Appendix 9 - Growth path, transport and genetic effects on beef eating quality and ability to cost-effectively meet beef market specifications

Up to 25% of Australian cattle fail to meet targets for hot standard carcase weight (HSCW) and fat specifications, at a cost of $15 to $30/head, depending on the target market. A recent study of feedlot cattle showed that in a 20,000 head sample of animals finished for short-fed markets, 28% missed HSCW specifications, foregoing $31,000 ($5.50/head) and 16% missed P8 fat specifications, forfeiting $54,000 ($17.50/head; Slack-Smith et al., 2009)**.**

The 'Regional Combinations' project of Beef CRC phase 2 aimed to investigate the best combinations of genetics and growth paths that would minimise compliance costs. Economic calculations regarding the profitability of different nutritional, genetic and time-of-calving combinations were reported in Davies et al. (2008), Griffith et al. (2009b) and related papers for individual beef enterprises representative of four southern Australian production regions. Those results were then aggregated up to the level of the Southern Australian cattle and beef industry and projected forward over a number of years into the future.

The aggregate economic analyses 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 ~$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 carcass types they produce.

These are gross benefits in that they do not account for 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 producers with a level of confidence to invest in pasture improvement, more targeted pasture management or supplementary feeding and hence to minimise the costs of non-compliance.

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Economic effects of alternate growth path, time of calving and breed type combinations across southern Australian beef cattle environments: industry-wide effects

G. R. Griffith

Cooperative Research Centre for Beef Genetic Technologies, University of New England, Armidale, NSW 2351, Australia, and New South Wales Department of Primary Industries, Armidale, NSW 2351, Australia.
Email: garry.griffith@dpi.nsw.gov.au

Abstract. The 'Regional Combinations' project and its biophysical outcomes, and the subsequent identification of the most profitable beef cattle production systems across different environments in southern Australia, have been described in several other papers in this special edition. In this paper, the economic calculations reported for each of the individual beef enterprises representative of the various state sites are aggregated up to the level of the Australian cattle and beef industry and then projected forward over several years into the future. To do this, an existing model of the world beef market is used. The analyses 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% real discount rate.

Introduction

The 'Regional Combinations' project was designed to evaluate the nutritional and genetic combinations affecting the quality of beef production at four sites in southern Australia – southern New South Wales (NSW), western Victoria (Vic.), south-east South Australia (SA) and south-west Western Australia (WA). The overall design and methodology was described by McKiernan *et al*. (2005), although most of the results have been reported in McKiernan *et al*. (2007).

One of the specific objectives of the project was to examine the economics of different combinations of beef cattle genetics and growth/nutritional pathways to achieve targeted specifications across these various environments. A farm-level modelling system has been described in Davies *et al*. (2008) that allows an economic evaluation of the experimental results across each site. The economic outcomes of applying this system at the NSW site have been reported in Davies *et al.* (2009).

The economic calculations reported in Davies *et al*. (2008) and related papers are for an individual beef enterprise representative of the relevant region. In the present paper, those results are aggregated up to the level of the Australian cattle and beef industry and then projected forward over several years into the future. To do this, an existing model of the world beef market is used.

Methods

Choice of modelling framework

The Dynamic Research Evaluation for Management or '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 *et al.* 1995) and has a rigorous theoretical base. It has been widely used in economic impact assessment studies over several years by many different national and international institutions. It has been used recently in several assessments of the potential value of new or existing Cooperative Research Centres (CRC) (Vere *et al*. 2005; Griffith *et al*. 2006*a*, 2006*b*; Jones *et al*. 2006).

DREAM has several different options 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 several 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 USA, Japan, Korea

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and an aggregate Rest of World (ROW). Australian beef is allowed to be available in all possible regional markets and to compete with beef from all possible regional suppliers.

Data required

The economic models underlying the DREAM software require the following datasets: (i) '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; (ii) 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 (iii) 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 recent Beef CRC renewal analysis was used (Griffith *et al*. 2006*a*). The year 2001–02 was chosen as the base year for the price and quantity data. 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 1. Notes explaining calculations relating to these data are given above 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 2. These are taken mainly from Zhao *et al*. (2000). Note that the domestic demand elasticities given in Zhao *et al*. (2000) have been reduced by two-thirds 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 (ABARE 2007). 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 the USA, 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.

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 with the USA and the ROW.

The relevant measures of K are defined in each of the scenarios that follow. The data in Tables 1 and 2 plus the relevant measures of K allow the DREAM software 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 several other variables and parameters (Wood *et al*. 2001). Many of these were the same as those used in the Beef CRC renewal analysis:

(1) the lag before the research results are available to cattle producers (1 year),
(2) adoption lags (2 years until maximum adoption, to match the Beef CRC accelerated adoption objectives),

Table 1. Base price and quantity data, beef and veal, 2001–02

ktcw, kilotonnes carcass weight; ktsw, kilotonnes shipped weight. Source: unless otherwise noted, all data are from Meat and Livestock Australia (2002). Consumption in each state is calculated as 35.5 kg/capita × state population for 2001–02 as given in Australian Bureau of Statistics (2003); live cattle exports are converted to kt by assuming a liveweight of 350 kg and an average dressing percentage of 54%. In the model, these equivalents are added to production in each Australian state, to rest of world consumption and to both world production and consumption; in the model Western Australia 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 hot standard carcass weight; the Northern Territory price is an average of Queensland and Western Australia; the United States price is Australian boneless cow beef, 90% chemical lean, free alongside ship; the Japanese price is Australian chilled boneless grass-fed fullset, free alongside ship; the Korean price is unit value of all Australian beef and veal exports to Korea, free on board

Region	Production	Consumption	Beef exports		Cattle exports		Price
	(ktcw)	(ktcw)	(ktcw)	(ktsw)	(ktsw)	(head)	($AU/t)
New South Wales	474	296	204	–	0.733	3877	3130
Victoria	355	171	144	–	8.464	44 785	3223
Queensland	978	129	556	–	28.507	150 829	2634
South Australia	86	54	37	–	4.571	24 184	2714
Western Australia	96	68	21	–	62.608	331 258	2550
Tasmania	45	17	21	–	–	–	2773
Northern Territory	1	7	–	–	50.121	265 190	2592
Australia	2034	742	1292	984	155.0	820 139	–
United States	11 762	12 268	(506)	–	–	–	4016
Japan	457	1207	(750)	–	–	–	5110
Korea	190	580	(390)	–	–	–	4295
Rest of world	35 753	35 399	354	–	–	–	4016
World	50 196	50 196	0	–	–	–	

(3) adoption levels (35%, to match the Beef CRC accelerated adoption objectives, but discounted back to 15% because many of the better producers will already have adopted this technology),
(4) disadoption if relevant (not considered to be relevant in this study),
(5) probability of success of the technology producing the expected outputs across all the target markets (80%),
(6) the time period over which the outcomes are to be assessed (15 years),
(7) the discount rate (7% real, to approximate the overdraft rate faced by commercial cattle producers),
(8) 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
(9) whether the technology is to be available outside the region where the RD&E occurred [not considered to be available outside the region where the RD&E occurred, with the exception of the spillover of Vic. results to SA and Tasmania (Tas.)].

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

Table 2. Base supply and demand elasticity values
Source: the base values are taken from Zhao *et al*. (2000)

Region	Supply elasticity	Demand elasticity
New South Wales	1.00	–0.33
Victoria	1.00	–0.33
Queensland	0.75	–0.27
South Australia	1.00	–0.33
Western Australia (north/south)	0.75/1.00	–0.27/–0.33
Tasmania	1.00	–0.33
Northern Territory	0.75	–0.27
United States	1.00	–3.00
Japan	0.70	–2.00
Korea	0.70	–2.00
Rest of world	1.00	–5.00

Results

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 tables 4 and 5 in Davies *et al.* (2008) was used to calculate a minimum advantage of $37/steer 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 355 kg, this advantage of $37/steer can be converted to 10.3 ¢/kg, or to 3.3% of the NSW equilibrium price of $3130/t defined in Table 1 above. The K-value is then 0.033 for NSW. This can be thought of as a 3.3% net reduction in the cost of producing a kg of beef in NSW from shifting from a slow to a fast growth path.[1]

Similarly for Vic., the information in table 6 in Davies *et al.* (2008) provided an advantage of $16/head for the fast treatment, autumn calving, for all breed types. For a mean carcass weight of 290 kg, this gave a K-value of 0.017, or a 1.7% reduction in the cost of producing beef in Vic. This value was also used for SA (where there was no growth path experimental data) and Tas. Finally, for southern WA, the information in table 7 in Davies *et al.* (2008) was used to calculate a K-value of 0.086, for the fast treatment across all breed types for autumn calving. This can be thought of as an 8.6% reduction in the cost of producing a kg of beef in southern WA.

Inputting these K-values into the model together with the other data and parameters described above produced the results shown in Table 3. 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%.

Therefore, using the model, data and assumptions described above, the aggregate benefits of an additional 15% 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. In terms of timing, the benefits are calculated to be $2.8 million after 1 year and $10.3 million after 5 years.

These benefits are caused 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 about impact and adoption profile. 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. This works out at around $950 per 100 breeding cows (present value over the 15-year time horizon) for those producers who adopt the technology. Conversely, beef producers in the rest of

Table 3. Present value ($×10^3) of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to fast growth paths

Region	Producer	Consumer	Total
New South Wales	43 321.4	162.0	43 483.4
Victoria	18 283.9	93.5	18 377.5
South Australia	3851.8	29.5	3881.3
Tasmania	1946.6	9.3	1955.9
Western Australia (south)	9794.9	27.3	9822.3
Total southern Australia	77 198.8	321.8	77 520.6
Total other (Australia)	–606.5	79.1	–527.3
Total rest of world	–18 976.7	19 732.9	756.2
Total world market	57 615.5	20 133.9	77 749.4

[1]The calculated K-values represent net reductions in variable costs as they are based on differences between steady state gross margins, and so reflect differences in both enterprise costs and returns between alternatives. However, they do not include any additional whole-farm costs, especially investment costs, required to implement the alternative production system (nor, any additional benefits derived from more efficient whole-farm input or output combinations).

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 ROW, who can now access greater quantities of beef at lower prices. However, the positive and negative market impacts outside of southern Australia essentially cancel each other out.

Time-of-calving comparisons

The second scenario examined is the comparison between calving times in those states where this was varied, averaged across breed types and using the 'conventional' slow growth rates at each site to avoid double counting.

For Vic., the information in table 6 in Davies *et al*. (2008) provided an advantage of $37/steer for the slow treatment, spring calving, for all breed types. For a mean carcass weight of 290 kg, this gave a K-value of 0.040, or a reduction in cost of production of 4.0%. This value was also used for SA and Tas. For southern WA, the information in table 5 in Davies *et al.* (2008) was used to calculate a K-value of 0.102 (a cost reduction of 10.2%), for the average across all breed types for winter calving.

Inputting these K-values into the model together with the other data and parameters described above produced the following results as shown in Table 4.

Therefore, the aggregate benefits of an additional 15% 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. In terms of timing, the benefits are calculated to be $2.4 million after 1 year and $8.9 million after 5 years. Again, almost all of the benefits accrue to southern Australian beef producers (around $840 per 100 breeding cows). NSW beef producers appear to lose from this scenario, because there was no time-of-calving experiment in NSW and hence no measured cost saving. However, for NSW enterprises where time-of-calving principles and technology were considered applicable, similar benefits could be assumed to accrue.

Carcass/breed type comparisons

The third possible scenario to examine is the comparison between carcass/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 reported in Davies *et al.* (2008) and related papers suggests that in many cases there were no significant differences in gross margins across breeds, even though there were differences in many of the carcass characteristics. All we can do in the present paper is to 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. The Charolais carcass 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 Charolais types achieved the best gross margin following slower pre-feedlot growth (due to high compensatory growth), but next to worst following the fast pre-feedlot phase. Although their growth rates in the feedlot stage were as high as for other breeds, there were additional feeding costs due to their higher average bodyweight. The higher feedlot entry 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 a high proportion having carcass 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 the 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 carcass types are relatively more or less suited to different market specifications.

The southern WA economic analyses confirmed these findings with the progeny of sires selected for high carcass yield having a slight advantage in overall value through their greater carcass weights. The Vic. site analyses also showed the importance of producing cattle with heavier slaughter weights, highlighted when comparing the Wagyu ($339/ha) to the other breeds ($373/ha) across all growth rates and times of calving. This was a $34/ha premium to the higher yielding sire classes. In SA, only the Angus breed was examined, but like the WA results, the progeny of sires selected for high carcass yield were clearly dominant (up to $17/ha).

Table 4. Present value ($\$\times10^3$) of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to winter or spring calving

Region	Producer	Consumer	Total
New South Wales	–234.2	146.0	–88.2
Victoria	43 367.8	84.3	43 452.1
South Australia	9147.7	26.6	9174.3
Tasmania	4622.4	8.3	4630.8
Western Australia (south)	11 635.5	24.6	11 660.2
Total southern Australia	68 539.2	290.0	68 829.2
Total other (Australia)	–546.6	71.3	–475.2
Total rest of world	–17 102.5	17 783.9	681.4
Total world market	50 890.1	18 145.3	69 035.4

Commercial v. research station

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

Table 5. Present value ($×10^3$) of producer, consumer and total benefits by state, rest of Australia and rest of world, shift to fast growth paths, Davidson and Martin (1965) discount

Region	Producer	Consumer	Total
New South Wales	43 336.7	152.4	43 489.2
Victoria	16 119.3	88.0	16 207.4
South Australia	3395.3	27.8	3423.1
Tasmania	1716.0	8.7	1724.7
Western Australia (south)	8305.6	5.7	8331.3
Total southern Australia	72 873.0	302.8	73 175.9
Total other (Australia)	–570.8	74.4	–496.3
Total rest of world	–17 860.6	18 572.4	711.7
Total world market	54 441.5	18 949.7	73 391.3

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 parts of the experiment were conducted on partner agency research stations, so a 15% discount (an arbitrary 50% reduction) was applied. The results are reported in Table 5.

Compared with the outcomes reported in Table 3, 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.

Discussion and conclusions

Economic calculations regarding the profitability of different nutritional, genetic and time-of-calving combinations have been reported in Davies *et al*. (2008) and related papers for individual beef enterprises representative of four southern Australian production regions. In this paper, those results are aggregated up to the level of the Australian cattle and beef industry and then projected forward over several years into the future. To do this, an existing model of the world beef market is used.

The aggregate economic analyses 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 Australian cattle and beef industries. The cumulative present values of each technology are around $70 million over a 15-year time horizon at a 7% real discount rate, with benefits in the first year of around $2–3 million and benefits after 5 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 carcass types they produce.

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. First, animals from slow growth paths still achieved satisfactory meat quality scores. This means that if cattle have been grown slowly before 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.

Second, 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 reported in Davies *et al*. (2008) and related papers, and used as the basis for the industry benefit calculations reported here, 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.

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NSW DEPARTMENT OF
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The Economic Effects of Early-Life Nutritional Constraints in Crossbred Cattle Bred on the NSW North Coast

Andrew R. Alford
Livestock Research Officer, NSW Department of Primary Industries, Armidale,
and Cooperative Research Centre for Beef Genetic Technologies

Linda M. Cafe
Technical Officer, NSW Department of Primary Industries, Armidale,
and Cooperative Research Centre for Beef Genetic Technologies

Paul L. Greenwood
Principal Research Scientist, NSW Department of Primary Industries, Armidale,
and Cooperative Research Centre for Beef Genetic Technologies

Garry R. Griffith
Principal Research Scientist, NSW Department of Primary Industries, Armidale,
and Cooperative Research Centre for Beef Genetic Technologies

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Abstract
Different patterns of nutrition during pregnancy and lactation can influence cow productivity and the performance of their offspring. An experiment was conducted on the North Coast of NSW whereby "low" and "high" pasture nutritional systems were imposed on a herd of Hereford cows during pregnancy, and then again from birth to weaning, with a crossover design also imposed to select offspring with extremes of growth to birth and/or weaning. Thus, four growth groups resulted – low-low, low-high, high-low, and high-high. Piedmontese and Wagyu bulls were used. After weaning, these offspring were grown out on the NSW Northern Tablelands and then finished to heavy market weights in a feedlot. The results of the experiment indicated that restricted early-life growth resulting in differences in weight of calves at weaning persisted until slaughter at 30 months of age. Animals that were smaller at weaning remained smaller at slaughter. Some compensation occurred following restriction of growth during lactation, but not following restriction of growth during pregnancy. However, neither carcass quality nor eating quality of the beef was adversely affected by growth restriction during early-life. An economic analysis of these data was done using the Beef-N-Omics decision support package. Two methods were used. The main results showed that for the representative cattle enterprise modelled, total gross margins ranged from $45,500 for the low-low system to $52,600 for the high-low system. Gross margin per hectare ranged from $114 for the low-low system to $132 for the high-low system, while gross margin per breeding cow ranged from $303 for the low-low system to $387 for the high-high system. In all cases, the gross margin for those groups with foetal growth based on a higher level of nutrition exceeded their peers on a lower level of nutrition. Therefore, it is more profitable for cows and calves to have access to a high standard of nutrition during pregnancy and up to weaning than for them to have access only to a poor standard of nutrition during this time period.

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Senior Author's Contact:
Dr Andrew Alford, NSW Department of Primary Industries Beef Industry Centre, JS Barker Building, University of New England, Armidale, NSW, 2351.
Telephone: (02) 67 701 813
Facsimile: (02) 67 701 830
Email: andrew.alford@dpi.nsw.gov.au

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Acronyms and Abbreviations Used in the Report

ABARE	Australian Bureau of Agricultural and Resource Economics
ADG	Average daily gain
BEEF CRC	Cooperative Research Centre for Cattle and Beef Quality
Beef-N-Omics	A software package (see Appendix G)
CFA	Cast-for-age
CW	Carcass weight
DM	Dry matter
ME	Metabolisable energy
MSA	Meat Standards Australia
RD&E	Research, development and extension

Executive Summary

Modern Australian beef cattle husbandry practices aim to grow cattle efficiently on pasture during the early phases of their lives, followed by the use of high quality feedstuffs during later growth phases to reduce the risk of not meeting the targeted premium market specifications. However, pasture-reliant growth of cattle is typically a prolonged process during which cattle experience widely differing nutrition levels and growth paths due to variable pasture quality and availability, climatic extremes, and constraints on management of cattle and pastures. Different patterns of nutrition during pregnancy and lactation can influence cow productivity and the performance of their offspring. This issue has assumed greater importance in recent times with the ongoing drought and the prospect of even greater variability in climate due to global warming.

An experiment was conducted on the North Coast of NSW whereby “low” and “high” pasture nutritional systems were imposed on a herd of Hereford cows during pregnancy, and then again from birth to weaning, with a crossover design also imposed to select offspring with extremes of growth to birth and/or weaning. Thus, four nutritional cow and offspring growth groups resulted – low-low, low-high, high-low, and high-high. The aim was to maximise the divergence, within animal welfare limitations, in foetal and pre-weaning growth of the progeny, and to investigate the subsequent differences in growth rates and carcass characteristics of offspring through to market weights. To cover the range of market specifications, both Piedmontese (high muscle growth and high birth weight) and Wagyu (high marbling and low birth weight) bulls were used. The progeny of the experiment were grown out or backgrounded on the NSW Northern Tablelands until about 26 months of age then finished in a feedlot for around 120 days.

The results of the experiment indicated that restricted early-life growth resulting in differences in weight of calves at weaning persisted until slaughter at 30 months of age. Animals that were smaller at weaning remained smaller at slaughter. Some compensation occurred following restriction of growth during lactation, but not following restriction of growth during pregnancy. However, neither carcass quality nor eating quality of the beef was adversely affected by growth restriction during early-life.

An economic analysis of these data was done using the Beef-N-Omics decision support package. Two different methods were used to test whether following the experimental protocols (different weights at feedlot entry) resulted in economic outcomes different from those resulting from applying typical commercial practice. The first (following the protocols) showed that for the representative cattle enterprise modelled, total gross margins ranged from $45,500 for the low-low system to $52,600 for the high-low system. Gross margin per hectare ranged from $114 for the low-low system to $132 for the high-low system, while gross margin per breeding cow ranged from $303 for the low-low system to $387 for the high-high system. The second method (adjusting for a common feedlot entry weight) showed slightly lower gross margins for each early-life treatment group, but the same ranking of groups. However, in all cases, the gross margin for those animals that commenced foetal growth on a high plane of nutrition and a high growth trajectory exceeded their peers on the low plane of nutrition and low growth trajectory.

It is more profitable for cows and calves to have access to a high standard of nutrition during pregnancy and up to weaning than for them to have access only to a poor standard of nutrition

during this time period. Further, if feed is in short supply and a choice has to be made, it is more profitable for cows to have access to a high standard of nutrition during pregnancy than for cows and calves to have access to a high standard of nutrition between partuition and weaning.

1. Introduction

Australian beef cattle producers are increasingly managing their production systems to better target specific markets for their stock. They can do this by selecting appropriate genotypes and by tailoring their nutritional management to allow better expression of genetic advantages. Market requirements range from those favoured by high yielding, lean carcasses, such as the domestic trade market, to those requiring high intramuscular fat or marbling content, such as the domestic Hotel-Restaurant-Institution market and the high end Japanese market. As a result, animals of markedly different genetic characteristics are used as terminal sires.

Modern beef cattle husbandry practices aim to grow cattle efficiently on pasture during the early phases of their lives, followed by the use of high quality feedstuffs during later growth phases to reduce the risk of not meeting the targeted market specifications. However, pasture-reliant growth of cattle is typically a prolonged process during which cattle experience widely differing nutrition levels due to variable pasture quality and availability, climatic extremes, and constraints on optimal management of cattle and pastures. Finishing cattle on grain may not be sufficient to overcome early-life nutritional deficiencies. Hence, it is important to understand the influences of different patterns of nutrition and growth during pregnancy and lactation on cows mated to sire-breeds with high muscling or marbling potential, and on the performance of their offspring. This requirement has assumed greater importance in recent times with the ongoing drought and the prospect of even greater variability in climate due to global warming.

In relation to the underlying biological relationships, foetal growth of cattle has been extensively studied in relation to calf survival. It has been shown that growth of the foetal calf can be slowed during the latter half of pregnancy by severely restricted maternal nutrition (Holland and Odde 1992). Similarly, during late pregnancy, the size of the dam can restrict the growth of foetuses with high prenatal growth potential (Ferrell 1991; Joubert and Hammond 1958). However, the consequences of foetal growth for subsequent performance, particularly in relation to carcass and eating quality characteristics at market weights, are less well understood (Greenwood *et al.* 2002, 2005) and do not appear to have been assessed in cattle differing in sire-genotype. For example, while severe growth retardation during foetal life has been shown to reduce muscle growth and increase fatness later in life in sheep (Greenwood *et al*. 1998, 2000; Villette and Theriez 1981), such retardation had lesser effects on body composition in Hereford cattle (Tudor *et al.* 1980).

Influences of pre-weaning nutrition on post-weaning growth and composition of cattle at market weights are better described (Berge 1991; Hearnshaw 1997). Nutritional restriction early in life can have prolonged effects on subsequent growth of cattle (Reardon and Everitt 1973) and severe restriction prior to weaning does not appear to result in increased carcass fatness when animals are recovered for prolonged periods on pasture (Tudor *et al.* 1980; Berge 1991; Hearnshaw 1997). However, when fed high energy diets, animals severely growth-retarded from birth to weaning were fatter at market weights than their counterparts well-grown to weaning (Tudor 1972; Tudor and O’Rourke 1980; Tudor *et al.* 1980). As with foetal growth, the influences of nutrition and growth prior to weaning on subsequent performance, and interactions between prenatal and pre-weaning nutrition and growth, in cattle of extreme sire-genotypes for muscling and marbling, have not been studied.

In the study reported here, hypotheses were proposed that cows mated to high muscle growth or high marbling potential bulls, and their offspring, will exhibit different liveweight and growth responses to divergent nutrition and growth during pregnancy and lactation. To test these hypotheses, low and high pasture quality and availability nutritional systems were imposed during pregnancy and from birth to weaning, with the aim of maximising divergence, within animal welfare limitations, in foetal and pre-weaning growth of progeny sired by Piedmontese (high muscle growth and high birth weight) and Wagyu (high marbling and low birth weight) bulls.

This study was also designed to provide subsets of animals with divergent prenatal growth (approximately 30 per cent difference in birth weight) and growth to weaning (approximately 0.5 *v.* 1.0 kg/day ADG) in divergent genotypes for related studies on molecular and cellular development of carcass tissues, and on carcass and eating quality characteristics. Ultimately, this information will be used to enhance models for phenotypic prediction of beef cattle performance.

Commercially, the information is also important for beef cattle producers to assess whether it is economically feasible to invest in different genetics and /or different nutrition systems.

In this report, the experimental results are reviewed, a farm-level modelling system is described that allows an economic evaluation of the experimental results, and the economic outcomes of applying this system in two different ways are reported. Implications are then drawn for beef cattle producers in the study area.

2. The Early-Life Nutrition and Growth Experiment

Overview of the Study

This experiment was conducted as a part of the research program of the Cooperative Research Centre for Cattle and Beef Quality (the Beef CRC). The objective was to study the long-term consequences of different patterns of early-life growth on subsequent growth to heavy market weights, and on the resulting carcass yield and eating quality characteristics (Greenwood *et al.* 2005, 2006). There was also interest in comparing high yielding and high marbling types of cattle.

The dams used in the experiment were Hereford cows and heifers (360 in total), and the sires were Piedmontese (muscling) and Wagyu (marbling) (four of each). The experiment was conducted at Grafton Agricultural Research and Advisory Station, on the NSW North Coast, over two breeding cycles. Mating commenced in November 2000, with calves being born in the winter/spring of 2001 and again in the winter/spring of 2002. Following post-weaning backgrounding and finishing on the NSW Northern Tablelands, the final progeny group was slaughtered in March 2005.

Cows were managed within ‘High’ and ‘Low’ nutritional systems at Grafton from diagnosis of pregnancy to parturition. Lactating cows and their calves were similarly managed until weaning at about 8 months of age. This produced calves with high or low birth weights, and high or low growth to weaning. Half of the animals swapped nutritional treatments at birth, resulting in progeny with the following combinations of early-life nutrition and growth:

- LL = Low during pregnancy, and Low during lactation
- LH = Low during pregnancy, and High during lactation
- HL = High during pregnancy, and Low during lactation
- HH = High during pregnancy, and High during lactation

The number of progeny reaching weaning from the two breeding cycles was 534. Of these, 240 core animals were selected, representing extremes of birth weight and growth to weaning. Following weaning, these core animals were grazed on improved temperate pastures (backgrounded) at Glen Innes Agricultural Research and Advisory Station on the New England Tablelands, in steer or heifer cohort groups until they reached around 500kg. They were then grain fed for 120 days at the Tullimba research feedlot west of Armidale. They were about 30 months of age at feedlot exit, when they were slaughtered at the John Dee Abattoir near Warwick in south-east Queensland. Carcass attributes were assessed there. This core group of 240 cattle has been used in the economic analysis, as there is a complete data set relating to each of these animals.

This experimental protocol approximated a common production system in the region where weaners are bred on the NSW North Coast and then grown out on the better quality pastures of the NSW Northern Tablelands.

The calendar of management events for progeny of the two breeding cycles is shown in Table 1, and a more detailed description is provided by Cafe *et al.* (2006b).

Table 1. Calendar of management events for the entire life of the progeny from each breeding cycle

Breeding Cycle 1

	2000		2001												2002												2003												2004		
	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Mating	■	■	■																																						
In-utero treatment				■	■	■	■	■	■	■	■																														
Calving									■	■	■	■																													
Pre-weaning treatment										■	■	■	■	■	■	■	■	■																							
Weaning																		■																							
Backgrounding																			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
Feedlotting																																					■	■	■	■	■
Slaughter																																								■	■

Breeding Cycle 2

	2001		2002												2003												2004												2005		
	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
Mating	■	■	■																																						
In-utero treatment	* ▒	▒	▒	■	■	■	■	■	■	■	■																														
Calving									■	■	■	■																													
Pre-weaning treatment										■	■	■	■	■	■	■	■	■																							
Weaning																		■																							
Backgrounding																			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
Feedlotting																																					■	■	■	■	■
Slaughter																																									■

* 60% of the cow herd were lactating with cycle 1 calves when cycle 2 mating occurred. Therefore the in-utero treatment for the cycle 2 calves of the lactating cows began at conception. For the remaining 40% of cows the in-utero treatment began in February (at pregnancy diagnosis).

Nutritional Treatments at Grafton

The early-life High and Low nutritional treatments were pasture-based, with the use of supplementation as required to meet the experimental growth targets and to ensure animal welfare requirements were maintained within the low nutritional systems.

The Low system was based on poor quality native and naturalised pastures on unfertilised duplex soils. The target growth rate for these calves was 500-600 grams per day.

The High system was based on improved pasture species on heavy alluvial flats and higher red alluvium. Irrigated ryegrass was used to fill the winter feed gap that prevails in this region, and to ensure continued High nutrition. The target growth rate for these calves was 800-900 grams per day.

During both breeding cycles, some strategic feed supplementation was required, but this was more significant in 2002/2003 due to the very severe drought occurring in the region at the time. Lactating cows and calves were fed a pelleted, complete ration for most of the pre-weaning period as there was very little dry matter available. The supplementation allowed the research growth targets to be met, while ensuring welfare standards were maintained (Cafe *et al.* 2006b).

The growth parameters for each early-life growth group are shown in Table 2. The calves selected for the low birth weight groups were some 10kg lighter than their high birth weight counterparts. Subsequent high nutrition up until weaning significantly raised daily gain and weaning weights, but those calves on high nutrition during pregnancy (HL and HH) were always ahead of their low nutrition counterparts (LL and LH).

Table 2. Summary of growth parameters to weaning for each early-life treatment group within the 240 core progeny

Early-life growth treatment	n	Birth weight (kg)	Weaning weight (kg)	Pre-weaning ADG (g/d)
LL	60	28.3	139	513
LH	60	28.9	210	826
HL	59	38.1	162	596
HH	61	39.5	233	923
s.e.d.		0.76	5.1	19.3

Backgrounding at Glen Innes

Three cohorts of progeny (two steer cohorts and one heifer cohort) were sent to Glen Innes to start pasture backgrounding soon after weaning. They grazed as cohort groups (n = 80 per cohort) for approximately 18 months. The pastures at Glen Innes comprise good quality temperate improved species (Fescue, Phalaris and White clover), producing high cattle weight gain over spring and summer, but little gain in the cold winter period.

Some supplementation was required at Glen Innes also during the 2002/2003 drought to ensure animals reached their target feedlot entry weights by approximately 26 months of age.

The growth of the early-life treatment groups during backgrounding is shown in Table 3. Again, those calves with high growth rate during pregnancy (HL and HH) were always ahead of their low growth counterparts (LL and LH). However, there was also some compensatory gain evident, with those calves that entered backgrounding on a slower growth path between birth and weaning (LL and HL) having faster backgrounding growth rates than their LH and HH peers.

Table 3. Summary of backgrounding growth for each early-life treatment group within the 240 core progeny

Early-life growth treatment	n	Weaning weight (kg)	Feedlot entry weight (kg)	Backgrounding ADG (g/d)
LL	60	139	473	602
LH	60	210	509	540
HL	59	162	511	628
HH	61	233	553	576
s.e.d.		5.1	9.0	12.3

Feedlot Finishing at Tullimba

The 240 core cattle were grain-fed at Tullimba feedlot for approximately 120 days after backgrounding. The feedlot growth and exit weights are shown in Table 4. Feedlot entry was based on cohort age, not on individual weights as would be done commercially. At the completion of feedlotting, the cattle were approximately 30 months of age. It is interesting that there is no evidence of compensatory gain in the feedlot – those animals that went in lighter grew more slowly than those that went in heavier.

Table 4. Summary of feedlot intake and growth for each early-life treatment group within the 240 core progeny

Group	n	Feedlot entry weight (kg)	Feed intake (t/hd/120d)	Feedlot exit weight (kg)	Feedlot ADG (g/d)
LL	60	473	1.51	629	1 465
LH	60	509	1.61	666	1 498
HL	59	511	1.68	682	1 598
HH	61	553	1.76	723	1 640
s.e.d.		9.0		13.2	61.9

Carcass Characteristics

Following feedlotting, the cattle were transported to John Dee Abattoir at Warwick in southern Queensland for slaughter and assessment of carcass attributes. Detailed carcass, yield and meat quality data were collected, a summary of which is shown in Table 5. Generally, the carcasses from all four treatments met the market specifications for the grain-fed export market that the abattoir supplies (however, examination of the P8 measures suggests that if specifications are tightened sufficiently, the HH pre weaning treatment in particular would be penalised more often given that industry currently aim for less than 18mm of fat).

Table 5. Summary of important carcass attributes for each early-life treatment group within the 240 core progeny

Early-life growth treatment	n	Carcass weight (kg)	Hot P8 fat depth (mm)	Retail meat yield (kg/animal)	Retail meat yield (%)	US marble score
LL	60	353	19.6	234	67.4	456
LH	60	376	21.2	243	65.7	441
HL	59	383	19.2	250	66.4	449
HH	61	409	22.0	265	65.5	436
s.e.d.		7.6	1.4	5.7	0.56	22.7

Conclusion

Restricted early-life growth resulting in differences in weight of calves at weaning persisted until 30 months of age. Animals that were smaller at weaning remained smaller at slaughter. Some compensation occurred following restriction of growth during lactation, but not following restriction of growth during pregnancy.

Carcass quality of these animals was not adversely affected by growth restriction during early-life, under present carcass specifications. Smaller animals had smaller carcasses, but tended to yield a higher proportion of meat than the larger animals. This was mainly due to the weight differences placing them at different stages of the growth curve, so that the larger animals had undergone more fattening than the smaller ones. Subcutaneous and intramuscular fat measures were not affected to the extent of influencing the value of the carcass. These findings have subsequently been confirmed in cattle grown slowly or rapidly to weaning and backgrounded to the same feedlot entry weights (Cafe *et al.* 2006a).

Similarly, eating quality of beef was unaffected by growth during early-life (see Greenwood *et al.* 2006), hence no differences in returns would occur if an objective beef marketing system such as Meat Standards Australia was used.

One aspect of the experimental design to remember when interpreting the outcomes is that animals were deliberately selected to exhibit extremes of growth from the nutritional treatments. This necessarily introduces a bias against the low groups and a bias toward the high groups. In this sense the experiment and the analyses that have followed are best-case vs worst-case scenarios.

3. Methodology for the Economic Evaluation

The nature of the experimental protocols resulted in a number of decisions being made that would not be consistent with normal commercial practice. For example, the very poor seasonal conditions at Grafton during much of the experimental phase necessitated the use of large levels of supplementation of some cow treatment groups to obtain the targeted high nutritional planes. These levels and consequent costs of feed supplements would be obviously uneconomic in commercial beef production terms. Further, because of the experimental protocols, feedlot entry was based on cohort age, not on individual weights as would be done commercially, and slaughter was also based on age rather than a target weight (although in this case the carcasses from all four treatments met the market specifications of the processor).

Therefore it was decided not to model the experimental data exactly as recorded, but to examine the implications of the experimental outcomes for a commercial producer by incorporating the key results into a representative cattle enterprise model. The limitations of this methodological approach to extrapolation of trial data to farm level analyses can be addressed to some extent through the appropriate validation of the model used and the use of sensitivity analyses of key assumptions (Dillon and Anderson 1990). See also the discussion in Davidson and Martin (1965) on this topic.

A farm level economic evaluation of the experimental outcomes was undertaken following the three production phases outlined above. This would be consistent with a representative farmer having a cow-calf breeding enterprise on the NSW North Coast as well as a growing-backgrounding enterprise in the adjacent Northern Tablelands region. Traditionally, North Coast beef production systems have focused upon store cattle breeding (Davies *et al*. 1999) while a broader range of enterprises such as breeding and growing out of beef cattle as well as the transfer in of store cattle from coastal regions for growing and finishing is typical of beef production in the Northern Tablelands (Alford *et al*. 2003). The farmer is also assumed to custom finish his cattle in a local feedlot.

The farmer is assumed to have 200ha of mixed pasture available on the North Coast, and another 200ha of mixed pasture available on the Northern Tablelands.

The economic evaluation is based on 2006 average prices and costs.

The Beef-N-Omics Model

The Beef-N-Omics software package (Dobos *et al*. 2006) was used in this evaluation. This package has been selected for all farm level modelling of new technologies relevant to Southern Australian beef production systems within the Beef CRC. It has been used by beef extension officers and some commercial producers over a number of years enabling practical validation of the model including the herd dynamics and metabolic energy demand algorithms derived from MAFF (1984) standards. The Beef-N-Omics program incorporates feed budgets and financial gross margin budgets for static herds. It is sufficiently flexible to allow for the input of various ages and liveweights for growing stock from weaning to turn-off.

To reduce the complexity of the economic analysis of the early-life nutritional study, it was decided to use Beef-N-Omics assuming the same land resource and associated pasture resource for each of the growth treatments. This avoids confounding effects of different capital investment in land and associated pasture management between nutritional treatments, confining the analysis to the major focus of the study. Thus, varying areas to improved pastures was not considered. Rather, pasture types and areas for each of the two different regions were held fixed across each growth path, but energy available for the cow herd was varied by altering the stocking rate to just avoid the use of supplementary feeding and still provide sufficient metabolisable energy (ME) to meet the four sets of cattle growth rates. Thus for example, for the cow-calf phase at Grafton, 150 breeding cows could be run on the standard 200 ha of pasture to achieve the LL growth path, but only 128 breeding cows could be run on the same pasture to reach the HH growth path. Limitations of this approach are recognised given the simple ME approach used by Beef-N-Omics and the associated pasture modelling, however the methodology allows for a consistent approach across all four experimental treatments.

Pasture Types

An accurate representation of pasture types and growth rates through the year is a crucial input into a Beef-N-Omics analysis. The Beef-N-Omics package contains an extensive pasture library, that has been built up from various NSW Agriculture trial data sets that were collated for use in the Prograze program (NSW Agriculture 1996). New pasture types can be added at any time.

A number of pasture growth profiles provided in the Beef-N-Omics library were tested for their similarity to the various pasture types implied by the cow/calf growth profiles for the various treatments. The different pastures mixes modelled in the representative enterprises (described below) were considered to be consistent with the pasture types and relative proportions available to the experimental treatments.

There are three pasture types assumed for the Grafton phase of the experiment:

1. Setaria (*Setaria sphacelata*), Rhodes grass (*Chloris gayana*) and White clover (*Trifolium repens*) (100ha).
2. Kikuyu (*Pennisetum clandestinum*) dominant pasture (60ha).
3. Short term ryegrass (*Lolium multiflorum*) with periodic nitrogen application (40ha).

The growth rates for these three pasture types are shown in Figure 1. The growth rates suggested for these subtropical species are consistent with those identified by Ashwood *et al*. (1992) where growth rates for Setaria and kikuyu pastures averaged between 50 and 60 kg DM/ha/day in late summer and early autumn and 5 kg/ha/day in winter.

In relation to the Glen Innes phase of the experiment, introduced pasture mixes are commonly utilised in the Northern Tablelands grazing systems to produce feeder cattle for the feedlot market or to finish beef cattle (Davies and Llewelyn 2006). Such pastures include introduced temperate grasses (eg., Phalaris [*Phalaris spp*.], Fescue [*Festuca arundinacea*], Cocksfoot [*Dactylis glomerata*], ryegrasses [*Lolium spp.*]) and legumes (eg., White clover [*Trifolium repens*] and Sub clover [*T. subterraneum*]). These pasture types and associated agronomic practices are detailed extensively for the region by various authors, for example Lodge and Whalley (1989), Lowien *et al*. (1997) and NSW Agriculture (1996).

The Beef-N-Omics model includes an introduced grass dominated pasture of Fescue (*Festuca arundinacea*) / Phalaris (*Phalaris spp*.) with at least 20 per cent base dry matter present as

White (*T. repens*) or Sub clover (*T. subterraneum*) and with annual maintenance fertilizer applications. This mix is assumed to cover the entire 200ha of available grazing land. The growth rate for this pasture mix is shown in Figure 2.

Figure 1. Grafton pasture growth rates for weaner production phase

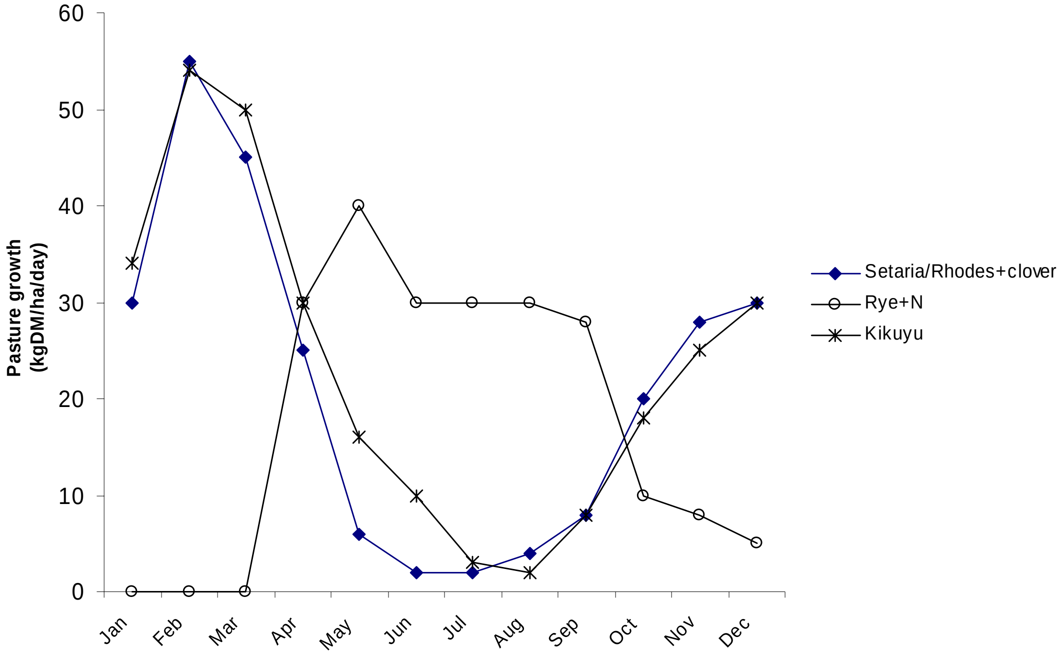
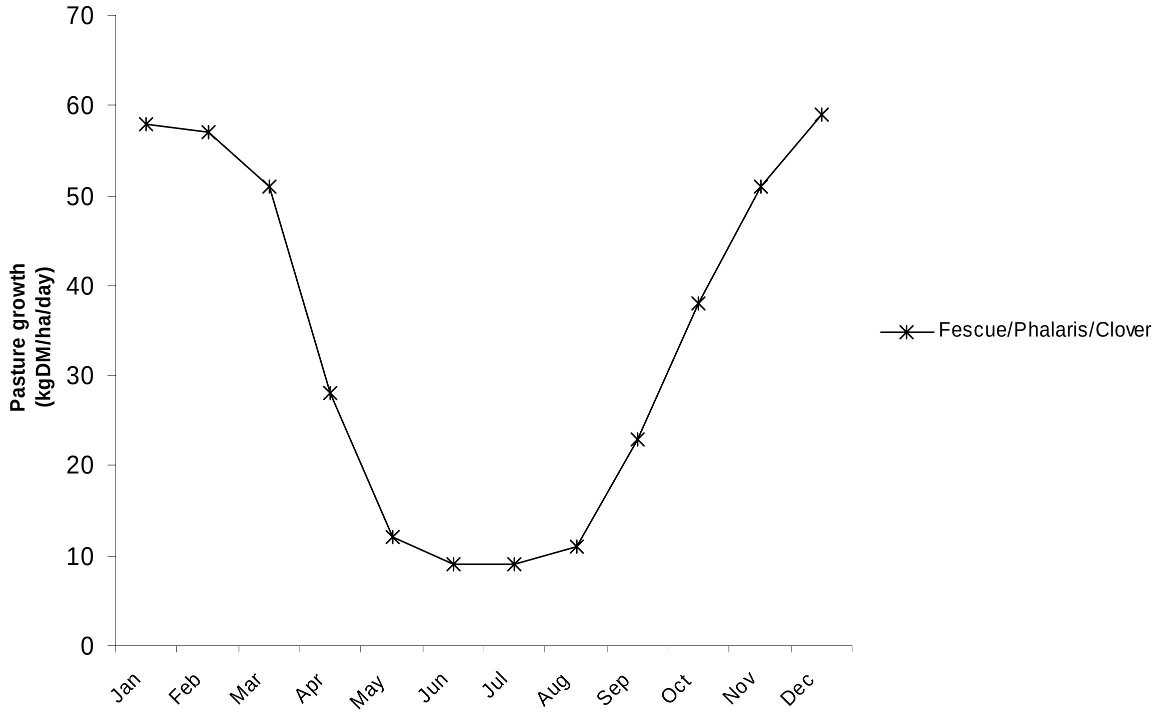


Figure 2. Glen Innes pasture growth rates for growing out/backgrounding phase



Cattle Prices and Costs

As noted above, prices and costs used in the analysis are for 2006.

Herd costs and returns for the cow-calf activity at Grafton are derived from a standard NSW Department of Primary Industries budget as shown in Appendix A. Costs for the Glen Innes backgrounding phase are shown in Appendix B. The costing of the feedlot phase of the experiment was derived from the feedlot operator. Details of feedlot costs and income for 2006 are provided in Appendix C. Apart from fixed per head charges, the cost of feedlotting is based upon feed consumed at an average price of $260 per tonne as fed (85% DM). Combined feed intake data for each of the four treatments were used to derive average feed consumed per head in the feedlot. Average intakes (t/hd) over the 120 day feedlotting phase were 1.51, 1.61, 1.68 and 1.76 t/hd for the LL, LH, HL and HH treatments respectively. Since the carcasses from all four treatments met the market specifications for the grain-fed export market that the abattoir supplies, a common price of $4.00/kg cw was applied to all fed cattle.

Budgets for the development and annual maintenance of the various pastures assumed in the analysis are provided in Appendix D and E for the Grafton phase, and in Appendix F for the Glen Innes phase. The cost used for the Grafton phase in the cost and return calculations is a weighted average based on the relative areas of the two pasture types. Also, the costs in the Appendices are on an annual basis – in the costs and return calculations done below, the pasture costs are each multiplied by 1.5 to account for the 18 month period that the Grafton pastures are feeding the cows and offspring to weaning, and the 18 month period that the Glen Innes pastures are feeding the backgrounding offspring to feedlot entry (Table 1).

Cattle Weights and Growth Rates

Given the basic pasture, cost and return data outlined above and in the Appendices, the economic implications of the various early-life growth treatments can be derived in two different ways.

In the first approach, the farm manager is assumed to closely follow the time lines of the experiment as shown in Table 1. Thus, all animals are backgrounded for the same period of time and they all enter the feedlot at the same time but at different weights (up to 80kg difference across the treatments). They spend the same amount of time in the feedlot but grow at different rates and exit the feedlot also at different weights (up to 100kg difference). The group weights and growth rates used are those described in Tables 2-4. While this approach would not be regarded as normal commercial practice, in this particular case there were no adverse commercial implications since the carcasses from all four treatments met the market specifications for the grain-fed export market that the abattoir supplies (Table 5). Based on these assumptions, the costs and returns for each of the four growth paths, by phase and in aggregate, are shown in the first section of Chapter 4.

In the second approach, the farm manager is assumed to follow different time lines than in the experiment. The animals are backgrounded for different periods of time so as to achieve a more common feedlot entry weight. They spend the same amount of time in the feedlot, grow at more similar rates and exit the feedlot at more similar weights. This approach is more like normal commercial practice, and has been followed in other analyses of cattle experimental data (Davies *et al*. 2007) where there have been more marked feedlot exit weight differentials and substantial penalties for non-compliance with market specifications.

Since there are no actual data for this type of management for the representative farm, it has to be simulated based on assumptions. Two main issues arise:

- whether animals that are held for longer or shorter periods on backgrounding would have the same average backgrounding ADG as that measured in the experiment; and
- whether animals that enter the feedlot at heavier or lighter weights would have the same average feedlot ADG as that measured in the experiment (with the same carcass specifications).

In relation to the first issue, any longer or shorter period on backgrounding required to achieve a group weight close to the average weight of all groups (around 512 kg) would be relatively small in relation to the overall backgrounding period of 18 months (Table 1). For example, the LL group entered the feedlot at an average weight of 473 kg (Table 3). To put on the additional 39 kg at their average backgrounding ADG of 0.6kg/day would take about 65 days – or about 10 per cent of the total backgrounding period. This is a relatively minor additional period and is also at the end of the backgrounding period, so growth rates during these extra days should not be much different from the average over the whole period. We assume therefore that for any early-life treatment group the same backgrounding ADG would apply over any shorter or longer period as well.

In relation to the second issue, there is a more direct relationship between entry weight and ADG in the feedlot, and the feedlot ADGs (Table 4) are almost three times those during the backgrounding period (Table 2). We have to be more careful in our assumptions here.

Fortunately, there are some other data available on some of these animals that will assist us (Cafe, L.M., unpublished data). Of the 240 core progeny, 154 animals were subjected to a detailed feed intake analysis at the Tullimba feedlot over a 70-day period. These were the 2001 born heifer cohort and the 2002 born steer cohort. The actual recorded data for these animals are shown in Table 6. Of note is the fact that the mean entry weight of these 154 animals and the weight for each of the early-life treatment groups is less than the weight for all of the core animals reported in Table 4 above (since there are a greater proportion of heifers in this smaller subset). However, their feedlot exit weights were generally heavier than the core animals.

Table 6. Summary of feedlot growth for each early-life treatment group within the 154 progeny tested for feed intake

Early-life growth treatment	Feedlot entry weight (kg)	Feedlot exit weight (kg)	Feedlot ADG (g/d)	Carcass weight (kg)
LL	453	631	1.53	353
LH	480	665	1.59	374
HL	502	707	1.75	395
HH	524	733	1.76	413
s.e.d.	8.9	12.3	0.052	7.2
All	490	683	1.66	384

Statistical models were run on this data set, adjusting for a common feedlot entry weight of 490kg (the mean weight of all the 154 animals)[1]. The model-predicted adjusted ADG and exit weights for each treatment are shown in Table 7. As expected, the daily gain and exit weights are higher for the LL and LH groups than actually recorded, but lower for the HL and HH groups.

The differences in weights and ADG between the actual recorded data for these 154 animals and the model predictions for the common entry weight were calculated and are reported in Table 8. For the two extreme treatment groups, there are differences of over 30kg for entry weight, over 40kg for exit weight, and over 0.006 for ADG.

Table 7. Summary of feedlot growth for each early-life nutritional group within the 154 progeny tested for feed intake, adjusted to a feedlot entry weight of 490kg

Early-life growth treatment	Feedlot entry weight (kg)	Feedlot exit weight (kg)	Feedlot ADG (g/d)	Carcass weight (kg)
LL	490	677	1.60	379
LH	490	678	1.61	382
HL	490	692	1.73	387
HH	490	689	1.70	390
s.e.d.	na	6.9	0.059	4.4
All	490	684	1.66	384

What we would like to do now is to use this information from the 154 animals that went through the feed intake trial to predict how the 240 core animals would have grown at a common entry weight. However, since the mean weights of this group of 154 animals are different to the mean weights of the 240 core animals (490 vs 512 for entry weight, 683 vs 675 for exit weight, respectively), we cannot just apply the absolute weight differences to predict how the 240 core animals would have grown at a common entry weight. Rather, we must apply proportional weight differences, as also shown in Table 8.

Table 8. Differences in feedlot growth for each early-life nutritional group within the 154 progeny tested for feed intake, adjusted to a feedlot entry weight of 490kg, minus actual feedlot entry weight

Early-life growth treatment	Feedlot entry weight (kg, %)	Feedlot exit weight (kg, %)	Feedlot ADG (g/d, %)	Carcass weight (kg, %)
LL	+37, 8.2	+46, 7.3	+0.07, 4.6	+26, 7.4
LH	+10, 2.1	+13, 2.0	+0.02, 1.3	+8, 2.1
HL	-12, 2.4	-15, 2.1	-0.02, 1.1	-8, 2.0
HH	-34, 6.5	-44, 6.0	-0.06, 3.4	-23, 5.6

[1] These were REML analyses including effects of birth weight, pre-weaning nutrition, sex/year cohort, sire-genotype and their interactions, with feedlot entry weight as a covariate (linear, and where significant, quadratic) to predict means at equivalent feedlot entry weight.

Thus, the percentage data in Table 8 were used to adjust the feedlot weights and ADG data for the 240 core animals. These results are shown in Table 9.

Table 9. Summary of feedlot intake and growth for each early-life treatment group within the 240 core progeny, adjusted to a common feedlot entry weight (490kg in the 154 progeny)

Early-life growth treatment	Feedlot entry weight (kg)	Feed intake (t/hd/120d)	Feedlot exit weight (kg)	Feedlot ADG (g/d)
LL	512	1.62	658	1 573
LH	520	1.64	675	1 529
HL	499	1.65	675	1 567
HH	519	1.67	699	1 553

The calculated feedlot entry weights are not all the same, but the spread in weights, intakes and ADGs are much reduced from the raw data. The implications of these new weights for the backgrounding phase are shown in Table 10.

Table 10. Summary of backgrounding growth for each early-life treatment group within the 240 core progeny, adjusted to a common feedlot entry weight (490kg in the 154 progeny)

Early-life growth treatment	Feedlot entry weight (kg)	Weight difference (kg)	Background ADG (g/d)	Days difference (d)
LL	512	39	602	+65
LH	520	11	540	+20
HL	499	-12	628	-19
HH	519	-34	576	-59

The cost, revenue and profit calculations were adjusted to include the new feedlot exit weights and feed intakes, and an allowance was also made for the extra backgrounding days required by the LL and LH groups, or the fewer backgrounding days required by the LH and HH groups, to achieve the predicted "common" feedlot entry weight.

Based on these assumptions, differences in costs and returns for each of the growth paths are shown in the second section of Chapter 4.

4. Results

Common Backgrounding and Feedlotting Periods

The gross margins for each of the four growth paths, in aggregate and per breeding cow and per hectare, are shown in Table 11 for the first approach to modelling the representative farm. The three phases are up to weaning, backgrounding, and finishing, respectively.

Under the LL scenario, where nutrition is restricted both during pregnancy and prior to weaning, 150 breeding cows can be run on the 200 ha of North Coast pasture that is described in Figure 1. Total costs over the two pasture phases are the highest under this scenario ($90,900), since most of the costs are on a per head basis or are related to the number of breeders. Even though numbers in the feedlot are high, the costs of feedlotting are relatively low because these animals are growing more slowly and they need less feed - $393/head over the feeding period or about $3.28/head/day. These are the lightest animals coming out of the feedlot (353kg carcass weight) but there are 121 of them, so feedlot income is almost $171,000. The net effect is an enterprise gross margin of $45,500 that translates to $114/ha or $303/cow.

In the LH scenario, where nutrition is restricted during pregnancy but not prior to weaning, only 132 cows can be run on the standard pasture area. Since there are less cows and calves, the costs over the two pasture phases are substantially lower ($85,200) than for the LL scenario. Feedlot costs are much the same as the LL scenario as there are fewer animals but they are growing faster and are therefore eating more - $418/head or $3.48/head/day. They are slightly heavier than the LL animals but there are less of them, so feedlot income is quite a bit lower at $165,400. Overall, the enterprise gross margin is higher than the LL case by about $1,000, which equates to $116/ha but $352/cow due to the lower numbers of cows.

In the case of the HL treatment, where nutrition is not restricted during pregnancy but is restricted prior to weaning, 144 breeding cows can be run on the 200 ha of pasture. Total costs over the two pasture phases ($88,100) are second highest, and the costs of feedlotting are the highest because there are almost as many animals as in the LL scenario but they are growing more rapidly and they need more feed - $437/head over the feeding period or about $3.97/head/day. These animals are relatively heavy coming out of the feedlot (383kg) and there are 118 of them, so feedlot income ($179,200) is the highest of any scenario. The overall balance is an enterprise gross margin of almost $52,600 that translates to $132/ha or $365/cow.

Finally, in the HH scenario, nutrition is not restricted either during pregnancy or prior to weaning. At these consistent high energy intakes and growth rates, only 128 cows can be run on the standard pasture area. Given these low numbers of animals, the costs over the two pasture phases are the lowest of any scenario ($84,000) and the total feedlot costs are also relatively low even though they are growing relatively faster and are therefore eating more - $459/head or $3.83/head/day. They are quite a bit heavier than all the other animals but there are less of them, so feedlot income is second lowest at $170,100. On balance, the lower costs have the most impact and the enterprise gross margin is $49,600, or at $124/ha and $387/cow.

Table 11. Gross margin budgets for each early-life nutritional treatment group, common backgrounding and feedlotting periods

Item	Value	LL			LH			HL			HH		
		Number	Cost	Income	Number	Cost	Income	Number	Cost	Income	Number	Cost	Income
Max. breeders		150			132			144			128		
Phase 1													
cfa bull	1 238	1		1 238	1		1 238	1		1 238	1		1 238
cfa cows	656	10		6 555	9		5 900	9		5 900	8		5 244
cull cows	656	17		11 144	16		10 488	17		11 143	15		9 833
Bull	1 700	2	3 400		1	1 700		1	1 700		1	1 700	
Replacement Heifers	775	31	24 025		27	20 925		30	23 250		26	20 150	
Livestock selling costs			3 607			3 231			3 451			3 068	
Health costs			2 345			2 125			2 276			2 056	
Pasture costs	88.05	200	26 415			26 415			26 415			26 415	
Cartage to backgrounding	10	126	1 260		114	1 140		122	1 220		108	1 080	
Phase 2													
Health costs			722			653			699			619	
Pasture costs	92.96	200	27 888			27 888			27 888			27 888	
Cartage to feedlot	10	122	1 220		111	1 110		118	1 180		105	1 050	
Phase 3													
Finished cattle	4.00	121 @353kg		170 852	110 @376kg		165 440	117 @383kg		179 244	104 @409kg		170 144
Feedlot costs		122 @$393/hd	47 961		111@ $418/hd	46 407		118 @ $437/hd	51 542		105 @$459/hd	48 157	
Induction	19.82	122	2 418		111	2 200		118	2 339		105	2 081	
Levy	5.00	121	605		110	550		117	585		105	520	
Cartage to abattoir	20	121	2 420		110	2 220		118	2 360		105	2 100	
Total Costs and Revenues			144 286	189 788		136 564	183 065		144 905	197 524		136 884	186 458
Total GM				45 502			46 501			52 619			49 574
GM/ha		400		113.75	400		116.25	400		131.55	400		123.93
GM/cow		150		303.35	132		352.28	144		365.41	128		387.30

Overall, the results of this analysis may be summarised as follows:

- For an experiment that set out to select animals that represented extremes of birth weight and growth to weaning, the economic implications are not that large. There is a 15 per cent difference in enterprise gross margin between the best case (HL) and worst case (LL) scenarios, but only an 8 per cent difference between the HL and HH groups and only a 2 per cent difference between the LL and LH groups. This provides more evidence of the relatively flat profit surfaces found in agricultural industries (Alford *et al*. 2003; Farquharson 2005; Pannell 2006).

- Given that context, it is more profitable for cows and calves to have access to a high standard of nutrition during pregnancy and up to weaning than for them to have access only to a poor standard of nutrition during this time period. The enterprise gross margin for the HH group comes to $49,600 ($124/ha and $387/cow), compared to the enterprise gross margin for the LL group of $45,500 ($114/ha or $303/cow). The net benefit is more than $4,000 to the enterprise. The value of the product from the 22 extra cows able to be run on the standard 200ha of pasture does not compensate for the extra costs of backgrounding and finishing those animals and for their substantially lower carcass weights.

- Further, if feed is in short supply and a choice has to be made, it is more profitable for cows to have access to a high standard of nutrition during pregnancy than for cows and calves to have access to a high standard of nutrition between parturition and weaning. The enterprise gross margin for the HL group is $52,600 ($132/ha or $365/cow), while the enterprise gross margin for the LH group is only $46,500 (or $116/ha or $352/cow). The net benefit is more than $6,000 to the enterprise, or $16/ha.

- Overall, the HL and HH groups clearly dominate the LL and LH groups in terms of total gross margin, margin/ha and margin/cow.

- It is evident that the gross margins are the result of some complex interactions between growth rates, stocking rates, numbers of animals being fed and kilograms of beef produced. The size of the gross margins for any one early-life treatment group, and perhaps the ranking of the groups, may change with a change in the assumed value of any one of a number of influencing variables. As one example, the sensitivity of the gross margin calculations to changes in the fed cattle price is shown in Table 12. For relatively small changes away from the assumed value of $4/kg, the LL group still exhibits the lowest gross margin, and the HL group still exhibits the highest gross margin. However, that is not the case for more extreme price changes. At very low prices, the HL group is no longer the most profitable and in fact is the second worst, while at very high prices, the LL group is no longer the least profitable.

Table 12. Sensitivity of enterprise gross margin to fed cattle price, common backgrounding and feeding periods ($)

Beef price		Early-life growth treatment			
% change	$/kg cw	LL	LH	HL	HH
-50	2.00	-39 924	-36 219	-37 003	-35 498
-25	3.00	2 789	5 141	7 808	7 038
-10	3.60	28 417	29 957	34 695	32 559
0	4.00	45 502	46 501	52 619	49 574
10	4.40	62 587	63 045	70 544	66 588
25	5.00	88 215	87 861	97 430	92 110
50	6.00	130 928	129 221	142 241	134 646

Common Feedlot Entry Weights

The gross margins for each of the four growth paths, in aggregate and per breeding cow and per hectare, were re-calculated for the second approach to modelling the representative farm. In particular, the cost, revenue and profit calculations were adjusted to include the new feedlot exit weights and feed intakes (Table 9), and an allowance for the extra backgrounding days required by the LL and LH groups, or the fewer backgrounding days required by the LH and HH groups, to achieve a predicted "common" feedlot entry weight (Table 10). The *changes* in the major values compared to Table 11 are given in Table 13.

- The obvious result here is that all the changes in gross margins due to the second method of calculation are negative. Thus, given the particular set of experimental data analysed here, it costs more to manage different groups of animals growing at different rates to achieve common feedlot entry weights than to manage animals to enter the feedlot at the same time. The fact that all the animals were able to meet market specifications, even though they were quite different final weights, plays a large role in this outcome. If there would have been a large number of animals discounted for not reaching specification, the impact of the second method would have been quite different.

- However, the differences in gross margins between the two methods are very small in all cases. The largest difference is for the HH group, and it is only 3.5 per cent of the base result reported in Table 11.

- Finally, the groups are ranked in the same order as for the first method – the HL group is the most profitable, followed by the HH group, the LH group and then the LL group. Thus whichever method is used, the same implications for producers would hold.

Table 13. Changes in the gross margin budgets for each early-life treatment group, adjusted to a common feedlot entry weight (490kg in the 154 progeny)

Item	Value	LL			LH			HL			HH		
		Number	Cost	Income	Number	Cost	Income	Number	Cost	Income	Number	Cost	Income
Max. breeders		150			132			144			128		
Changes in backgrounding pasture costs	0.50/hd/d	122@65d	3 965		111@20d	1 110		118@-19d	-1 121		105@-59d	-3 098	
Changes in finished cattle revenue	4.00/kg	121 @15kg		7 260	110 @2kg		880	117 @-5kg		-2 340	104 @-18kg		-7 488
Changes in feedlot costs	260/t	122 @$28/hd	3 416		111@ $8/hd	888		118 @ $-8/hd	-944		105 @$-25/hd	-2 625	
Changes in total costs and revenues			7 381	7 260		1 988	880		-2 065	-2 340		-5 723	-7 488
Changes in total GM				-121			-1 118			-275			-1 765
Changes in GM/ha		400		-0.30	400		-2.80	400		-0.69	400		-4.41
Changes in GM/cow		150		-0.81	132		-8.47	144		-1.91	128		-13.79

* the allowance of $0.50/head/day for changes in pasture backgrounding cost is based on current adjustment rates (Davies et al 2007).

* the new carcase weight was calculated by applying a common dressing percentage of 0.56.

5. Discussion

The experiment analysed here was conducted on the North Coast of NSW. "Low" and "high" pasture nutritional systems were imposed on a herd of Hereford cows during pregnancy, and then again from birth to weaning, with a crossover design also imposed to select offspring with extremes of growth to birth and/or weaning. Thus, the analyses are essentially best-case and worst-case scenarios due to this selection of extremes.

The main result shows this divergence. It is more profitable for cows and calves to have access to a high standard of nutrition during pregnancy and up to weaning than for them to have access only to a poor standard of nutrition during this time period. The enterprise gross margin for the HH group comes to $49,600 ($124/ha and $387/cow), compared to the enterprise gross margin for the LL group of $45,500 ($114/ha or $303/cow). The net benefit is more than $4,000 to the enterprise, $10/ha or $84/cow. The value of the product from the 22 extra cows able to be run on the standard 200ha of pasture does not compensate for the extra costs of backgrounding and finishing those animals and for their lower carcass weights.

Calculating costs, returns and profits by a different method gave roughly the same numerical results, and in both cases the groups are ranked in the same order – the HL group is the most profitable, followed by the HH group, the LH group and then the LL group.

However, another result is that the economic implications are not that large. There is a 15 per cent difference in enterprise gross margin between the best case (HL) and worst case (LL) scenarios, but only an 8 per cent difference between the HL and HH groups and only a 2 per cent difference between the LL and LH groups. Given that extremes were selected, this provides more evidence of the relatively flat profit surfaces found in many agricultural industries (Alford *et al.* 2003; Farquharson 2005; Pannell 2006).

Commercially, the information is also important for beef cattle producers to assess whether it is economically feasible to invest in different genetics and /or different nutrition systems. For example, given the calculated net benefit of $10/ha or $84/cow between the LL and HH groups, this is the upper bound on the amount of money the typical producer could invest each year in pasture improvement to shift them from a LL growth path to a HH growth path.

It is also planned that this type of information will be used to enhance models for phenotypic prediction of beef cattle performance. This is the subject of current work in the Beef CRC.

One outcome that was not measured in this experiment was the impact of maternal nutritional setbacks on subsequent reproductive performance. It would be expected that cows that suffered a nutritional setback would take longer to re-conceive and/or exhibit a lower re-conception rate than cows that had a high standard of nutrition during their previous pregnancy or prior to re-conception. There is no Australian evidence on this issue, but there is some recent work in the US (Stalker *et al*. 2006).

We have not discussed sire-breed effects, although these aspects of the overall experimental design are covered in Cafe *et al*. (2006b) and in Greenwood *et al.* (2006). In the core data set, sire breed and early-life nutrition or growth interactions were not evident for the commercial characteristics of interest.

6. Conclusions

Different patterns of nutrition during pregnancy and lactation can influence cow productivity and the performance of their offspring. An experiment was conducted on the North Coast of NSW whereby “low” and “high” pasture nutritional systems were imposed on a herd of Hereford cows during pregnancy, and then again from birth to weaning, with a crossover design also imposed. Thus, four nutritional groups resulted – low-low, low-high, high-low, and high-high. Piedmontese and Wagyu bulls were used. After weaning, the offspring of these cows were grown out on the NSW Northern Tablelands and then finished to heavy market weights in a feedlot.

The results of the experiment indicated that restricted early-life growth resulting in differences in weight of calves at weaning persisted until 30 months of age. Animals that were smaller at weaning remained smaller at slaughter. Thus the hypotheses proposed “that cows mated to high muscle growth or high marbling potential bulls, and their offspring, will exhibit different liveweight and growth responses to divergent nutrition and growth during pregnancy and lactation” could not be rejected. Some compensation occurred following restriction of growth during lactation, but not following restriction of growth during pregnancy. However, neither carcass quality nor eating quality of the beef was adversely affected by growth restriction during early-life.

An economic analysis of these data was undertaken using the Beef-N-Omics decision support package. Two different methods were used. The main method showed that for the representative cattle enterprise modelled, total gross margins ranged from $45,500 for the low-low system to $52,600 for the high-low system. Gross margin per hectare ranged from $114 for the low-low system to $132 for the high-low system, while gross margin per breeding cow ranged from $303 for the low-low system to $387 for the high-high system. In all cases, the gross margin for those groups that started life on a higher level of nutrition exceeded their peers on a lower level of nutrition.

A slightly different type of analysis showed that it costs more to manage different groups of animals growing at different rates to achieve common feedlot entry weights than to manage animals to enter the feedlot at the same time. However, the differences in gross margins between the two methods are small in all cases. The largest difference is for the HH group, and it is only 3.5 per cent of the base result reported in Table 11. And in both methods the groups are ranked in the same order – the HL group is the most profitable, followed by the HH group, the LH group and then the LL group. Thus whichever method is used, the same overall findings are robust and the same implications for producers would hold.

While the economic implications are not that large, it is more profitable for cows and calves to have access to a high standard of nutrition during pregnancy and up to weaning than for them to have access only to a poor standard of nutrition during this time period. Further, if feed is in short supply and a choice has to be made, it is more profitable for cows to have access to a high standard of nutrition during pregnancy than for cows and calves to have access to a high standard of nutrition between partuition and weaning.

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Appendix A: North Coast Cow-Calf Income, Costs and Herd Parameters

Enterprise Unit: 100 cows
Representative Year - 2006 dollar values

Income:					$
42	Steer weaners	*To backgrounding/feedlotting*			
42	Heifer weaners	*To backgrounding/feedlotting*			
6	CFA cows	230 kg d.w.	\hd	@ 285 ¢/kg d.w.	3 933.00
12	Cull cows	230 kg d.w.	\hd	@ 285 ¢/kg d.w.	7 866.00
1	Cull bulls	450 kg d.w.	\hd	@ 275 ¢/kg d.w.	1 237.50
				Total Income	**$13 036.50**

Variable Costs:

Animal health -	vaccination, drenching and vet costs					$
	Cows	100	@	$12.80	\hd	1 280.00
	Bulls	3	@	$98.33	\hd	294.99
	Calves	84	@	$2.43	\hd	204.12
Ear tags	Heifers	20	@	$15.68	\hd	313.60
Selling Costs						
Cartage	Sales/ Purchases	39	@	$7.00	\hd	273.00
Commission	Sales Revenue	$ 13 036.50	@	3.5%		456.28
Yard dues	No. of head	19	@	$3.00	\hd	57.00
MLA levy	No. of head	19	@	$5.00	\hd	95.00
Tail tags	No. of head	19	@	$0.11	\hd	2.09
NLIS tags	No. of head	84	@	$2.90	\hd	243.60
Freight to abattoir	kg dw.	4 590	@	$0.05	\kg dw	229.50
Cartage to backgrounding	No. of head	84	@	$10.00	\hd	840.00
Replacements						
	- Heifers	20	@	$775.00	\hd	15 500.00
	- Bull	1	@	$1 700.00	\hd	1 700.00
			Total Costs			**$21 489.18**

Various prices taken from NSW DPI (2006) Beef gross margins budgets for 2006 (including herd health costs) for north coast herds. Available http://www.agric.nsw.gov.au/reader/beefbud (Viewed 6 Dec 2006).

Herd parameters:	
Calving date	July - September
Weaning rate	84 %
Average weaning age	7 months
Adult mortality	2 %
Yearling mortality	2 %
Calf mortality	2 %
Bull requirement	3 %
Bull cull rate	25 %
Heifers first joined	2 years
Cow age at last joining	9 years
Other culls	5 %

Age structure

Cow age (years)	**Number**
2	20
3	17
4	15
5	13
6	11
7	9
8	8
9	7
Total joined	100
cfa cows	6

Appendix B: Northern Tablelands Growing Out (Backgrounding) Costs

(based on the base North Coast 100 cow breeding herd)

Variable Costs

Animal health -	vaccination, drenching and vet costs					**$**
	Yearlings	86	@	$5.73	\hd	492.78
Cartage to feedlot	Sales/ Purchases	84	@	$10.00	\hd	840.00
				Total Costs		**$1 332.78**

Animal health costs taken from NSW DPI (2006) Beef gross margins budgets for 2006. Available http://www.agric.nsw.gov.au/reader/beefbud (Viewed 6 Dec 2006).

Appendix C: Feedlotting Income and Costs

(based on the base North Coast 100 cow breeding herd)

Income:					**$**
42	Steers	*Refer to Table 5 for final weights*	@	$4.00/kg cw[1]	*Table 11*
42	Heifers	*Refer to Table 5 for final weights*	@	$4.00/kg cw[1]	*Table 11*

Variable Costs[2]:

	vaccination, drenching and vet costs					**$**
Animal induction & Shire levy	No. of head	84	@	$19.82	\hd	1 664.88
Feedlotting costs	Tonnes fed \hd	84	@	$260.00	\t as fed	
Selling Costs						
MLA levy	No. of head	84	@	$5.00	\hd	420.00
Cartage to abattoir	No. of head	84	@	$20.00	\hd	1 680.00

[1] Prices for feedlot cattle are not available publicly. However the National Livestock Reporting Service does quote a price for southern Queensland 100 day grainfed cattle 300-420 cwt kg, dentition 2-4. As at 19/1/07 this category had a price range of 345 to 385 c/kg cwt (average of 366 c/kg cwt). Given that over 2006 the EYCI averaged 341.8 c/kg cwt, and at 19/1/07 the indicator was 305.5 a difference of 36.3 c/ kg cwt (or 10% lower) than the 2006 average, then a value of 400 c/kg cwt is a reasonable estimate of feedlot finished stock as described for the propose of this report.

[2]Feedlot costs provided by commercial feedlot reflecting the average cost per head during 2006.

Appendix D: Short-term ryegrass gross margin

Enterprise Unit: hectare
Representative Year – 2006 dollar values

Assumes seed is spread with superphosphate application and then irrigated, after being appropriately heavily grazed.

Variable costs	Rate	Unit			Unit	TOTAL ($/ha)
Seed						
Ryegrass (Concord)	40	kg/ha	@	$4.00	per kg	160.00
Fertiliser						
SuperP (spread)	100	kg/ha	@	$420	per tonne	42.00
Urea (spread)	125	kg/ha	@	$670	per tonne	83.75
Water						
Pumping costs (over 7 appl.)	2	ML/ha	@	$30.00	per ML	60.00
TOTAL ANNUAL COSTS						**$ 345.75 /ha**

* Fertiliser and seed costs from NSW DPI obtained from NSW DPI crop and pasture budgets for 2006. Available http://www.agric.nsw.gov.au/reader/wincropbud (Viewed 6 Dec 2006) or direct from produce supplier.

Appendix E: Permanent Subtropical Pasture gross margin and production parameters

Setaria (*Setaria sphacelata*), Rhodes grass (*Chloris gayana*) and White clover (*Trifolium repens*)

This is a permanent pasture which relies upon the clover seedbank to maintain legume component therefore inputs are minimal with only maintenance fertilizer of superphosphate required.

Enterprise Unit: hectare
Representative Year – 2006 dollar values

Variable costs	Rate	Unit			Unit	TOTAL ($)
Maintenance Fertiliser						
SuperP (spread)	150	kg/ha	@	$420	per tonne	63.00/ha

* Fertiliser and seed costs from NSW DPI obtained from NSW DPI crop and pasture budgets for 2006. Available http://www.agric.nsw.gov.au/reader/wincropbud (Viewed 6 Dec 2006) or direct from produce supplier.

Appendix F: Permanent Temperate Pasture Gross Margin

Enterprise Unit: hectare
Representative Year – 2006 dollar values

Establishment costs[1,2]	Rate	Unit			Unit		TOTAL ($/ha)
Disc (x2)	0.58 x2	hrs/ha	@	$19.32	per hour		22.41
Scarifier (x2)	0.42 x2	hrs/ha	@	$17.22	per hour		14.46
Sowing - combine	0.29	hrs/ha	@	$25.49	per hour		7.39
Seed							
Demeter Fescue	5	kg/ha	@	$5.00	\kg		25.00
Australian Phalaris	2.5	kg/ha	@	$8.70	\kg		21.75
Perennial ryegrass (Impact)	1.5	kg/ha	@	$5.50	\kg		8.25
White Clover (Haifa)+ innoc, lime	1	kg/ha	@	$4.50	\kg		4.50
Fertiliser							
Starter	125	kg/ha	@	$530	per tonne		66.25
Herbicides							
Glyphosate 450 (x2)	1.2 x2	L/Ha	@	$5.00	per litre		12.00
Spray application (x2)	0.1 x2	Hrs/ha	@	$22.16	per hour		4.43
TOTAL ESTABLISHMENT COSTS							**$ 186.44**
Variable costs	Rate	Unit			Unit		TOTAL ($)
Lifespan of Perennial Pasture				15	years		
ESTABLISHMENT COSTS PER YEAR – Amortized*							**17.96**
Maintenance Fertiliser							
Years 2-4 SuperP (spread)	375	kg/ha	@	$420	per tonne	157.50	
Years 5-15 SuperP (spread)	125	kg/ha	@	$420	per tonne	52.50	
			Average annual maintenance fertiliser				75.00
TOTAL ANNUAL COSTS							**$ 92.96 /ha**

* Pasture establishment costs were amortized using a 5 per cent interest rate and 15 year term.

[1]Tractor and implement variable costs from DPI Guide to Tractor and Implement Costs for a 57 KW (77HP) PTO tractor. Available http://www.agric.nsw.gov.au/reader/machine+water (Viewed 6 Dec 2006)
[2] Fertiliser and seed costs from NSW DPI obtained from NSW DPI crop and pasture budgets for 2006. Available http://www.agric.nsw.gov.au/reader/wincropbud (Viewed 6 Dec 2006) or direct from produce supplier.

Appendix G: Beef-N-Omics

The Beef-N-Omics computer package (Dobos *et al.* 2006) is designed to analyse the effects that different management practices have on the profitability of a beef herd. The program integrates herd structures, feed budgets and financial gross margin budgets for beef cattle breeding herds.

User inputs are required on aspects of the beef enterprise 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 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 subsequently on herd gross margins. Adjustments to any of those parameters will be reflected in changes in monthly feed consumption and herd gross margin from which the principles of beef cattle management can be reinforced.

Beef-N-Omics is a static herd model designed so that all the inputs are used in the calculations. This assumes that these inputs have been the same for the entire history of the herd being analysed.

Because of this, Beef-N-Omics cannot be used accurately to assess the outcome of changes to aspects like sales policy, breeding or culling policy or calving patterns which will only be applied for a year or two, for example, during droughts.

Beef-N-Omics is not a FULL biological model. Local estimates can be used, but if accurate information is available, then more precise reports are generated. A disadvantage with this approach is that users must remember to input all the correlated consequences of any change to major inputs. A misleading output could result if this is not the case.

Examples are provided in the User’s Manual.

NSW Department of Primary Industries
Economic Research Report Series

(All available at http://www.agric.nsw.gov.au/reader/10550)

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