by $140/head with the right genetics and nutrition. MLA Prograzier, Winter edition 2004.

John Wilkins and John Irwin (2004). European genetics earns $140 more for beef. Farming Ahead, No 151 August 2004.

Annette Cross (2004). “Combinations” helps with breeding types. Today’s Feed Lotting. Winter edition 2004, pp. 20,30.

“High yields, quality can go hand in hand” (Kevin Elsley reporting) The Land, 4 March 2004 p 54. (Reporting Grafton Field Day).

John Irwin, Bill McKiernan, John Wilkins and Alastair Rayner (2004). Summary of preliminary results from NSW Agriculture/CRC “Regional Combinations” Project. Field day notes, NSW Agriculture, ARAS Grafton, 21 February 2004.

9.6 Appendix 6 – AJEA Paper (Methodology)

The following paper (McKiernan *et al.,* 2005) contains the overview of the methods over all sites as referred to throughout the text.

McKiernan WA, Wilkins JF, Barwick SA, Tudor GD, McIntyre BL, Graham JG, Deland MPD Davies L (2005) CRC "Regional Combinations" Project – effects of genetics and growth paths on beef production and meat quality: experimental design, methods and measurements. *Australian Journal of Experimental Agriculture* **45 (7-8),** 959-969.

http://www.publish.csiro.au/journals/ajea