FINAL REPORT

DAQ.065 - Nutritional and Managerial Strategies to Increase Annual Liveweight Gain and Improve Product Quality

by

Queensland Department of Primary Industries

for the Meat Research Corporation

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Part 1 Project Summary

Project Title **Nutritional and managerial strategies to increase annual liveweight gain and product quality**

Project No: **DAQ.065**

Research Organisation and Locations:

QDPI Swan's Lagoon, Brigalow and Brian Pastures Research Stations; Animal Research Institute, Brisbane; cattle properties in central and southern Queensland

Commencement: 1 October 1989

Completion: 31 March 1995

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Objective

To develop nutritional and managerial strategies to increase annual liveweight gain of growing and finishing steers, surplus heifers and cull cows; and hence improve the capability to regularly produce carcases to meet the range of market specifications. In particular to:

- Establish nutritional and managerial strategies to increase annual liveweight gain of cattle fed a basal pasture diet by an integrated use and timing of supplements and growth enhancers between weaning and slaughter.

- Ensure that carcases produced can be consistently targeted to a wide range of markets.

Summary

The project demonstrated how returns on cull cows and heifers could be increased through various pasture and grain feeding methods. Increasing the nett value of steers and surplus heifers by paddock grain supplementation during the last 12 months pre-slaughter was achieved. Various combinations of supplements, HGPs and rumen modifiers increased turn-off liveweight by up to 100 kg in steers grazing native pasture in north Queensland. Lifting turn-off weights of steers grazing sown grass pastures in central Queensland was also possible with additional grain or protein supplements. Ways to provide better supplements for young weaners were identified and a number of supplements and additives to supplements were investigated for weaners. A dose response was established for

cottonseed meal supplements both in the dry season and wet season. Transferring cattle at different ages to finishing pastures established that, the younger the age of transfer, the quicker the cattle reached turn-off weight.

Many of the results were incorporated into a booklet as a management package to help producers identify and reach various carcase markets.

Part 2 Executive summary

Background and Industry Context

The project was supported in mid 1989. Industry signals at that time were that export markets for beef would increase significantly over the next five years. Carcases required for future markets were likely to range from about 180 to 250 kg from cattle up to 18-20 months of age, about 280-350 kg from cattle preferably less than 30 months of age, as well as the manufacturing type carcases. Within each of the first two categories, there were markets for grass/crop fed and feedlot finished cattle. In most cases the feedlot period was in the order of 100 to 120 days, therefore liveweights into feedlots were about 425 to 475 kg and 200 to 325 kg for the heavy and light carcase markets, respectively.

For the heavy carcase market, age at slaughter had not been of major concern although 7 teeth (about 3½ years) had been a nominal age cut-off point for the Japanese market. However, 3½ years of age at slaughter is old by comparison with that achieved by producers in southern Australia, USA and European countries. Rightly or wrongly, consumers associate older animals with tough meat and this opinion of northern Australia beef is widely held. There is some evidence to support the contention that about 2 to 2½ years of age is about the upper limit for quality table meat. Additionally, turn-off at this age can be compatible with increased herd productivity and profitability. The lighter carcase markets want carcases from animals with 2 teeth or less and under 24 months of age.

Herd productivity under northern Australian conditions is characterised by:

(i) *High mortality rates and low weaning rates.*

(ii) *Low annual liveweight gain.* Native and, to a lesser extent, improved pastures provide the foundation of the northern beef industry. However, annual liveweight gains from these pastures are often low and variable. Low rates of gain not only increase the age at which preferred carcase weights are reached but also restrict flexibility of marketing because cattle are usually not in marketable condition at the lower market weights. Hence, these rates of gain largely restrict slaughter cattle to markets for older and heavier carcases. In turn, the older age at slaughter markedly reduces herd turn-off rates.

(iii) *Low weights of cull cows.* Cull cows contribute up to 20 to 30% of cattle sold from a herd depending on the weaning rate of the herd, assuming low breeder herd mortality rates. Hence, the liveweight of these cows at sale will have a marked effect on production, provided that the pre-sale finishing period is kept to a minimum. In many northern Australian environments cull cows are in poor condition and have low liveweights at the end of their final lactation. If cull cows have to be retained for say twelve months to finish, the advantages may be negated by the reduction of breeders and followers necessary to maintain appropriate stocking rates. There is clearly a need to identify techniques to quickly finish cull cows.

There are many different ways to improve liveweight gain and reduce age at turn-off including better sustainable pastures, permanent genetic gain and improved supplemental inputs. With the first two, their benefits may not be realised immediately. This project opted to explore managerial and supplemental manipulations that can be superimposed on various pastures to capitalise on existing marketing opportunities for cattle.

Objectives

The objective of the project was to develop nutritional and managerial strategies to increase annual liveweight gain of growing and finishing steers, surplus heifers and cull cows; and hence improve the capability to regularly produce carcases to meet the range of market specifications. In particular to:

- Establish nutritional and managerial strategies to increase annual liveweight gain of cattle fed a basal pasture diet by an integrated use and timing of supplements and growth enhancers between weaning and slaughter.

- Ensure that carcases produced can be consistently targeted to a wide range of markets.

Methodology

The project was initially divided into 5 tasks.

Task 1 Increasing returns from the marketing of cull cows and heifers.

Task 2 Increasing the nett value of steers and surplus heifers by supplementation during the last 12 months pre-slaughter.

Task 3 Maximising annual growth rates of steers and surplus maiden heifers to reduce age of turn-off.

Task 4 Identifying new nutritional strategies to maximise liveweight gain.

(a) Early weaner diets and growth rates.
(b) New feed additives or feeding levels for the standard protein meal or molasses based supplements for weaners in their first year post weaning.

Task 5 Increasing returns from steers by transferring to finishing country at various ages.

Task 6/7 Economic evaluation and technology transfer.

The project used the resources of the Queensland Department of Primary Industries with the support of the CSIRO Division of Food Processing, Meat Research Laboratory, Cannon Hill. A number of cooperating beef producers have provided considerable support on their properties by allowing use of their cattle and facilities as well as access to their data.

Experimental work concentrated mainly on the QDPI research stations, Swan's Lagoon, Brigalow, Brian Pastures and Rocklea. The production systems of a number of innovative producers were monitored on properties or at abattoirs in central and south-east Queensland.

Results

Task 1 Increasing returns from the marketing of cull cows and heifers

- The data showed that lactating cows utilise dietary energy about 50% more efficiently than dry cows.

- With finishing cows, it is more effective overall to wean the calf and feed it separately since lactation costs the cow about 0.7 kg/day of liveweight gain.

- Younger leaner cows respond more efficiently to supplementation.

- Supplementary concentrates gave much larger growth responses on poor pasture than on good pasture although the overall growth rate was still much less. For example in one experiment it took about 18 kg of concentrate to produce 1 kg of extra carcase on native pasture hay and 90 kg of concentrate to do the same on sorghum hay.

- The data allowed a reasonable prediction of the likely effect of supplementary concentrates and/or weaning on carcase growth in the cull cow. By combining the price schedule for a range of carcase specifications with the response data, good estimates could be made of likely cow value and profitability.

TASK 2 ***Increasing the nett value of steers and surplus heifers by supplementation during the last 12 months pre-slaughter***

- Monitoring of commercial lot-feeding operations targeting domestic, short term and long term feeding gave a good basis for evaluating lot-feeding as a managerial option for producers. Benefits were increased carcase weight, preferred subcutaneous fat cover and fat distribution and whiter fat and a more consistent product but its commercial viability was often jeopardised by price fluctuations.

- Animals selected for high growth on pasture had similar feed conversion efficiencies to unselected cattle but still grew faster in a feedlot. Although leaner at turn-off, selected animals had similar levels of marbling. Neither sex nor selection influenced other meat quality characteristics such as meat colour, cooking loss, ultimate pH and meat tenderness. Thus the fear that selection for high growth rate could detrimentally affect meat quality is ill founded.

- Feeding grain to grazing cattle increased growth rate and carrying capacities and was an efficient way to convert grain into extra carcase gain. The response by individual animals depended particularly on pasture quality (greatest on poor pasture) and on animal size (least in mature animals).

- Response data, which was collected across a wide range of pasture conditions and classes of cattle, along with market specifications, prices and descriptions of target cattle, made it possible to give reasonable predictions of likely profitability. These are presented in the management package 'Meeting beef markets: nutritional and managerial opportunities'.

- Failure of carcases to meet premium specifications was due mainly to older age, under and over weight, inappropriate rump-fat depth and yellow fat.

- Increasing growth rate made the attainment of most carcase specifications easier and increased the proportion of carcases meeting the targeted specifications.

- Apart from one experiment, lotfeeding for 5-6 weeks reduced the mean Aus-Meat fat colour score by >1 unit and in one case, this reduction shifted all unacceptable animals (60%) into the acceptable range. However the range of fat scores within a group is often wide and the magnitude of any reduction is likely to depend on the size of the initial score, the condition (fatness) of the animal, its grain intake and growth rate in the feedlot.

- Feeding grain to grazing cattle apparently did not influence fat colour, although some intermediate effect might be expected.

Task 3 ***Maximising annual growth rates of steers and surplus maiden heifers to reduce age of turn-off***

- Steers raised on native pasture alone in north Queensland on average reached 530 kg liveweight at 3½ years of age. Various combinations of supplements (based on molasses plus 8% urea *ad lib.* or cottonseed meal), HGP and rumen modifiers increased this liveweight by up to 100 kg at a similar age with a corresponding 52 kg increase in carcase weight.

- Combinations of HGP and perennial stylo pasture increased carcase weight by 64 kg compared with untreated supplemented cattle on native pasture in north Queensland. Steers grazing stylos with additional supplementary grain were turned off at 2.7 years of age with an average carcase weight of 347 kg, with 95% of these carcases meeting 6 tooth Jap Ox specification. These young steers had brighter meat of more acceptable tenderness than their 8 month older contemporaries.

- An improvement in liveweight gain between weaning and 2.5 years of age was similar for Brahman cross steers given a protein supplement plus a rumen modifier in both winter/spring and an HGP either in years 1 or 2. With this same supplement combination, sequential use of Compudose in the first and second years following weaning, gave a lower liveweight response.

- Feeding a grain ration to steers grazing buffel grass pastures in either the second or first and second post-weaning periods achieved advantages respectively of 27 to 34 kg and 34 to 39 kg in liveweight and 22 to 29 and 24 to 31 kg in carcase weight over unsupplemented animals. Steers on buffel-Seca had a 24 to 38 kg liveweight and a 2 to 20 kg carcase weight advantage over buffel pasture alone. With buffel-Seca pastures, steers supplemented with grain in the second or first and second post-weaning periods respectively had turn-off liveweight advantages of -5 to 40 kg and 18 to 34 kg and carcase weight advantages of 14 to 34 and 27 to 28 kg.

  In many instances, increased nutritional inputs resulted in more carcases reaching premium priced markets. For example, with steers grazing buffel or buffel-Seca pastures with or without grain supplementation, the increase in carcase weight when slaughtered at 30 months of age resulted in more carcases meeting Japanese grass-fed specification. Only 20% of carcases from the buffel control group met specification whilst 80-100% of carcases from buffel and grain supplemented groups met specification. Likewise, only 30% of carcases from unsupplemented buffel-Seca pastures met specifications compared with 80-95% in the buffel-Seca and grain supplemented groups. The product was very tender with no observed differences in meat colour, fat colour and tenderness from fed or non-fed groups

- Heifers fed a grain ration in the paddock during periods when growth rate fell below 0.5 kg/day, or in a feedlot when they were 120 kg below target slaughter weight, reached 200 kg carcase weight up to 6-9 months earlier than steers and heifers grazing pasture alone. Heifers on pasture and supplemented with grain had a 7 month earlier turn-off than unsupplemented heifers when targeted at 240 and 280 kg carcase weights. In comparison, heifers on pasture then finished in a feedlot reached 280 kg carcase weight only 4 months earlier than pasture-only heifers. On pasture alone, steers grew 10%, 9% and 16% faster than heifers to turn-off at 200, 240 and 280 kg carcase weight respectively. However, increased nutritional inputs for heifers were not always desirable in targeting specific markets. Heifers were best suited for the domestic market and could attract severe price penalties when targeted for heavier carcase markets. At a 200 kg carcase weight target, 86%, 77% and 55% of heifers from pasture, pasture plus grain and feedlot regimes respectively were suitable for the Australian supermarket trade. In contrast only 18%, 14% and 0% respectively were suitable for the Japanese grass-fed 3-cut market (280 kg). Particularly in the latter case, the majority of carcases were overfat.

  In the heifers, carcase subcutaneous fat cover, marbling scores and fat content of the striploin samples increased, while fat colour became less white as carcase weight increased. Heifers from the pasture regime recorded greater subcutaneous fat depth, higher marbling scores and striploin fat content and marginally less white fat than contemporary steers. The nutritional regime had no direct impact on meat tenderness, while there was no difference in tenderness of meat samples from heifers and steers of similar weight

- Between spaying at 15 months of age and slaughter at 30 months of age, there was little difference in liveweight gain of heifers left entire, surgically spayed or immunologically spayed with Vaxstrate. However there were some intermediate differences particularly post-surgical spaying. Different spaying techniques did not influence market suitability with almost all heifers being suitable for the Korean grass-fed market. Spaying techniques had no bearing on meat product quality attributes such as colour, marbling or tenderness but the surgical scar can exclude the carcase from the Korean market as well as downgrade the hide value.

- A number of commercial production systems were monitored. Annual liveweight gains ranged from 110-256 kg/head. As could be expected, as the proportion of more fertile land increased on each property, so did the proportion of sown pasture and legume, particularly leucaena, increase with resultant improvements in liveweight gain, market acceptability and product quality.

Differences between breeds in both production and carcase parameters were generally small but there was quite high within-breed variation in some cases. A trend for European-cross bloodlines to have heavier and leaner carcases was observed on some properties. Growth promotants, primarily Compudose on pasture-based systems, increased liveweight gain by 5-10% and produced heavier and leaner carcases. Steers lot-fed for 60-70 days (due to drought) with commercial 'finisher' grain based rations averaged 1.1-1.2 kg/hd/d while in the lot, and graded as prime grass-fed. Carcases were heavier and had more fat cover than comparable pasture-only steers.

There was no clear trend for differences in carcase weights and dressing percentages between different pasture production system. Grain supplementation did appear to improve dressing percentage.

Carcases from all production systems were generally of high market acceptability for all parameters measured (> 80%). There was an overall trend for more grass-fed carcases to be unacceptable due to being underfinished and/or underweight.

There was no clear trend in marbling score between production systems However meat and fat colour improved (ie lower scores) with sown pasture and/or leucaena systems. This improvement is attributable in part to the reduced age of turn-off, given observed increases in both fat and meat colour scores with increased dentition measured at slaughter.

Task 4 ***Identifying new nutritional strategies to maximise liveweight gains***

There were a several parallel activities directed at weaners in their first year post-weaning.

A. ***Ways to alleviate stress, better and more cost efficient diets and the impact of early weaning on subsequent growth rate.***

- There was no clear liveweight advantage to including a probiotic in a weaner supplement.
- Grain-based or molasses, urea and cottonseed meal supplements proved equally effective as supplements for young calves weaned in April at 82 kg until they reached 150 kg in August-September.
- The growth rate of calves weaned at 109 kg at 3 months of age was compared with that of normal weaned calves of 6 months of age (≈220 kg). Compensatory growth allowed calves weaned early onto molasses-based supplements to make up some ground on normally weaned calves, whereas calves weaned early onto a grain based supplement lost ground relative to all groups. Mean liveweight gains until turn-off for cattle receiving nil CSM, CSM in the first winter, CSM in the first 3 winters and for normal weaned calves were 416, 419, 443 and 449 kg respectively. There is probably no commercial advantage in using higher quality supplements for early weaners providing moderate growth rates in later life can be maintained.
- Post-weaning, radical weaners (weaned at 60 kg) grew faster and partially caught up to the liveweight of the later weaned/older calves, but by 2½-3½ years of age were still 3 to 8% lighter than the later weaned/older steers, this trend reflecting the initial differences in weaning weights. A similar trend of 3 to 8% differences was reflected in carcase weights (243-264 kg), a difference in value of $50.
- All of the data indicates that early weaned calves are unlikely to fully make up the liveweight deficit compared with calves weaned older and heavier. However this is offset by the improved reproductive performance and survival rates of the cows.

B. ***New feed additives or feeding levels for the standard protein meal or molasses-based supplements for weaners in their first year post-weaning.***

(i) *adding high fat content supplements to molasses-based supplements*

- Response curves to the addition of different levels of rice pollard and whole cottonseed were established. Whole cottonseed was the more viable proposition as it is half the cost of rice pollard. For an extra 9c/day in feed cost, the addition of 620 g/day of whole cottonseed increased liveweight gain from -0.1 to 0.4 kg/day.

- Cotton oil at the rate of 20 or 40 g/kg of mixture was added to M8U. Liveweight gain was reduced and the higher levels of cotton oil appeared detrimental.

- Isoplus is a proprietary mixture of volatile fatty acids produced by Eastman Kodak and was added at the rate of 30 g/kg to M8U. There was no effect on liveweight gain.

(ii) *Reducing supplement costs by using the rumen modifier, avoparcin*

- The equivalent of 70 mg/day avoparcin incorporated into a urea/CSM supplement increased liveweight gain from 0.04 to 0.11 kg/day. However by reducing the amounts of both avoparcin and CSM fed twice weekly, cost savings could be made without jeopardising liveweight performance. The basic supplement cost of $1.26/week for 3.5 kg CSM could be reduced to $0.56/week when 1.4 kg CSM and 250 mg of avoparcin were fed.

(iii) *Rumen modifiers to increase growth rate*

- The addition of 50 mg monensin/kg mixture of M4U increased liveweight gain from -0.10 to 0.04 kg/day whilst the addition of 50 mg/kg to M8U over 72 days increased liveweight gain from 0.06 to 0.14 kg/day. There was only a minor increase in supplement intake and a reduction in roughage intake resulting in a marked improvement of feed conversion ratio.

(iv) *Yeast products*

- A dried yeast culture, Yea-Sacc® was included in a urea, cottonseed meal and sorghum supplement at 0, 5, 10 and 15 g/head/day. There was an increase in liveweight gain from 0.06 to 0.12 kg/day at the 15 g/head/day level but not at the 5 or 10 g/head/day. However at this higher dose rate, Yea-Sacc was not cost effective.

- 10 g/day of a yeast additive (Diamond V) was added to a 0.5 kg grain supplement. Liveweight gain was increased from 0.14 kg/day to 0.19 kg/day but the response was not cost effective.

(v) *Safflower oil*

- Oils are energy dense supplements which may boost performance at low levels of feeding. The addition of safflower oil at 100 g/head/day on native pasture hay caused a depression in liveweight gain. This was due to the oil reducing hay intake.

(vi) *Vitamins and minerals*

- The addition of niacin (1 g/day) to 0.5 kg/day of cottonseed meal had no effect on liveweight gain or feed intake.

- 100 g/day of a mineral mix added to 0.5 kg/day cottonseed meal supplement stimulated feed intake by 20% and caused an increase in liveweight gain from 0.17 kg/day to 0.23 kg/day.

(vii) Alternate protein sources

- Copra meal could be substituted for cottonseed meal in supplements for weaners.

- Palatability of WCS fed alone as a supplement was low whereas supplements of CSM and CSM/WCS mixtures were readily consumed and gave the highest feed intakes. Both CSM and WCS were effective as supplements to reduce liveweight loss and gave similar responses when similar amounts of supplement protein were provided. Therefore on a basis of per unit weight, CSM had about twice the value of WCS in this pen study.

(viii) Infrequent feeding of supplements

- Virginiamycin added to a grain supplement allowed it to be fed weekly without obvious health problems but liveweight gain was depressed.

(ix) Adding grain to a molasses urea supplement

- Higher levels of paddock feed supplements as a means of production feeding steers to meet higher priced market specifications were investigated. The addition of crushed grain at 25 or 50% *ad lib.* to a standard M4U + 5% CSM mixture increased liveweight gain from 0.45 to 0.74 and 1.06 kg/day respectively compared with 0.91 kg/day for *ad lib.* grain. The M4U/CSM mixture containing 50% grain produced a 16% higher liveweight gain than *ad lib.* grain, with a 30% reduction in feeding costs.

(x) Exploiting compensatory gain through wet season supplementation

- It may be possible to exploit compensatory growth during the wet season and thus increase annual growth rates by providing wet season supplementation with nitrogen. Two studies were performed to test these concepts, a pen study mimicking a dry season followed by a wet season then a wet season grazing study using protein supplementation.

- Brahman cross weaner steers were subjected to 2 different planes of nutrition during a preliminary feeding period such that liveweight changes were -8 or + 10 kg over 60 days. Then they were fed good quality rhodes grass hay and supplemented with 7 levels of cottonseed meal from 0 to 1500 g/day. Previous nutrition had no effect on subsequent growth. Control animals gained 0.12 kg/day and this was increased by 0.36 kg/day with 250 g/day of cottonseed meal. Subsequent increments of cottonseed meal resulted in a linear growth response and for every kg of cottonseed meal fed, growth rate was increased by 0.44 kg/day. The response relationship derived indicated that cottonseed meal supplementation offers an economically viable strategy to increase growth rates.

- In a follow-up grazing study, Santa Gertrudis weaners were supplemented, from February to June, with 5 levels of cottonseed meal from 0 to 2000 g/day. The main response occurred between weeks 6 and 11 when pasture conditions had dried off markedly. The supplement response relationship was linear, and within the range of supplements used, growth rate was increased by 0.47 kg/day for every kg of cottonseed meal fed. Supplement intake had no effect on subsequent performance of steers when fed a high concentrate feedlot ration.

TASK 5 Increasing returns from steers by transferring to finishing country at various ages

As a general rule, the younger the age of transfer, the quicker cattle reached their turn-off weight, reflecting the longer period of better nutrition. However this was not always true as drought conditions reduced liveweight gain on finishing pastures. An economic analysis suggests the profitability of transfer at different ages will depend upon the ownership of the cattle. Where the same person owns the breeding and finishing country, the younger the transfer to finishing country, the more profitable

the operation. Where there are 2 operators involved, it is more profitable for the store producer to sell weaners or yearlings if there is more than a 10c or 15c/kg increase respectively in price over that of 2½ year old stores. For the store buyer, a maximum of 30c/kg extra can be paid for either weaners or yearlings over that of 2½ year old stores to break even.

TASK 6/7 ***Economic evaluation and technology transfer***

- A management package based on a hard copy format was developed. It is directed at cattle producers looking to improve their cattle enterprise profitability by targeting new markets. It contains a pathway to follow and the expected performance of animals under various nutritional regimes.

- 47 articles have appeared in provincial and rural newspapers and magazines. There have been addresses at 20 field days, producer meetings or industry sponsored days, and 21 papers have appeared in journals and conference proceedings.

Recommendations arising from the project

These include:

- wide distribution of the experimental results throughout northern Australia
- engaging the services of a professional paper writer
- commissioning reviews of several technical components including production feeding, cull cow finishing and early weaning management
- determining the success of the management package
- broaden the extrapolation of the results by field testing in other native pasture communities
- workshopping future strategies for cattle nutritional research
- any future work should reflect an understanding of the nutritional limitations of the base pasture
- pursuing a number of nutritional strategies and understanding the cause of and exploiting compensatory gain
- improve the prediction of catttle performance under different nutritional conditions
- investigate further the responses to wet season/summer supplementation
- determining the influence of previous management on feedlot performance
- the impact of radical weaning on the heifer calf's subsequent reproductive performance and lifetime productivity

Part 3 Final Report

1. Background and Industry Context

The project was supported in mid 1989. Industry signals at that time were that export markets for beef would increase significantly over the next five years. Although the carcase specifications for these markets were not defined precisely, it was apparent that a range of carcase types would be required. Carcases required for future markets were likely to range from about 180 to 250 kg from cattle up to 18 - 20 months of age, about 280 - 350 kg from cattle preferably less than 30 months of age, as well as the manufacturing type carcases.

Within each of the first two categories, there were markets for grass/crop fed and feedlot finished cattle. In most cases the feedlot period was in the order of 100 to 120 days Liveweights going into feedlots were therefore about 425 to 475 kg and 200 to 325 kg for the light and heavy carcase markets respectively.

For the heavy carcase market, age at slaughter had not been of major concern although 7 teeth (about 3½ years) had been a nominal age cut-off point for the Japanese market. However, 3½ years of age at slaughter is old by comparison with that achieved by producers in southern Australia, USA and European countries. Rightly or wrongly, consumers associate older animals with tough meat and this opinion of northern Australian beef is widely held. This is a marketing disadvantage that has to be overcome. There is some evidence to support the contention that about 2 to 2½ years of age is the upper limit for quality table meat. Additionally turn-off at this age can be compatible with increased herd productivity and profitability. The lighter carcase markets generally want carcases from animals of 2 teeth or less and under 24 months of age.

In 1989, the northern Australian beef herd was about 11.3m head (52% of the national herd) but produced only 37% of the national slaughter cattle (2.9m) and 43% of the national carcase production (632,000 tonnes). A major proportion of production was from carcases greater than 3.5 years of age, hence turn-off rates are low by comparison with the potential rates.

There are several factors contributing to herd productivity under northern Australian conditions. These include:

(i) *High mortality rates.* This has been a major problem but technologies to overcome this have been developed, eg supplementary feeding, environmentally adapted cattle, strategic weaning, astute selling policies and property development. Many of these technologies are well recognised in the industry and adoption is a commercial judgement which largely depends on price and cost factors.

(ii) *Low weaning rates.* There have been a number of recommendations developed from other projects (eg DAQ.44; DAQ.062) including ways to achieve target joining liveweight, disease control and early and radical weaning.

(iii) *Low annual liveweight gain.* Native and, to a lesser extent, improved pastures provide the foundation of the northern beef industry. This must continue if producers are to remain competitive on domestic and world markets. However, annual liveweight gains from these pastures are often low and variable (Table 1). Low rates of gain not only increase the age at which preferred carcase weights are reached but also restrict flexibility of marketing because cattle are usually not in marketable condition at the lower market weights. Hence, these rates of gain largely restrict slaughter cattle to markets for older and heavier carcases. In turn, the older age at slaughter markedly reduces herd turn-off rates.

(iv) *Low weights of cull cows.* Cull cows contribute up to 20 to 30% of cattle sold from a herd depending on the weaning rate of the herd, assuming low breeder herd mortality rates. Hence, the liveweight of these cows at sale will have a marked effect on production, provided that the pre-sale finishing period is kept to a minimum. In many northern Australian environments cull cows are in poor condition and have low liveweights at the end of their final lactation. If cull cows have to be retained for say twelve months to finish, the advantages may be negated by the reduction of breeders and followers necessary to maintain appropriate stocking rates. There is clearly a need to identify techniques to quickly finish cull cows.

Table 1 **Recorded weaning weights and annual liveweight gains by regions in northern Australia**

Region	Weaning weight (kg)[2]	Annual liveweight gain (kg)[3]	Annual average daily gain (kg/day)
High rainfall coastal strips	195	180	0.49
Brigalow belt	195	165	0.45
Speargrass belt	180	130	0.36
Arid zone (Mitchell grass downs and Alice Springs region)	na[1]	130	0.36
Kimberley district	145	130	0.36
Gulf/Darwin/Peninsular	155	95	0.26
Victoria River district	na	70	0.19

1 na - not available

2 Age at weaning as well as soil, pasture type and climatic factors will markedly affect weaning weights.

3 Annual liveweight gains could be expected to range 30 to 50 kg above or below these averages according to soil, pasture type and climatic factors.

Source: Holroyd and O'Rourke 1989 [1]

Potential increases in herd production by increasing annual liveweight gain were estimated by using the herd simulation model, Stockman[2]. The model outputs indicated that:

- Response to increases in annual liveweight gain was greatest at highest weaning rates. Also the response to increasing weaning rates was greatest at highest annual liveweight gain.
- Increasing liveweight gain from 130 to 190 kg annually gave the major portion of the response over the range examined.
- Increasing annual liveweight gain from 190 to 220 kg gave very small response when sales were restricted to heavy cattle. However, in the models with mixed age sales responses carried through to 220 kg at high weaning rates (>75%).
- There was no direct incentive to sell steers or surplus heifers at lighter weights until weaning rates were >75%, when liveweight and gross income produced were marginally higher at the mixed age at sale models. However, different combinations of livestock prices may modify these results.
- At a weaning rate of 55%, improving liveweight gain from 130 to 160 kg, 160 to 190 kg and 190 to 220 kg per year increased, gross income by $27, $11 and $2 per adult equivalent respectively At 85% weaning rate the comparable figures were $43, $20 and $3 per adult equivalent respectively.
- Sales of cull cows made up from 20% of total sale numbers at high (85%) weaning rates to 30% at low (55%) weaning rates. Thus, weights of cull cows make a significant contribution to herd production. Also, the contributions of responses to techniques which increase herd production include extra cull cows as well as extra steer and surplus heifer sales. Hence, the liveweight at which cull cows are sold will have an impact on whole herd responses to improved annual liveweight gain.

Successful competition for a significant share of both existing and new markets depends on a consistent supply of the product demanded by this market. To do this, methods to minimise the effects of seasonal and annual fluctuations in growth rate have to be improved so that producers have better control over the class of cattle produced.

There are many different ways to improve liveweight gain and reduce age at turn-off including better sustainable pastures, permanent genetic gain and improved supplemental inputs. Whilst the first two, better pastures and genetics, are desirable, their presence may not be realised immediately. This project has opted to

[1] Holroyd, R.G. and O'Rourke, P.K. (1989). Collation of basic biological data on beef cattle production in North Australia. Final Report AMLRDC Project DAQ.NAP M2.

[2] Rudder, T.H. (1989) - AMLRDC Application Form for Grants (New or Existing Projects). Project Title - Nutritional and managerial strategies to increase annual liveweight gain and product quality 1st August 1989.

explore managerial and supplemental manipulation that can be superimposed on various pastures to capitalise on existing marketing opportunities.

2. Objectives

The objective of the project was:

To develop nutritional and managerial strategies to increase annual liveweight gain of growing and finishing steers, surplus heifers and cull cows, and hence improve the capability to regularly produce carcases to meet the range of market specifications. In particular to:

- Establish nutritional and managerial strategies to increase annual liveweight gain of cattle fed a basal pasture diet by an integrated use and timing of supplements and growth enhancers between weaning and slaughter.
- Ensure that carcases produced can be consistently targeted to a wide range of markets.

Within the overall objective, specific objectives to achieve the desired results by 1994 were:

- Identify potential opportunities to increase, from weaning to slaughter, average annual liveweight gain of steers and surplus heifers to > 190 kg and establish techniques to realise these opportunities.
- Identify methods to increase the liveweight gain in the final 12 months pre-slaughter.
- Determine nutritional and managerial regimes to ensure that cull cows are at least fat score 3-4 by May-June following weaning of their last calves.
- Incorporate appropriate carcase and meat quality measurements in the evaluation of the above results.

3. Methodology

The project commenced in mid 1989 with a completion date of March 1995.

The project was initially divided into 5 tasks with a task leader responsible for progress in that area. These tasks were:

Task 1 Increasing returns from the marketing of cull cows and heifers.

Task 2 Increasing the nett value of steers and surplus heifers by supplementation during the last 12 months pre-slaughter.

Task 3 Maximising annual growth rates of steers and surplus maiden heifers to reduce age of turn-off.

Task 4 Identifying new nutritional strategies to maximise liveweight gain.

(a) Early weaner diets and growth rates.
(b) New feed additives or feeding levels for the standard protein meal or molasses-based supplements for weaners in their first year post-weaning.

Task 5 Increasing returns from steers by transferring to finishing country at various ages.

The project used the resources of the Queensland Department of Primary Industries with the support of the CSIRO's Division of Food Processing Meat Research Laboratory, Cannon Hill. A number of co-operating beef producers have provided considerable support on their properties by allowing use of their cattle and facilities as well as access to their data.

A mid-term review of the project was conducted in August 1992 by K.G. Rickert, D. Crombie and V.H. Oddy. As a result of two of the recommendations of the NAP2 Co-ordination, viz:

- A co-ordinated economic analysis of results from the project should be recognised as a separate task that requires additional expertise.

- Preparation of a range of extension material should follow the economic analysis to allow producers to assess the relative merits of HGPs, molasses, urea, grain, cottonseed meal and other feed additives in different situations.

To address these recommendations, an additional task, 'Task 6/7 Economic evaluation and technology transfer' was created.

Experimental work concentrated mainly on the QDPI research stations, Swan's Lagoon, Brigalow, Brian Pastures and Rocklea. The production systems of a number of innovative producers were monitored on properties or at abattoirs in central and south-east Queensland. Locations of the sites used are presented in Figure 1. Staff involved in the project are listed in Table 2.

Table 2 Staff of the project team

Project Leaders:
Tom Rudder,# Brisbane (until November 1991)
Lyle Winks,# Brisbane (from December 1991 to June 1992)
Richard Holroyd, Animal Research Institute (from July 1992)

Task Leaders:

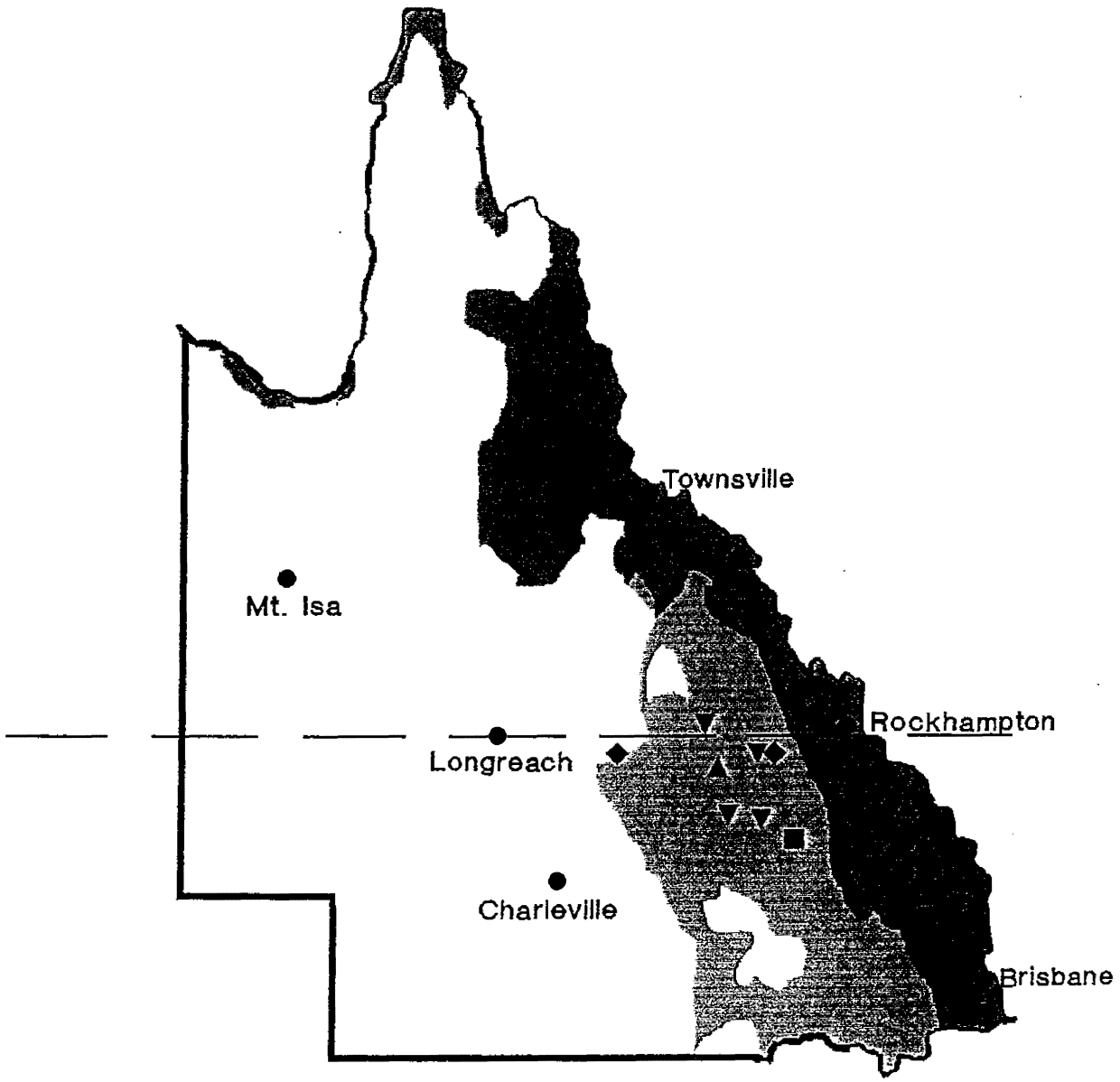
Task 1	Bill Gulbransen, Brian Pastures
Task 2	Ross Barnett#, Emerald
Task 3	Ian Loxton, Rockhampton
Task 4	John Lindsay, Swan's Lagoon
Task 5	Russ Tyler, Gayndah
Task 6/7	Roger Cheffins, Bundaberg

Scientific and Technical Staff:

Animal Research Institute, Yeerongpilly, Brisbane	Richard Holroyd, Gary Blight, John Connell, Bob Dillon[#], Jim Kidd, Stuart McLennan, Peter Martin, Alan Neill, David Strachan#
Ayr	Alan Laing
Biloela	Col Esdale
Brian Pastures Research Station	Bill Gulbransen, Robyn Roberton, Steve Sinclair, Kay Taylor
Brigalow Research Station	Michael Jeffery, Tom James, Allan Lloyd, Tom Mullins, Andrew Whyte#
Emerald	Ross Barnett#
Gayndah	Russ Tyler
Mackay	Ross Dodt
Meat Research Laboratory, Cannon Hill, Brisbane	Robert Dickinson, Robin Shorthose, Janet Stark
Rockhampton	Andrew Bourne, Michael D'Occhio, Alan Lisle, Ian Loxton, Ken Murphy, Salena van der Mark, Tim Ryan#, Ross Shepherd#
Swan's Lagoon	John Lindsay, Desiree Bawden, Neil Cooper, Rob Dixon, Roger Cox, Rodd Dyer, Bev Gelling, the late Ian Kendall, Dave Smith
Toowoomba	Jim Cavaye
Townsville	Bill Holmes
University of Queensland	Dennis Poppi

[#] formerly QDPI

FIGURE 1 - DAQ-065 SITES



Not all of the staff were involved at all times throughout the project. In the initial stages, the project consisted mainly of scientific and technical staff but towards the latter stage, particularly with the development of Task 6/7, a number of economists and extension officers contributed to the team's activities.

Each task area is reported separately for background and industry relevance, methodology, experimental inventory, results and discussion.

4. Results and Discussion

4.1 Task 1 Increasing returns from the marketing of cull cows and heifers

4.1.1 Background and industry context

Cull female cattle make up 30% of the annual turn-off from the Queensland beef herd. Therefore they constitute a significant proportion of income for most beef enterprises. Cull cows are often in poor or backward store condition after rearing their final calf. These cows are either sold in this condition or are held on the property for 6 to 12 months to finish. Both cases have a cost. The former results in less profitable carcases for both the producer and the processor whilst the latter involves proportionally fewer breeders on the property actually used for breeding. Therefore a reduction in breeder numbers means a reduction in sales of higher priced steers and heifers. Techniques to economically increase liveweight and fat score of cull cows before the end of the pasture growing season will be advantageous to both producer and processor.

Previous work has indicated that finishing cull cows is a viable management option both on pasture and in feedlots. At Brian Pastures, culled cows in poor body condition and grazing mature native pasture converted supplementary grain to extra carcase gain at an apparent rate of 22:1 and increases in the value per kg carcase weight ensured the practice was profitable[1]. However other work with cull cows grazing native pasture and supplemented with combinations of molasses, urea and meatmeal was not commercially viable. Eventhough subcutaneous fat cover and carcase weight could be increased, apparent conversion ratio of supplement to extra carcase was 42:1 over 2 trials[2]. Other work showed that subcutaneous fat cover of cull cows fed in a feedlot could be increased to 10 - 13 mm (rump site) from about 1 mm in 78 days. Carcase gain was 63 - 78 kg and feed conversion ratios were 10 - 12:1[3]

This task aimed to develop cost effective strategies to increase returns to producers from the culled female portion of their sales.

4.1.2 Objectives

To determine nutritional and managerial regimes to ensure that cull cows are fat score 3 - 4 by May - June (end of the pasture growing season) following weaning of their last calves.

To develop nutritional and managerial strategies to improve the marketability of cull cows.

4.1.3 Methodology

Six experiments were conducted either at Brian Pastures or Brigalow Research Station. These experiments examined a range of feeding options for pregnant, lactating and non-lactating cows. The experiments are outlined in Table 3 and are reported in detail in 'The Experimental Collection - DAQ.065' document.

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[1] Gulbransen B (1990). Using supplementary grain to increase the marketability of culled cows. *Proc. Aust. Soc. Anim. Prod.*, **18**:228-231.

[2] Gulbransen B and Standfast N F (1985). Brian Pastures Annual Report, p21. Gulbransen B and Standfast N F (1986). Brian Pastures Annual Report, p24.

[3] Plasto A W - unpublished data.

Table 3 Experimental details for cull cow studies in Task 1

Expt. No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
1/1	Utilisation of supplementary energy in cow/calf production	Jan - May 1990 Brian Pastures	Pen 70 d	24 lactating empty cows and calves and 18 dry cows	Forage sorghum hay (8. 0kg/day) + nil, 2.5, 5.0 or 7.5 kg/day grain
1/2	Effect of quality of basal forage on substitution rate and on carcase weight gain of cows and calves supplemented with grain	Feb - June 1991 Brian Pastures	Pen 84 d	48 lactating empty cows and calves	Sorghum hay + nil, ½ *ad lib.* or *ad lib.* grain Spear grass hay + nil, ½ *ad lib.* or *ad lib.* grain
1/3	Effect of supplementing grazing cull cows with grain during lactation or post-weaning	Feb - June 1991 Brian Pastures	Grazing 132 d	56 lactating empty cows and calves	Lactation/Finishing nil, 2, 4 or 6 kg/day concentrate Finishing nil, 2, 4, or 6 kg/day concentrate
1/4/1	Effect of time of slaughter and nutritional regimes on the value of cull cow calf units and the yields of saleable meat from lactating cull cows	Aug 1990 - May 1991 Brigalow	Grazing 90 or 97 d	124 Brahman cross cows	Pregnant cows initial slaughter Lactating cows and calves . grazing pasture . early weaned cows on pasture and calves on pasture + grain . creep fed . grain fed
1/4/2	as for 1/4/1	July 1991-June 1992 Brigalow	Grazing 90 d	85 aged Brahman cross cows	as for 1/4/1
1/5	Effect of nutritional regimes on growth rates, carcase attributes, yield of saleable meat and value of non pregnant (recently weaned) cull cows using grazing strategies	July - Nov 1991 Brigalow	Grazing 112 or 117d	72 2year old empty Brahman cross cows	Initial slaughter Pasture only Pasture + *ad lib.* grain
1/6/1	Effect of nutritional regimes on growth rates, carcase attributes, yield of saleable meat and value of non pregnant (recently weaned) cull cows using grazing and feedlot strategies	July - Oct 1992 Brigalow	Grazing/ feedlot 82 to 207 d	100 8- 10 year old Brahman cross cows	* Initial slaughter 170 kg carcase wt 210 kg carcase wt * Pasture only Pasture + *ad lib.* grain Feedlot * Carcase wt + gain 170 + 30 kg + 60 kg 210 + 30 kg + 60 kg
1/6/2	as for 1/6/1	July 1993 - May 1994 Brigalow	Grazing/ feedlot 37 to 310 d	80 8-11 year old Brahman cross cows	* Initial slaughter 150 kg carcase wt 185 kg carcase wt * Pasture only Pasture + *ad lib.* grain Feedlot * Carcase wt + gain 150 + 30 (feedlot) + 50 (pasture treatments) + 80 (all treatments) 180 + 30 (feedlot) + 50 (pasture treatments) + 80 (all treatments)

4.1.4 Results

An initial experiment examined *utilisation of supplementary energy in cow calf production* (Expt 1/1). When fed 8.0 kg/day of forage sorghum hay, lactating cows gained -0.25 kg/day and their calves 0.33 kg/day, compared with 0.38 kg/day for dry cows. At 5.0 kg/day of grain supplement, liveweight gains were 0.15, 0.76 and 0.92 kg/day for lactating cows, calves and dry cows respectively. The overall response to the supplementary grain mix for the cow/calf unit (0.83 kg/day) was approximately 50% greater than for the dry cow. With dry cows each extra kilogram of liveweight gain cost 9.3 kg grain mix, compared with 6.0 kg of grain mix in the cow/calf unit. However, these are "true" responses, and where substitution can come into play the responses by the animals are much less. Removal of the calf was worth an extra 0.63 kg/day liveweight gain to the cow. Therefore weaning the calves and

supplementing them directly with the grain mix is likely to be a more effective way to improve the liveweights of cows and calves.

The *effect of quality of basal forage on substitution rate and on carcase weight gain of cows and calves supplemented with grain* was examined in Experiment 1/2. The basal diets affected the performance of the animals markedly, with cows losing an average of 0.13 kg/day liveweight on spear grass hay diets (-0.46 to 0.22 kg/day, depending on grain intake), and gaining an average of 0.57 kg/day on the sorghum hay diets (0.46 to 0.68 kg/day). The apparent conversion ratio of grain to extra carcase gain was 18:1 on spear grass hay. On the sorghum hay diet, the grain mix replaced its own weight of hay, producing only a small growth response, and the apparent conversion ratio was 90:1. After allowing for substitution effects, the true conversion ratios were 14:1 and 15:1 respectively.

Cows reduced their intakes of spear grass hay and sorghum hay by 0.65 kg and 1.0 kg respectively for every kilogram of grain mix eaten. In the paddock, this pasture-sparing effect can be exploited to increase profitability directly or to reduce grazing pressures. Milk production of the cows was influenced by diet and calf growth averaged 0.74 kg/day on spear grass hay and 1.02 kg/day on sorghum hay diets. Calves whose dams were fed *ad lib.* grain mix gained about 0.1 kg/day more than those whose dams were unsupplemented.

Experiment 1/3 investigated the *effect of supplementing grazing cull cows with grain during lactation or post-weaning (finishing).* Supplementation with the grain mix did not effect the growth rate of the calves which was already high at 0.9 kg/day. During the lactation period of 56 days, supplemented cows gained 18 kg more liveweight than unsupplemented cows, and during finishing (77 days) supplemented cows gained 35 kg more liveweight than unsupplemented cows. During lactation there was not a clear response to increased levels of supplementation, possibly due to large variations between animals in their intakes of supplement. Overall, however, increasing levels of supplementation led to heavier cows. Responses to supplementation varied from 1 kg of extra carcase gain for every 17 kg of grain mix at low levels of supplementation to 1 kg of extra carcase gain for every 35 kg of grain mix at the high levels. Cows supplemented during both lactation and finishing ate an average of 190 kg more grain mix than cows supplemented during finishing only, and gained an extra 11 kg of carcase weight, a requirement of 17.3 kg of supplement for every extra kilogram of carcase gain.

The *influence of time of slaughter and nutritional regimes on the value of cull cow calf units and the yields of saleable meat from lactating cull cows* was reported in Experiments 1/4/1 and 1/4/2. Pasture conditions during the treatment period were such that unsupplemented cows and calves gained approximately 0.2 and 0.8 kg/day of liveweight respectively. No treatment had any influence on calf growth. However, weaning of the calf allowed the cow to gain an extra 28 kg carcase weight, at a cost of 350 kg grain mix (eaten by the calf). Creep-feeding had virtually no effect on growth of either the cow or the calf, despite the calf eating about 120 kg of grain mix. When both the cow and the calf were supplemented *ad lib.* with grain mix the cow gained an extra 20 kg of carcase at a total cost of 850 kg of supplement. At this intake there was clearly a high level of substitution of supplement for pasture, and each extra kilogram of carcase cost 42.5 kg of supplement, which compares with a cost of 12.5 kg of supplement when the calf was weaned and fed separately. Rump fat depths and yields of saleable meat increased with carcase weights, providing potential benefits in the proportion of carcases meeting higher-priced specifications.

The *effect of nutritional regimes on growth rates, carcase attributes, yield of saleable meat and value, of non-pregnant (recently weaned) cull cows* was evaluated in Experiment 1/5. In 112 days of grazing frosted pastures, the unsupplemented cows gained 17 kg of carcase, whereas the supplemented cows ate 1020 kg of grain mix and gained an extra 52 kg of carcase, so each extra kilogram of carcase gained required 19.6 kg of supplement. Rump fat depths were also higher (13 v 3 mm) in the supplemented cows and total yields of saleable meat (but not percentages) were higher in the supplemented cows, leading to a much greater proportion of supplemented cows grading into the higher priced primal cut market (97 v 3%).

Experiments 1/6/1 and 1/6/2 examined the *effect of nutritional regimes on growth rates, carcase attributes, yield of saleable meat and value, of non-pregnant (recently weaned) cull cows using grazing and feedlot strategies.* Empty cows with mean initial carcase weights of approximately 150 kg (liveweight 359 kg) and 185 kg (liveweight 425 kg) were either lot-fed, supplemented with grain mix

while grazing buffel grass pastures, or grazed buffel grass pastures alone at 3 ha/head. The cows were slaughtered after gaining either approximately 50 or 80 kg carcase weight. Growth rates for lotfed, supplemented and unsupplemented cows respectively were 1.16, 0.72, and 0.40 kg/day, and times to slaughter were 1-3 months, 3-4 months and 8-10 months. Lotfed cows ate 13-14 kg of feed per day and supplemented cows ate 8-9 kg/day of grain mix. The heavier cows required approximately 10% more feed than the light cows, and those fed for an 80 kg carcase gain required approximately 10% more feed each day than those fed to gain 50 kg carcase. Overall, cows which weighed 66 kg liveweight more at the start of feeding required approximately 10% more feed to grow at the same rate as light cows. In the feedlot, cows which were fed to gain 80 kg carcase weight grew approximately 80% as fast as cows fed to gain 50 kg and required approximately 10% more feed per day. In the feedlot, each kilogram of carcase gain required approximately 15 kg of feed, and at pasture, each kilogram of extra carcase gain required approximately 20 kg of supplementary grain mix. Increasing carcase weights resulted in greater fat depths and greater proportions of carcases reaching primal cut grades.

4.1.5 Discussion

The experiments in Task 1 have concentrated largely on developing response relationships to supplementary grain for a range of practical circumstances. These relationships necessarily encompass animal factors (class, weight, condition), pasture factors (quality, quantity) and level of supplementation, because these are the major influences on the magnitude and nature of the response.

Animal factors

Our data support the belief that lactating cows utilise dietary energy about 50% more efficiently than dry cows. They also show that when cow performance is important (eg when finishing), it is more effective overall to wean the calf and feed it separately, since lactation costs the cow about 0.7 kg/day of liveweight gain.

As liveweight and body condition increased so too did the proportion of fat in the gain and the energy cost per unit of gain. The literature suggests that a 500 kg cow eats about 15% more than a 400 kg cow for the same gain, and our data are in good agreement. So younger, leaner cows respond more efficiently to supplementation.

Plant factors

These experiments have shown how pasture quality affects the rate at which supplementary concentrate replaces pasture in the diet, and hence how it affects the magnitude of the animal's response. Supplementary concentrates gave much larger growth responses on poor pastures than on good pastures, although the overall growth rate was still much less. For example, in one experiment it took 18 kg of concentrate to produce 1 kg of extra carcase on native pasture hay and 90 kg of concentrate to do the same on sorghum hay.

A shortage of pasture has the effect of reducing the substitution effect and increasing the response to the supplement.

Amount of supplement

Data from these experiments showed that the amount of supplement eaten has a large effect on the efficiency with which it is utilised. For a particular class of animal in particular pasture conditions, the response per unit of supplement fed decreased as the amount of supplement fed increased. Our trials showed that, in practice, the incremental response at a low level of supplementation may be three times that at a high level.

Identification of cost effective options

Our results indicate that there are opportunities to make worthwhile short term profits from selective treatment of culled cows prior to disposal. However, each situation needs to be evaluated carefully

because returns depend upon the class of the animal being fed and on feed and carcase prices. Returns can vary from a profit of $40 to a loss of $30 per head.

This data can be used to help define:

(a) likely responses to supplements/treatments
(b) when feeding is most/least profitable
(c) the most profitable animals to feed
(d) price margins needed to break even at a range of supplement prices

The objective of Task 1 was to estimate the likely profitability of any option for any existing set of circumstances. This requires reasonable estimates of:

(a) the current value of the cow
(b) the likely values of treated and untreated cows
(c) the costs of treatment

The data allow a reasonable prediction of the likely effect of supplementary concentrates and/or of weaning on carcase growth in the cow, which in turn allows an estimate of likely treatment costs. The price premium for moving one step up in cow price schedules is typically in the range 5-35 c/kg carcase weight. Since this premium applies across the whole carcase, it often makes a greater contribution to increasing the value of the cow than does the extra carcase weight, and implies that selection of cows for treatment is important to overall profitability. By combining the price schedule for a range of carcase specifications with the response data, an estimate can be made of likely cow value and profitability.

For example, a 350 kg cow (carcase weight 155 kg) in store condition (P8 fat depth 5-10 mm) will need to gain about 30 kg carcase weight to increase her fat depth by 5 mm. On current prices this will increase the value of the carcase by 35c/kg (from $1.45 to $1.80) to return $108 per cow, and will require about 0.5t supplement fed over two months (17/1 conversion ratio). At current high supplement prices ($200+ per tonne fed out) supplementation would hardly be attractive, but changes in cow and grain prices can alter this dramatically. The same estimates can be made for different carcase price schedules, classes of cows, and grain prices, to give an indication of likely viability at a particular time.

4.2 Task 2 Increasing the nett value of steers and surplus heifers by supplementation during the last 12 months pre-slaughter

4.2.1 Background

The ability to control growth rates of steers and surplus heifers raised on a predominantly pasture nutritional regime is becoming increasingly important as specifications for carcases become more discriminating. Development of nutritional strategies to ensure that growing cattle reach target market liveweights and carcase attributes during the current season will have a two-fold benefit. Firstly, turn-off will be assured and hence management to ensure maintenance of satisfactory stocking rates will be easier to implement. Secondly, producers will have a better chance to target market specifications more accurately.

4.2.2 Objective

This was to identify preferred methods to increase liveweight and ensure that target liveweight is achieved during the final 12 months pre-slaughter.

4.2.3 Methodology

Ten experiments and 3 observations on feedlotting strategies on commercial properties were conducted. The experimental details are outlined in Table 4 and are reported in detail in 'The Experimental Collection - DAQ.065' document.

Table 4 Experimental details for studies in Task 2

Expt. No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
2/1	Using grain to top-off steers in the paddock	July-November 1989 Brian Pastures	Grazing 111 d	49 Brahman cross steers	Native pasture NP NP + supplementary grain $^1/_3$ *ad lib* NP + supplementary grain $^2/_3$ *ad lib.* NP + supplementary grain *ad lib.*
2/2	Effect of selection for growth and heat resistance on growth, feed conversion efficiency and meat quality	August 1989 - March 1990 Brian Pastures	Feedlot 170 ± 22d	35 AXBX steers and 37 AXBX heifers	UPWT - selected for high growth rate to 600 days TEMP - selected for low rectal temperature CONT - minimal selection differential for 600 day weight
2/3	Effect of grain feeding on fat colour and other carcase traits in previously grass fed *Bos indicus* steers	August - December 1990 Rocklea	Feedlot 0-175 d	100 Brahman cross steers	Feedlot for 0, 35, 70, 105 and 175 days
2/4/1	Feedlotting steers and heifers for Australian domestic market	February 1991 - November 1991 Mundubbera	Feedlot 92-120 d	Weaner Brahman cross steers and heifers	Monitoring feedlot performance
2/4/2	Feedlotting steers for Japanese grain fed (short fed) market	November 1991 - October 1992 Springsure	Feedlot 126 d	2262 Brahman cross steers	Monitoring feedlot performance
2/4/3	Feedlotting steers for Japanese high quality (200 days grain fed market)	Gayndah	Feedlot 208 d	38 Santa Gertrudis cross steers (540 kg)	Monitoring feedlot performance
2/5/1	Energy supplementation in paddock to increase the nett value and improve meat quality of finishing steers for the Korean market	July 1990 - February 1991 Brigalow	Grazing 7 m	110 2 y.o. Brahman cross steers	Initial slaughter Pasture only Pasture plus *ad lib.* grain
2/5/2	As for 2/5/1	July 1991 - January 1992 Brigalow	Grazing 7 m	99 2 y.o. Brahman cross steers	Initial slaughter Pasture only Pasture plus *ad lib.* grain
2/6	Effects of grain feeding for varying lengths of time in a feedlot on LWG and carcase and meat attributes	July 1991 - November 1991 Brigalow	Feedlot 0-119 d	90 Brahman cross steers	Initial slaughter Slaughter at days 42, 56, 91 and 119
2/7	Effect of short term grain feeding on bovine body-fat colour	October - December 1991 Rocklea	Feedlot 56 d	95 3 y.o. Brahman steers	Initial slaughter (78 head) Slaughter at 56 days (17 head)
2/8	Effect of roughage quality on responses to supplementary grain	February - May 1992 Brian Pastures	Pens 107 d	56 2½ y.o. Brahman cross steers	Forage sorghum or dolichos lab lab hay + nil, $^1/_3$ *ad lib.*, $^2/_3$ *ad lib* or *ad lib.* supplementary grain mix
2/10	Utilisation of whole cottonseed by cattle fed native pasture hay	August - October 1991 Brian Pastures	Pens 56 d	48 Brahman cross steers	NP hay *ad lib.* + 1.0 kg/day whole cottonseed (WCS) + 2.0 kg/day WCS + 1.3 kg/day cottonseed meal (CSM) + 2.3 kg/day sorghum grain + 0.7 kg/day CSM + 1.5 kg/day sorghum grain

4.2.4 Results

Experiment 2/1 used *grain to top-off steers in the paddock*. Unfinished (for the Japanese market) 2½-year-old Brahman steers grazing mature native pastures and supplemented for 111 days with either nil, 3.5, 6.1 or 8.5 kg/hd/day of sorghum grain, had carcase weight gains of - 0.01, 0.19, 0.26 and 0.34 kg/hd/day respectively. Corresponding fat depths at the P8 rump site were 6.3 9.3, 10.6 and 10.9mm. The proportion of carcases meeting target market specifications increased as the amount of supplementary grain increased, and each extra kilogram of carcase gain required 18, 22 or 24 kg of supplementary grain for 3.5, 6.1 and 8.5 kg/hd/day levels of supplementation respectively

Lotfeeding requires cattle which are more efficient converters of expensive, high quality feeds. More efficient cattle are more profitable for the lot-feeder. In a joint experiment with CSIRO, the *effect of estimated breeding values (EBVs) on meat quality and feed utilisation of lot-fed Bos indicus cross cattle* was examined in experiment 2/2. Cattle with a wide range of EBVs for growth were fed from shortly after weaning until slaughtered at Australian domestic trade weights. Selected cattle grew faster than control cattle while at pasture, but not differently in the feedlot. At the same carcase weight selected cattle were leaner but had similar levels of marbling. Selection for high EBV did not significantly affect feed conversion efficiency. Steers ate more and grew faster than heifers. They were also leaner and less marbled, and converted feed to gain more efficiently. Neither selection nor sex influenced meat quality characteristics such as meat colour, cooking loss, ultimate pH, and meat tenderness.

One hundred Brahman cross steers were used to determine the *effect of grain-feeding on fat colour and other carcase characteristics in grass-fed Bos indicus steers* (experiment 2/3). Steers previously grazing pasture were lot-fed for 0, 35, 70, 105 or 175 days, to assess changes in fat colour, and other carcase characteristics. The average liveweight gain during feeding was 0.7 kg/day, and after 35 days, Aus·Meat fat colour scores had decreased from 3.9 to 2.4 on a scale of 0(polar white) to 9 (creamy yellow). Fat colour decreased further with time, although two animals still had fat colour scores of 6 after 70 and 105 days respectively, and another had a score of 4 after 175 days. Steers fed for 175 days had more marbling but also had darker meat.

Feedlotting strategies to produce suitable animals for various markets were monitored on several commercial properties. *Weaner steers and heifers were lotfed for the Australian domestic market* for 92-120 days on a contract basis in a commercial feedlot (Experiment 2/4/1). The lower feed intake found in this study (c. 2.3% of liveweight) compared to values quoted in literature for animals of this type on grain based rations, could have been partly due to high stocking densities in the pens. Nevertheless apparent feed conversion was good (4.9 kg ration DM eaten : 1 kg liveweight gain) and average liveweight gains for steers and heifers were 1.15 and 1.0 kg/hd/day respectively. Steers had higher carcase weights and P8 fat depths than heifers. Comparative breed data for both liveweight performance and carcase parameters suggested that differences between breeds were small and insignificant. An exception was the observed leaner carcases for those steers and heifers derived from European breed sires. Economic assessment, in terms of profit margins calculated in the feedlot, showed levels of profitability for steers ranging from $20-29/head. The marginal loss calculated for the heifer turn-off (-$2.43/head) was largely attributable to the low sale price received.

Steers, both hoverbed and purchased, were grained for an average of 126 days in an owner operated feedlot to supply (on contract) carcases suitable for the Japanese grained (shorted) market (Experiment 2/4/3). It was estimated that the steers consumed 2.5% of liveweight, with a feed conversion ratio of 10.3 (kg ration eaten : kg liveweight gain) and liveweight gain of 1.3-1.5 kg/hd/day. Carcase and chiller assessment parameters were of high acceptability within the defined market specifications (a range of 92-100% acceptability rate for all parameters measured). Comparative breed data for both liveweight performance and carcase/meat quality parameters suggested that differences between breeds were small and insignificant; with a large degree of variation within breeds. A possible exception were the leaner carcasses observed for European derived breed types. Economic assessment, in terms of profit margins calculated in the feedlot, showed a decline in profitability from $35 per head to -$60 per head for purchased feeder steers. Hoverbed feeder steers were $33 per head more profitable at each price schedule due to a lower calculated cost (c/kg LAW) into feedlot. The estimated losses per head sustained in the latter period of 1991 were unavoidable due to the decline (-27 c/kg HSCW) in sale price received from processor as a result of wholesale market pressures in Japan.

The performance of *steers lotfed for the Japanese high quality (200 days) grain fed market* was monitored in Experiment 2/4/4. In this study, 38 Santa Gertrudis cross steers (540 kg) which had previously been grazing predominantly speargrass pastures, were lotfed for 208 days. Overall LWG was 1.4 kg/day with an estimated final liveweight of 819 kg. Measured HSCW was 446 kg. Despite securing a contract (over-the-hooks) premium price for the product, downgrading by the meatworks (due to excess weight and fat cover, yellow fat and age) negated this market advantage. Consequently only animals grading the premium 290 c/kg carcase showed an estimated profit. With regard to "ideal" market specifications, trial animals were too heavy in the carcase, a sizeable proportion over-fat at the rump (P8) site and age of turn-off was high. Purchase of younger, lighter steers would still meet market specifications and allow greater margins for profit. Such animals may also reduce the risk of downgrading due to yellow fat cover.

Experiment 2/5 examined the *effect of energy supplementation in the paddock to increase nett value and improve meat quality and of Brahman cross steers finished for the Korean market.* Steers fed *ad lib.* grain in the paddock grew faster and were turned-off earlier for the Korean grassfed market (maximum times 88 *v* 213 days). Supplementary grain increased both dressing percentage (by up to 1.6%) and subcutaneous rump fat depths, but did not appreciably improve meat colour, subcutaneous fat colour, marbling, or fat content of the striploin. However, fat colour of the supplemented animals was less variable than for animals on pasture only, with Aus-Meat fat colour scores generally 5 or less. The striploin (*Longissimus dorsi*) and eye-round (*Semitendinosus*) meat samples were of average tenderness, with no apparent improvement in response to the supplement. Supplementary grain proved to be profitable, but profitability decreased as the length of the feeding period increased.

The effects of *grain-feeding for varying lengths of time in a feedlot on liveweight gain and carcase and meat attributes of Brahman steers* was investigated in Experiment 2/6. Feeding for a minimum of 42 days significantly reduced intermuscular fat colour. Average Aus-Meat colour scores decreased from 5.5 at day 0 to 4.2 after 42 days, and to 2.9 after 91 days in the feedlot, while, as expected, carcase weight, rump fat depth and dressing percentages increased with time in the feedlot. All meat samples were of average tenderness and meat colour improved marginally over time. Lot-feeding had no effect on the tenderness of either the striploin or eye round meat samples.

Experiment 2/7 - *Effect of short-term grain feeding on bovine body-fat colour* - was funded mainly from Project CS-150, with some input from DAQ.065, and was designed to measure serial changes in the concentration of carotenoids in the fat tissue of cattle lot-fed for 8 weeks. Despite the fact there was a rapid and sustained fall in serum ß-carotene concentration, there was no effect on the carotenoid concentrations of rump subcutaneous fat. Moreover, there was no reduction in Aus-Meat fat colour score when compared with the initial slaughter group. This result was surprising, particularly in the light of previous findings, but may result from the poor performance of the cattle in the feedlot, where the mean liveweight gain was only 0.59 kg/day.

The ability to choose the most profitable times to supplement cattle with grain hinges on being able to predict accurately their growth response to the supplement. Experiment 2/8 examined the *effect of roughage quality on responses to supplementary grain.* This experiment was designed to help overcome the shortage of response data on medium quality forages. Brahman cross steers (440 kg LAW) fed in pens for 107 days on sorghum or dolichos hay, gained 0.42 and 0.56 kg/day respectively. When supplemented with up to 7.0 kg/day grain they ate less hay but gained more liveweight (1.07 and 0.94 kg/day respectively). Conversion ratios of supplementary grain to carcase gain were 14:1 and 20:1 respectively, matching reasonable closely the patterns obtained in earlier work.

Whole cottonseed contains 20% more energy than grain and about twice as much protein making it potentially a useful supplement. Even though in recent years it has gained wide acceptance as a drought feed and as a minor component of feedlot rations, its role as a supplement for cattle grazing native pasture is unknown. The *utilisation of whole cottonseed by cattle fed native pasture hay* was studied in experiment 2/10. Forty-eight Brahman cross steers (mean liveweight 383 kg) fed poor quality native pasture hay were supplemented with whole cottonseed (WCS), cottonseed meal (CSM), or sorghum grain. Steers ate up to 1.7 kg/head/day of WCS and increased their intakes of poor quality hay by approximately 25%. WCS increased liveweight gains by up to 0.66 kg/day from a base of -0.36 kg/day. CSM proved equally effective as a supplement but sorghum grain was less so.

A *hormonal growth promotant (Compudose 400®) combined with winter/spring supplements* of protein meal and a rumen modifier was used with Brahman cross steers in the second year following their weaning, as a means of increasing liveweight gain (Experiment 3/6). The treatment increased the final liveweight (545 v 505 kg) and the liveweight gain (170 *v* 123 kg), but final liveweights were still below the preferred minimum target liveweight (570-580 kg) for premium export markets.

Experiment 3/7 looked at *maximising annual liveweight gains on buffel-Seca pastures to reduce turn-off age of steers.* Steers grazing buffel grass pastures and fed *ad lib.* supplementary grain in the second winter-spring period post-weaning gained 27 kg liveweight and 22 kg carcase weight more than unsupplemented steers. Similar steers grazing buffel grass pastures augmented with Seca stylo gained 40 kg more liveweight and 34 kg more carcase weight than steers grazing buffel-Seca pastures only. Both fed groups grazing buffel-Seca pastures achieved the target growth rate of 0.55 kg/hd/day for the duration of the experiment, but compensatory growth of unfed steers during the summer following supplementation reduced the benefits of supplementation. When slaughtered at 30 months of age, all of the carcases from the supplemented cattle met Japanese 3-cut grassfed market specifications, compared with only 20% of carcases from the unsupplemented steers. Similarly, 95% of carcases from the supplemented steers on buffel-Seca graded for the Japanese market compared with only 30% of carcases from unsupplemented steers. Despite the marked improvement in market grading achieved through supplementing with grain, the financial returns were poor. However, at the time of the assessment the cost of grain was higher than normal, and the presently available premiums for younger turn-off had not been introduced. Feeding had no effect on the meat tenderness of both striploin and eye round muscles, but all meat was tender, principally because the steers were slaughtered young. Rump fat depths of supplemented steers were marginally greater than those of unsupplemented steers on both pasture types, and eye muscle areas and meat and fat colours were similar to those of unsupplemented steers. Dressing percentages of supplemented steers were also greater than those of unsupplemented steers.

In a second draft of steers, performance on buffel pastures was similar, however, advantages in final liveweight and carcase weight to grain ration feeding on buffel-Seca pastures were lower. Market grading acceptability was similar to draft 1.

4.2.5 Discussion

The emergence of increasingly significant market penalties and premiums in the beef industry is making it important for producers to target their production systems towards particular carcase specifications. The most effective way to do this is through management and modification of diet and growth rate.

The experiments in Task 2 had a common thrust in that they aimed to reduce age of turn-off (ie increase growth rate), to increase the proportion of carcases meeting target market specifications, and to increase profitability. These were examined by (a) lotfeeding, (b) supplementation of grazing cattle and (c) factors influencing carcase specifications.

(a) Lotfeeding

Lotfeeding is an important part of the beef industry, both directly, for the size and the value of its markets, and indirectly, because of its stabilising influence on cattle prices. Lotfeeding is also a management option which can have dramatic effects on age at sale, throughput, herd structure, and property income.

Monitoring of commercial lotfeeding operations targeting domestic, short term and long term feeding gave a good basis for evaluating lotfeeding as a managerial option for producers (Experiments 2/4/1, 2/4/3, 2/4/4). Benefits such as increased carcase weight, better finish and fat colour and a more consistent product were highlighted. However its commercial viability was often jeopardised by price fluctuations, or in one case, a significant proportion of carcases not reaching specification with a consequential downgrading of value because of the initial unsuitability of cattle for that market. The information gathered made it possible to evaluate the likely profitability or otherwise of a lotfeeding operation in its own right. By using this information in conjunction with herd models it becomes relatively easy to predict the likely effects on herd structure, throughput, and profitability of the property, of introducing a lotfeeding phase into an existing production system.

Animals selected for high growth rate on pasture (Experiment 2/2) had similar feed conversion efficiency but still grew faster in a feedlot. Although leaner at turn-off, selected animals had similar levels of marbling. The fear that selection for high growth rate could detrimentally affect meat quality, is therefore ill founded.

(b) Supplementation

Supplementation of grazing cattle can be an effective way to improve growth rate and carcase quality, making it possible to more accurately target market specifications and to avoid the carryover of unfinished cattle at the end of the growing season. Most of the supplementary feeding experiments in Task 2 used grain (concentrates) as the supplement, although protein meals have also been used. Feeding grain to grazing cattle has been found to increase growth rates of the cattle and carrying capacities of the pastures, as well as to be an efficient way to convert grain into extra carcase gain. The response by individual animals depends particularly on pasture quality (greatest on poor pasture) and on animal size (least in mature animals).

The profitability of supplementation depends largely on the efficiency of the growth response by the animal, on grain prices and on the premiums obtained for achieving higher-priced market specifications. Response data were collected across a wide range of pasture conditions and classes of cattle. Along with market specifications and prices and descriptions of the target cattle, these data make it possible to give reasonable predictions of the likely profitability of feeding in particular circumstances. A framework for this is presented in the management package 'Meeting beef markets: nutritional and managerial opportunities' document.

(c) Carcase specifications

Carcase specifications are determined mainly by sex, age, weight, rump-fat depth, fat colour, meat colour, eye-muscle area, and marbling. Those most likely to be involved in the failure of carcases to meet premium specifications are age, weight, rump-fat depth, and fat colour. As shown in most experiments in Task 2, increasing growth rate makes the attainment of most carcase specifications easier, and increases the proportion of carcases meeting the targeted specifications.

Fat colour is becoming increasingly important in determining the suitability of carcases for premium export markets, and a significant proportion of carcases attract large penalties (>$100) for failing to meet specifications. Apart from one case, experiments in Task 2 have shown that lotfeeding for 5-6 weeks can reduce the mean Aus-Meat fat colour score by >1 unit (10 point scale). In one case this reduction shifted all unacceptable animals (60%) into the acceptable range. However, the range of fat scores within a group is often wide, and the magnitude of any reduction is likely to depend on the size of the initial score, the condition (fatness) of the animal, and its growth rate in the feedlot. Feeding grain to grazing cattle apparently did not influence fat colour, although some intermediate effect might be expected.

There is presently no practical way to assess individual fat colour scores pre-slaughter, but knowledge of the historical fat colour scores of cattle from the same origin should give a useful guide to the likely benefits of a short period of lotfeeding.

(d) Product quality

Meat marbling scores and striploin fat content were generally higher in heavier carcases. Colour of meat was always brighter in younger animals. Nutrition had little direct impact on product quality except for fat colour which whitened in lotfed animals. Nutrition had it greatest impact on meat tenderness where improved nutrition resulted in increased growth rates and reduced turn-off ages. Where turn-off ages were reduced by at least 9 months of age, the meat of the younger animals was far less influenced by the connective tissue contribution to toughness.

4.3 Task 3 Maximising annual growth rates of steers and surplus maiden heifers to reduce age of turn-off

4.3.1 Background

The age at which steers reach target slaughter liveweights in northern Australia is commonly >3½ years, with up to 5½ years not uncommon. These ages at slaughter represent ineffective use of resources, and carcases of these ages are really only suitable for manufacturing purposes when compared with carcases produced in more environmentally benign regions. The ability to produce cattle that reach slaughter liveweights at ≤ 2½ years of age would enhance the capacity of cattle producers in northern Australia to successfully compete with southern cattle producers for premium table markets. Previous work at Brigalow Research Station showed that a combination of protected protein supplements, a rumen modifier and a hormonal growth promotant in the first winter/spring period post-weaning will give a liveweight response of 42 kg in weaners, which was partially sustained in the post-supplementation period.

The implementation of early weaning programs and improved management of breeding herds in northern Australia has increased the number of surplus weaner heifers. These potentially can be directed into premium beef markets. Unwanted pregnancies, because of lack of cattle control, can delay turn-off of heifers and surgical spaying has traditionally been used to prevent this. Also there is the perception that spayed heifers grow faster than entire heifers.

More precise market specifications for carcases have been introduced in recent years and meeting these specifications attracts a premium price. However many of these specifications can only be met by younger animals, hence age of turn-off, at existing carcase weights, needs to be reduced. In this task we targeted a carcase weight of 300 kg at 2.5 years from improved pastures and 3.5 years from native pastures. This equates to annual post-weaning gains of 190 kg on improved pastures and 140 kg on native pastures. This task was therefore concerned with boosting growth rates between weaning and slaughter.

4.3.2 Objective

To identify potential opportunities to increase weaning to slaughter average annual liveweight gains of steers and surplus heifers and to establish techniques to realise these opportunities.

4.3.3 Methodology

There were 2 approaches undertaken to evaluate ways of increasing growth rates between weaning and slaughter and targeting different market specifications.

(a) The response to provision of additional protein or energy, rumen modifiers and growth promotants was measured in precise grazing studies at either Swan's Lagoon Research Station in the subcoastal spear grass region of north Queensland, at Brigalow Research Station in the brigalow lands of central Queensland, or at Brian Pastures Research Station in the inland Burnett region. Experimental details are outlined in Table 5.

(b) A number of innovative production systems on commercial beef properties were monitored in central and southern Queensland (Table 6). Sites involved pasture based beef production systems utilising combinations of improved native pasture, and sown pasture systems which may have included supplementary grain feeding, forage crop and leucaena. Systems could be broadly categorised into:

- native pasture
- native pasture augmented with legume species
- sown pastures
- lucerne pastures with access to native pasture, weaning to turn-off
- native pasture in first year post-weaning with sown pasture from year 2 until turn-off
- sown pasture with leucaena, weaning to turn-off
- sown pasture with grain supplementation in dry (winter) seasons from weaning to turn-off
- combinations of sown pasture, forage crops and grain supplementation
- forage crop finishing on winter oats or summer sorghum and dolichos

Table 5 Summary of experiments in Task 3

Expt No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
3/1	Monensin and avoparcin as additives for molasses urea supplements	Nov 1988 - June 1991 Swan's Lagoon	grazing native pasture 3 y	120 Brahman cross steers	Native pasture (NP) - unsupplemented NP + molasses + 8% urea (M8U) NP + M8U + 150 mg/kg avoparcin NP + M8U + 50 mg/kg monensin NP + M8U + 150 g CSM NP + M8U + 150 g CSM + 200 mg/kg avoparcin Supplements in first and third dry season; half animals implanted with Compudose 200 in first and third dry season.
3/2	Trenbolone acetate and oestradiol plus dry season supplements	Sep 1989 - May 1992 Swan's Lagoon	grazing native pasture 2 ½ y	180 Brahman cross steers	Native pasture (NP) - unsupplemented NP + molasses plus 8% urea plus 1% salt (M8U) in third dry season (year 3) and Compudose 200 at the start of the third wet season (Year 3) NP + M8U in years 1 and 3 plus lasalocid and Compudose 200 in year 3 NP + M8U in years 1 and 3 plus trenbolone acetate in dry of years 1 and 2 and Revalor at the start of the third wet season NP + M8U in years 1 and 3 and Compudose 200 in years 1 and 3 NP + M8U in years 1 and 3 and Compudose 200 in year 3 Irrigated pasture plus Compudose 200 in year 3 Perennial stylos plus P supplements and Compudose 200 in year 3
3/3	Trenbolone acetate plus cottonseed meal in the dry season	Aug 1990 - June 1993 Swan's Lagoon	grazing native pasture 3 y	108 Brahman cross steers	Native pasture (NP) - unsupplemented NP + CSM in dry season of year 1 and 3 ± TBA ± Revalor wet or dry season combinations NP + M8U in dry season of year 1 (± TBA) and CSM in dry season of year 3
3/4	Levels of cottonseed meal or grain plus HGP	June 1991-June 1994 Swan's Lagoon	grazing native pasture ± perennial stylos 3 y	200 Brahman cross steers	Native pasture (NP) - unsupplemented NP + CSM ± avoparcin (first dry season) and *ad lib.* 3% urea, 10% CSM (MUC) in second dry season NP + CSM in first ± second and third dry season NP + *ad lib.* grain in first and second dry season and MUC in third dry season Perennial stylos + P supplements ± Revalor ± grain
3/5	Improving the lifetime growth of cattle	July 1990-Oct 1992 Brian Pastures	grazing 16 m	Brahman cross weaners, 56 steers and 56 heifers	Nil supplement - native pasture Concentrates in winter only Concentrates in winter only (legume in pasture) Concentrates throughout year Concentrates in winter, cottonseed meal in summer
3/6	Maximising liveweight gains of *Bos indicus* cross cattle grazing improved pastures on brigalow lands using supplementation in successive years	Aug 1989- May 1991 Brigalow	grazing improved grass pastures 21 m	180 Brahman cross steers	Control (C) grazing rhodes/panic/buffel pastures. C + CSM + Avoparcin + Compudose 400 in first winter/spring. As for 2 except supplements in second winter/spring. As for 2 except supplements in first and second winter/spring. As for 4 plus control of ecto- and endo-parasites.
3/7	Maximising annual liveweight gain of buffel-Seca pasture (2 drafts)	Aug 1990-April 1992 Aug 1992-April 1994 Brigalow	grazing buffel ± Seca pastures 20 m	72 Brahman cross steers in each draft	Buffel + no supplement Buffel + grain in second winter/spring Buffel + grain in first and second winter/spring Buffel + Seca + no supplement Buffel + Seca + grain in second winter/spring Buffel + Seca + grain in first and second winter/spring
3/8	Evaluation of nutritional strategies on liveweight gains and carcase and meat characteristics of surplus heifers from weaning to slaughter	July 1992 to Mar 1994 Brigalow	grazing improved grass pasture ± feedlot 20 m	216 Brahman cross heifers and 72 Brahman cross steers	Pasture only (buffel/rhodes/panic) - heifers and steers Pasture + *ad lib.* grain - heifers only Pasture + feedlot finishing - heifers only Target carcase weights of 200, 240 and 280 kg
3/9	Liveweight gain, carcase parameters and meat attributes of maiden heifers left entire, surgically or immunoliogically spayed	June 1992- May 1994 Brigalow	grazing improved grass pastures 2 y	90 Brahman cross heifers	Entire Surgically spayed Immunologically spayed
3/11	High intake supplements and HGPs to boost liveweight gains	July 1992-March 1995 Swan's Lagoon	grazing native pasture ± perennial stylos 2 ¾ y	145 Brahman cross steers	Native pasture (NP) - no supplement NP + CSM (years 1 and 2) + MUC (molasses, 3% urea, 10% CSM + monensin) in year 3 dry season NP + grain *ad lib.* in year 1, 2, 3 dry seasons NP + MUC in year 1, 2, 3 wet seasons Stylos + P supplements ± *ad lib.* grain in year 1 and 2 dry seasons
3/12	Pasture quality in central Queensland	July 1990-June 93 Brigalow Rowanlea Berrigurra	pasture quality monitoring		Pasture yields and composition; dry matter, N, P and Ash

Table 6 Details of production systems on commercial beef properties in Task 3

Expt No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
3/10/1	Hoverbed steer production system utilising improved native pastures and sown legume pastures	May 1991-April 1994 Nanango	grazing 3y	136 steers and 45 heifers (*Bos indicus* & *Bos taurus*)	Monitoring liveweight and carcase performance of animals grazing native pasture improved with both legume (mainly lucerne + stylos and lotononis) and introduced grasses (rhodes varieties) ± Compudose ± opportunity feedlotting
3/10/2	Hoverbed steer production system utilising improved native pastures and sown pastures	Dec 1991-June 1994 Boondooma	grazing 2½ y	179 *Bos indicus* cross and *Bos taurus* cross steers	Monitoring liveweight and carcase performance of steers grazing forest country (native pasture) for weaners/yearlings, scrub country (sown pastures) for finishing steers ± contract feedlotting
3/10/3	Hoverbed steer production system utilising sown pastures and leucaena	April 1992-May 1994 Rolleston, Baralaba	grazing 2y	231 *Bos indicus* cross steers	Monitoring liveweight and carcase performance on: (i) sown pastures (buffel, green panic, rhodes) + leucaena, at Rolleston (ii) sown pastures (buffel, green panic) + Compudose at Baralaba
3/10/4	Hoverbed and purchased steer production system utilising annual medic and stylos in native pasture	July 1992-Oct 1993 Gayndah	grazing 4-11 m	99 *Bos indicus* cross steers	Monitoring liveweight and carcase performance on: (I) native pasture + medics (ii) native pasture + fine stem stylo
3/10/5	Production systems utilising sown pastures with forage crops and grain supplementation for hoverbed and transferred in steers	Feb 1991-Feb 1993 Capella	grazing 2y	185 *Bos indicus* cross steers	Monitoring liveweight and carcase performance on: (i) buffel pasture ± grain supplementation (ii) buffel pasture + forage sorghum
3/10/6	Hoverbed steer production system utilising improved native pastures, sown pastures and forage crops	June 1990-Nov 1993 Chapingah	grazing 2½ y	113 *Bos indicus* cross and *Bos taurus* cross steers	Monitoring liveweight and carcase performance of steers weaned onto forest country (native pasture + fine stem stylo, and siratro), followed by scrub country (green panic, rhodes + purple pigeon) then finished on forage (oats in winter, sorghum and dolichos in summer).
3/10/7	Steer production systems utilising sown pastures with grain supplementation	Feb 1991-Dec 1992 Bauhinia Downs	grazing 21 m	472 *Bos taurus* and *Bos indicus* cross	Monitoring liveweight and carcase performance of steers on 2 systems: (i) buffel pasture + grain supplementation (ii) buffel pasture + grain supplementation + feedlot
3/10/8	Steer productivity following graslan treatment of brigalow regrowth	July 1990-Sep 1993 Blackwater	grazing 3¼ y	400 *Bos indicus* cross steers	Monitoring liveweight and carcase performance of steers on buffel pastures ± graslan ± Compudose 400
3/10/9	Animal productivity from improved pastures in subcoastal central Queensland	July 1990-April 1994 Calliope	grazing 2½ y	200 steers: Brahman, Santa Gertrudis and BrxSG	Native pasture Improved pasture followed by forage oats (draft 1) Improved pasture followed by short term lotfeeding (draft 2)
3/10/10	Hoverbed steer production system utilising sown pastures and leucaena	July 1992-May 1994 Banana	grazing 21 m	177 *Bos indicus* cross steers	Monitoring liveweight and carcase performance of steers on sown pasture (buffel, green panic, rhodes) and leucaena
3/10/12	Hoverbed steer and heifer production system utilising grain feeding strategies to target the local trade (domestic) market	Feb 1991-Sep 1993 Monto	grazing 2½ y	436 *Bos indicus* cross steers and heifers	Monitoring liveweight and carcase performance of steers and heifers on forest country + grain or feedlot
3/10/13	Hoverbed steer production system utilising native and sown pastures	April 1991-Oct 1993 Chapingah	grazing	156 *Bos indicus* cross steers and heifers	Monitoring liveweight and carcase performance of steers and heifers on: (i) native pasture + siratro and lotononis (ii) sown pastures (rhodes and lucerne)

4.3.4 Results

Some experimental highlights are given for each of the previous areas examined.

4.3.4.1 Improving growth rate on pastures in north Queensland

(a) Native pasture

Brahman cross weaner steers were supplemented with molasses/urea (M8U) plus the rumen modifiers monensin or avoparcin as well as being implanted with Compudose 200 in the wet season. At the end of the third and final wet season, steers given M8U and also implanted with Compudose 200 were 67 kg heavier than untreated animals (Expt 3/1). The response to the HGP alone was 40 kg. The addition of monensin to M8U was a useful alternative to an HGP course as these steers were 61 kg heavier than controls.
Studies showed that the androgenic HGP, trenbolone acetate, reduced dry season liveweight loss in steers but to be most effective, rumen nitrogen levels needed to be adequate. At 3.5 years of age, steers which had not been supplemented weighed 515 kg. Steers supplemented post-weaning with M8U followed by a Compudose 200 implanted at the start of the third wet season had 31 kg heavier carcases (Expt 3/2). There appeared to be no benefits in repeated implants of Compudose 200 in years 1 and 3. There was no benefit in adding the rumen modifier, lasalocid, to a M8U dry season supplement.

One study assessed specifically the effect of Revalor (trenbolone acetate 140 mg, 17β oestradiol 20 mg) plus cottonseed meal in the dry season (Expt 3/3). Revalor increased growth rate and the carcase weight of 3½ year old steers was increased by 42 to 73 kg depending on the treatment schedule. As well, Revalor treated animals produced leaner carcases.

Further studies (Expts 3/4 and 3/11) with levels of cottonseed meal or grain plus an HGP, showed that at 3.5 years of age, untreated steers weighed 540 kg. The use of HGPs in unsupplemented steers increased final liveweight by up to 39 kg and this could be boosted a further 30 kg using a combination of HGPs and dry season supplement. These combinations increased carcase weight by up to 52 kg whereas HGP alone increased carcase weight by 31 kg in the unsupplemented controls.

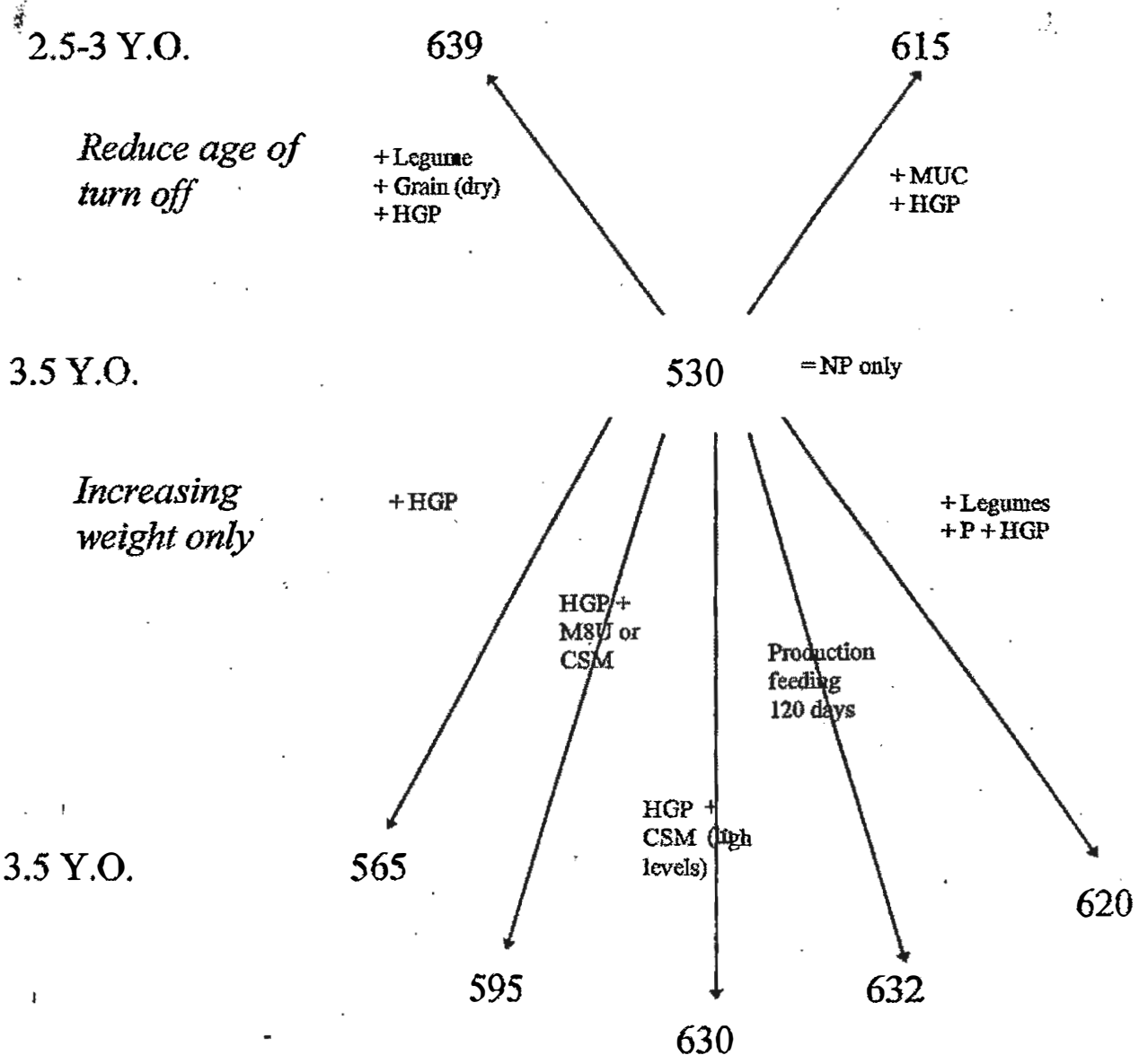
(b) Stylo based pastures

Steers grazing perennial stylos plus P supplements and implanted with Compudose 200 in their final year were 100 kg heavier in liveweight and 72 kg heavier in carcase weight than unsupplemented native pasture controls (Expt 3/2). The HGP alone contributed an additional 33 kg carcase weight on the stylo based pastures. A combination of HGP and perennial stylo increased carcase weight by 64 kg compared with untreated supplemented cattle on native pasture (Expt 3/4).

In the final experiment (Expt 3/11), high intake levels of supplements and HGPs were examined in various combinations. Steers grazing stylos with additional supplementary grain were turned off at 2.7 years of age with an average carcase weight of 347 kg, 95% of these carcases meeting 6-tooth Jap Ox specification. In contrast steers grazing native pasture and supplemented with either high level grain or molasses/urea combinations had carcases ranging from 306 to 328 kg at 3 years of age but only 65-80% met the Japanese market 6 tooth specifications.

The work at Swan's Lagoon has looked at partitioning responses to combinations of supplements, HGPs and rumen modifiers on native pastures and stylo based pastures. These results are summarised in Figure 2.

Figure 2 **Responses to combinations of supplements, HGPs and rumen modifiers in grazing steers at Swan's Lagoon**



(c) Market suitability

In each case, as treatment influenced growth rate, there was a corresponding increase in carcases meeting better quality markets For instances, in experiment 3/4, grading suitability for the Japanese grassfed fullset market ranged from 20% to 100% depending upon treatment with the balance of carcases being suitable for the Korean grassfed or US markets. Only 20-30% of carcases of steers supplemented with CSM in the absence of HGPs made the Japanese market whilst CSM and HGP recorded 50-60% suitability, being almost similar to grain based treatments (± HGP) or stylo augmented pastures in the absence of HGPs. Steers grazing stylo augmented pastures plus wet season P supplementation and grain supplements in the second dry season with Compudose 200, had carcases which were 100% suitable for the Japanese grassfed fullset market.

(d) Improvement in product quality

A limited number of product determinations based on laboratory analysis of meat colour, tenderness and fat colour was made. In general. steers aged 3.5 years and older had darker and tougher meat due to the contribution of age related connective tissue than younger animals from higher input nutritional regimes. There was also a tendency for younger animals to have a more desirable subcutaneous fat colour.

The most acceptable product quality in respect to whiter fat, brighter and more tender meat resulted from regimes where steers were turned off at 32 months of age from perennial stylo pastures and grain supplements, in comparison to regimes that only reduced turn-off age to 38 months of age.

4.3.4.2 Improving growth rates on brigalow and better scrub soils

Experiment 3/6 demonstrated that an improvement in liveweight gain between weaning and 2.5 years of age was similar for Brahman cross steers given protein supplement and a rumen modifer in both winter /spring and an HGP (Compudose 400) either in years 1 or 2 (37 *v* 42 kg). With this same supplement combination, sequential use of Compudose in the first and second years following weaning, gave a lower liveweight response (27 kg).

Feeding a grain ration to steers grazing buffel grass pastures in either the second or first and second post-weaning periods achieved advantages respectively of 27 to 34 and 34 and 39 kg in liveweight and 22 to 29 and 24 to 34 kg in carcase weight (Expts 3/7/1 and 3/7/2) over unsupplemented animals. Steers on buffel-Seca had 24 to 38 kg liveweight and 2 to 20 kg carcase weight advantages over buffel pasture alone. With buffel-Seca pastures, steers supplemented with grain in the second or first and second post-weaning periods respectively had turn-off liveweight advantages of -5 to 40 kg and 18 to 34 kg and carcases weight advantages of 14 to 34 and 27 to 28 kg.

Feeding a grain ration in the paddock during periods when growth rate fell below 0.5 kg/day or in a feedlot when heifers were 120 kg below target slaughter weight resulted in heifers reaching a 200 kg carcase weight up to 6-9 months earlier than steers and heifers grazing pasture alone (Expt 3/8). Heifers on pasture and supplemented with grain had a 7 month earlier turn-off than unsupplemented heifers when targeted at 240 and 280 kg carcase weight. In comparison, heifers on pasture then lotfed to reach 280 kg carcase weight reached this target only 4 months earlier than pasture-only heifers. On pasture alone, steers grew 10. 9 and 16% respectively faster than heifers to turn-off at 200, 240 and 280 kg carcase weights

Between spaying at 15 months of age and slaughter at 30 months of age, there was little difference in liveweight gain of heifers left entire, surgically spayed or immunologically spayed with Vaxstrate. However there were some intermediate differences particularly post-surgical spaying.

Market suitability

In many instances, increased nutritional inputs resulted in more carcases reaching premium priced markets. For example, with steers grazing buffel or buffel-Seca with or without grain supplementation, the increase in carcase weight when slaughtered at 30 months of age resulted in more carcases meeting Japanese grass-fed specification. Only 20% of carcases from the buffel control group met specification whilst 80-100% of carcases from buffel and grain supplemented groups met specification. Likewise only 30% of carcases from unsupplemented buffel-Seca pastures met specifications compared with 80-95% in the buffel-Seca and grain supplemented groups.

However, increased nutritional inputs for heifers were not always desirable in targeting specific markets. Heifers were best suited for the domestic market and could attract severe price penalties when targeted for heavier carcase markets. At a 200 kg carcase weight target, 86%, 77% and 55% of heifers from pasture, pasture plus grain and feedlot regimes respectively were suitable for the Australian supermarket trade whilst only 18%, 14% and 0% respectively were suitable for the Japanese grass-fed 3 cut market (280 kg). Particularly in the latter case, the majority of carcases were overfat.

Different spaying techniques did not influence market suitability with almost all heifers being suitable for the Korean grass-fed market.

Product quality

Grain feeding of young steers at pasture marginally improved marbling scores yet had little impact on meat colour or fat colour. Meat tenderness of these steers all slaughtered at the same age was excellant with no difference between fed and non-fed steers.

With heifers, age at slaughter or treatment had either little or inconsistent effects on meat attributes. Most meat was in the ideal colour range as was intermuscular and subcutaneous fat colour scores although marbling scores were low. Tenderness of meat samples was highly acceptable. The nutritional regime had no direct impact on meat tenderness. However, younger animals due to improved nutrition at the same carcase weight tended to have more tender eye round meat samples highlighting the greater contribution of connective tissue to meat toughness with increasing animal age. Any difference in meat tenderness between pasture finished steers and heifers was more a reflection of turn-off age differences, not the sex of the animal.

Spaying techniques had no bearing on product quality.

4.3.4.3 Monitoring production systems in central and southern Queensland

An overview of each production system showing potential performance, inputs required and possible constraints is shown in Table 7. A list of pasture and forage resources is outlined in Table 8. Figure 3 demonstrates that the more fertile land classes allowed sown pasture and crop to increase liveweight gain and reduce age of turn-off. The three systems illustrated are (i) forest country of native pasture (spear grass predominant), (ii) combinations of native and sown pastures (rhodes grass and green panic) with forage crop (oats) finishing on forest and scrub country respectively, and (iii) sown lucerne on alluvial soils with access to improved native pastures. Overall liveweight gain (weaning to turn-off) for systems (i) - (iii) were 0.36, 0.45 and 0.7 kg/hd/day respectively; equating to annual gains of 131, 165 and 256 kg/hd.

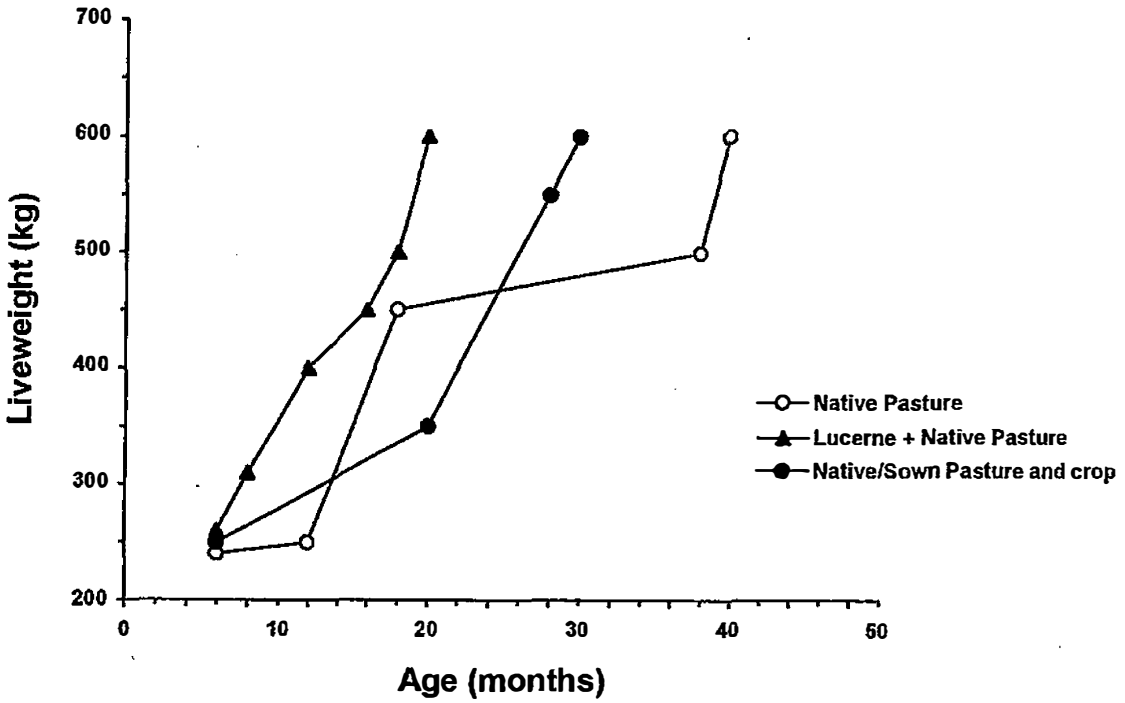
Table 7 **Overview of each commercial production system monitored : their performance, inputs required and potential constraints**

Production system	Growth rates/ age of turn-off	Product quality	Inputs	Constraints
Native pasture (predominantly black speargrass) and/or legume augmentation. *Target Market:* Korean grassfed Japanese grassfed - 6 and 8 tooth specs	150-160 kg/hd/yr with additional 15-20 kg/hd for legume. Turn-off at 40 + months of age.	Generally acceptable fat cover, carcase weight variable. Meat colour acceptable to good. Fat colour variable. Trend for meat quality parameters to improve as age of turn-off decreases. Muscle area generally acceptable.	Generally low input extensive operations. Legume establishment if applicable.	Low rainfall - effects on pasture quality and quantity. Little flexibility in system for alternative market options. Legume establishment cost/failure?
Native pasture and sown pasture. *Target market:* Japanese grassfed - 4 and 6 tooth specs; possibly Korean and heavy Australian domestic trade.	180-256 kg/hd/yr depending on sown pasture species and season. Turn-off at 25-35 months of age.	As above. Generally better meat and fat colour associated with the reduced age in turn-off, but variability remains. Muscle area acceptable.	Sown pasture establishment. More intensive pasture and stock management. Increased marketing flexibility in system to meet different markets.	Cost of pasture establishment and failure, maintenance and renewal. Reliance on rainfall/climate for pasture quality and quantity.
Sown pasture and leucaena. *Target market:* Japanese grassfed - 2, 4 and 6 tooth specs.	220-240 kg/hd/yr. Turn-off less than 31 months of age.	As above. Less variability in meat and fat colour noted with younger turn-off.	As above plus leucaena establishment and maintenance.	As above but expected lifespan of leucaena (15+ years) would offset establishment costs.
Native and/or sown pasture base system with forage crop finishing. *Target market:* Japanese grassfed - 2, 4 and 6 tooth specs.	LWG range on forage crop 0.8-1.2 kg/hd/day, depending on forage type used. Turn-off age as for sown pasture with potential to reduce age of turn-off prior to dry season. (3-6 months earlier).	Forage finishing improved carcase weight and fat cover. Improvements in meat quality parameters (if detectable) would be attributable to reduced age of turn-off. No suggestion from these studies that forage type used resulted in fat colour different from similar steers finished on pasture only.	Forage crop establishment. More intensive crop + stock management. Increased marketing flexibility. Ability to adjust grazing pressure on pasture.	Cost of crop establishment and failure. Reliance on rainfall/climate for crop quality and quantity. Poor management of stocking rate and marketing skills could result in downgrading for overfat carcases.
Grain supplementation in the paddock:- - on forage crop - on pasture *Target market:* Japanese grassfed - 2, 4 and 6 tooth specs Heavy Australian domestic trade.	Extremely variable with supplement intake and pasture/crop quality. Potential to reduce age of turn-off and reduce carry-over of steers into next season.	Improvements in carcase weight and fat cover (finish). Improvements in meat quality parameters (if detectable) would largely be attributable to reduced age of turn-off. Improvement in fat colour (whiter fat) equivocal but numerous factors including days on grain and proportion of diet as grain.	Grain ration. Infrastructure for paddock feeding. More intensive pasture/crop and stock management. Substitution effects, beneficial on increasing stocking rate and/or reducing grazing pressure - increasing grazing/crop days.	Grain ration cost. Potential animal health problems if poorly managed. Forecast budgeting essential as product still graded as 'grassfed'.

Table 8 **List of pasture/forage resources utilised within Task 3 field sites**

Native Pasture	Sown Pasture	Forage Crops	Legume Species
Queensland bluegrass (*Dichanthium sericeum*) *Urochloa* spp. Black speargrass (*Heteropogon contortus*) *Aristida* spp. Pitted bluegrass (*Bothriochloa decipiens*) Forest bluegrass (*Bothriochloa bladhii*)	Rhodes grass (*Chloris gayana* cvv.) Lucerne (*Medicago sativa* cvv.) Green panic (*Panicum maximum* cvv.) Buffel grass (*Cenchrus ciliaris* cvv.) Leucaena (*Leucaena leucocephala* cv. Peru) Purple pigeon grass (*Setaria incrassata*) Silk sorghum (*Sorghum* spp.)	Forage oats (*Avena* spp.) Forage sorghum (*Sorghum* hybrids) Dolichos (*Lablab purpureus*)	Lotononis (*Lotononis bainesii*) Fine stem stylo (*Stylosanthes guianensis* var. *intermedia*) Seca stylo (*Stylosanthes scabra* cv. Seca) Wynn cassia (*Cassia rotundifolia* cv. Wynn) Barrel medic (*Medicago truncatula* cvv.) Snail medic (*Medicago scutellata* cvv.) Siratro (*Macroptilium atropurpureum*)

Figure 3 Growth patterns for various commercial production systems



(a) Forage cropping systems

Forage cropping was on the more fertile land classes, often within a pasture rotation phase but was also used on one property as an aid to tree regrowth control. A summary of results was that weight gains were highest on dolichos (1.2 kg/hd/day), followed by oats (1.1 kg/hd/day) and sorghum (0.8 kg/hd/day).

General carcase and meat attributes were similar for all forages and were mainly in the range of 300-330 kg for carcase weight, 11-22 mm for P8 fat depth, 4-6 teeth for dentition, 1-2 for marbling scores, 1-3 for meat colour, 3-5 for fat colour and 70-79 cm^2 for rib-eye area.

(b) Pasture based systems

Steers finished off these systems had variable production and carcase parameters. As would be expected, as the proportion of more fertile land increased on each property, so did the proportion of sown pasture and legume, particularly leucaena, increase with resultant improvements in liveweight gain, market acceptability and product quality.

Differences between breeds in both production and carcase parameters were generally small but there was quite high within-breed variation in some cases. A trend for European-cross bloodlines to have heavier and leaner carcases was observed on some properties. However numbers involved were generally small and may have been biased by different paddocks and properties.

Growth promotants, primarily Compudose on pasture-based systems, increased liveweight gain by 5-10% and produced heavier and leaner carcases.

Steers lot-fed for 60-70 days to grade as prime grass-fed on commercial 'finisher' grain based rations (due to drought conditions) averaged 1.1-1.2 kg/hd/day while in the lot. Carcases were heavier and had more fat cover than comparable pasture-only steers.

Initial liveweights on each property were a general indicator of weaning weights. Production systems utilising improved pastures and sown pastures had heavier weaner weights than properties on native pasture.

Annual liveweight gains ranged from 110 - 256 kg/hd across the production systems, again with the trend for higher gain from more fertile land classes and sown pastures and crop. Grain supplementation also improved liveweight gain, but the improvement depended on substitution factors, particularly related to the pasture quality at the time of feeding.

Production systems with highest weight gain resulted in youngest turn-off for specific markets. These ranged from 1.5 - 2.5 years with sown pastures and/or leucaena for the Japanese market as opposed to greater than 3 years of age with native pasture systems.

There was no clear trend for differences in carcase weights and dressing percentages between different pasture production systems. Production systems with higher weight gain produced similar weight carcases at a younger age. Higher growth rates allowed greater flexibility in market options resulting in lighter carcase turn-off for the Korean/EC market in some instances. Grain supplementation did appear to improve dressing percentage. P8 fat depth was positively correlated to HSCW across all production systems. For carcase and weight attributes, most were in the range of 265 - 354 kg for carcase weight, 8-22 mm for fat depth, 2-6 teeth for dentition, 1-2 for marbling scores, 1-4 for meat colour, 2-6 for fat colour and 55-84 cm^2 for rib eye muscle area.

Carcases from all production systems were generally of high market acceptability for all parameters measured (> 80%). There was an overall trend for more grass-fed carcases to be unacceptable due to being underfinished and/or underweight. This trend was not evident in later (1993/94) turn-off of sown pasture and/or leucaena-fed steers where both under and over fat and under weight carcases were recorded. However delays in turn-off to attract higher market price combined with favourable seasonal conditions would have been influential factors.

Year of turn-off did not appear to influence HSCW or P8 fat depth for those steers monitored Although some relationships were positive, this could be attributed to cattle being held longer prior to turn-off. Indeed there was an increase in dentition measured at slaughter from 1990-1994 and observations are consistent with the dry conditions having negative influences on growth rates and finish.

There was no clear trend in marbling score between production systems, but meat and fat colour improved (ie lower scores) with sown pasture and/or leucaena systems. This improvement would be attributable in part to the reduced age of turn-off, given observed increases in both fat and meat colour scores with increased dentition measured at slaughter.

There was no clear trend in rib-eye muscle area between production systems. However there was a positive relationship between rib-eye muscle and hot standard carcase weight.

4.4 Task 4 Identifying new nutritional strategies to maximise liveweight gains

There were several parallel activities in this task and the primary focus was directed at young weaners in their first dry season. These activities were:

- ways to alleviate stress with young weaners; better and more cost efficient diets and the impact of early weaning on subsequent growth patterns.

- identifying, for weaners in their first year, new feed additives or feeding levels for the standard protein meal or molasses based supplements.

4.4.1 Early weaner diets and growth rates

4.4.1.1 Background

Early weaning (down to 100 kg liveweight) is becoming an established practice in northern beef herds as a means, not only of increasing reproductive rates, but also of increasing breeder survival and decreasing the necessity to supplementary feed breeders . Even younger weaning down to 60 kg (radical weaning) is seen as an option in drought to minimise breeder losses.

There is concern that radical weaners of 2-3 months of age may have stunted growth rates post-weaning as these weaners are initially in a transition stage from a high quality milk based diet to a reliance on pasture. Also these younger weaners, being stressed, may be more susceptible to diseases and parasites such as coccidiosis. There are various options to overcoming stress in young weaners, based on providing balanced nutrition and medication.

4.4.1.2 Methodology

Four grazing experiments were conducted at either Swan's Lagoon or Brian Pastures. Descriptions and treatments involved are outlined in Table 9.

Table 9 Experimental details for studies on early weaner diets and growth rates in Task 4

Expt No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
4/1	Growing out young weaners from 2 months of age	Feb 1989 - May 1992 Swan's Lagoon	grazing 3½ y	88 Brahman cross weaner steers	Radical weaners - weaned at 2 months and grazed native pasture. Radical weaners - weaned at 2 months and grazed perennial stylo Normal weaners - weaned at 6 months and grazed native pasture. Late weaners - weaned at 9 months and grazed native pasture.
4/5	Assessing diets for early-weaned calves	Jan 1990 - Dec 1992 Brian Pastures	grazing 3 y	40 male and 40 female Brahman cross weaners	Nil supplement. 0.5 kg/head/day CSM in first winter following weaning. 0.5 kg/head/day CSM in first winter following weaning, then 0.75 kg/head/day in the next 2 winters.
4/6	Reducing post-weaning stress and growing out from 70 kg at weaning	May 1990 - May 1993 Swan's Lagoon	pens/ grazing 3 y	68 Brahman cross weaner steers	At weaning or weaning + day 10, supplemented for 15 days with - protein & energy supplement (cottonseed meal + crushed sorghum) ± probiotic - protein & energy supplement (copra meal & crushed sorghum) At day 100, segregated on weaning weight into young (70-120 kg) and normal (135-164 kg) weaners
4/11	Energy sources for radically weaned calves	April 1992 - June 1994 Swan's Lagoon	grazing 2 y	100 Brahman male and female weaners	Radical weaners (male and female) in April and from June to August either 1 kg/day of grain mix or *ad lib.* molasses, 3% urea and 20% cottonseed meal. Normal weaners (male and female) in August.

4.4.1.3 Results

One approach used to *overcome stress in young weaners* was to examine the effect of treating young weaners with a lactic acid producing probiotic, either as a drench or incorporated into a sorghum/CSM based supplement. Probiotics help the digestive process by preventing the build-up of harmful gut bacteria. In experiment 4/6 there was no clear liveweight advantage to including a probiotic in a weaner supplement and there was no effect on worm burden or oocyst counts in the 100 day post-weaning period.

Grain based or molasses/urea/cottonseed supplements were compared as *different energy sources for radically weaned calves.* They proved equally effective as supplements for young calves weaned in April at 82 kg until they reached 150 kg in August-September (Expt 4/11). Supplements were either 1 kg/day of a grain mix containing 16% CP or *ad lib.* (2.5 kg/day) mix of molasses, 3% urea and 20% cottonseed meal plus minerals. Both groups of radically

weaned calves gained at 0.33 kg/day whilst their unweaned contemporaries gained at 0.6 kg/day.

Three experiments looked at *subsequent growth rates of radically weaned calves until 2½ - 3½ years of age.* The comparisons were made with either:

(a) steers born at the same time but weaned at different dates; in February at 2 months of age or in June at 6 months of age (Expts 4/1 and 4/11).

(b) steers born in different months but weaned at the same time in May (Expt 4/9).

Post-weaning, the radical weaners grew faster and partially caught up to the liveweight of the later weaned/older calves but by 2½ - 3½ years of age, were still 3 to 8% lighter than the later weaned/older steers, this trend reflecting the initial differences in weaning weights. A similar trend of 3 to 8% difference was reflected in carcase weights (243 - 264 kg), a difference in value of $50.

In another experiment at Brian Pastures (Expt 4/5), the growth rates of calves weaned at 109 kg at 3 months of age (109 kg) were compared with those of normal weaned calves of 6 months of age (≈ 220 kg). The liveweight gains of these young weaners supplemented with various levels of molasses, sorghum and cottonseed meal (0.53 - 0.79 kg/day) could not match that of the late weaned sucking calves (0.9 kg/day). At normal weaning time, all of the young weaned animals were either not supplemented, supplemented in the first winter, or first, second or third winters with CSM until turn-off. Compensatory growth allowed calves weaned early onto molasses based supplements to make up some ground on normally weaned calves, whereas calves weaned early onto a grain based supplement lost ground relative to all groups. Mean liveweight gains for the 3 years for cattle receiving nil CSM, CSM in the first winter, CSM in the first 3 winters and for normal weaned calves were 416, 419, 443 and 449 kg respectively.

This latter experiment suggests that there is probably no commercial advantage in using higher quality supplements for early weaners providing moderate growth rates in later life can be maintained. All of the data indicate that early weaned calves are unlikely to fully make up the liveweight deficit compared with calves weaned older and heavier. However this is offset by the improved reproductive performance of the cows.

The main value in radical weaning is to reduce the cost of supplementary feed for the breeder. Radical weaning supplementary feed costs are $40-55, whereas the cow and calf unit needs $27 of feed coupled with a subsequent drop in pregnancy rate of 10-15% units (≈ $30 breeder). Therefore radical weaning as a strategy is likely to break even in the least favourable scenario with the added bonus of increasing breeder survival rates.

4.4.2 New feed additives or feeding levels for the standard protein meal or molasses based supplements for weaners in their first year post-weaning

4.4.2.1 Background

Increased annual liveweight gains in weaners grazing native pastures are likely to be achieved consistently by significant inputs of energy and protein supplements. These inputs will be needed during periods when seasonal conditions prevent adequate pasture growth particularly during the dry season, and this is where research on supplementary feeding has been directed.

However there is some evidence that weaners because of their high requirement for protein may respond to additional supplemental inputs in the growth phase of pasture (wet season). Pasture growth responds rapidly to increased soil moisture and warm conditions at the onset of the wet season producing an abundance of new green plant material. The protein in this is highly digestible and very soluble leading to high rumen ammonia concentrations but only moderate supplies of amino acids for direct absorption in the intestine. So even in the wet season animals may respond to a protein source with high rumen bypass characteristics. One study looked at a number of potential supplements or supplemental additives which offered

potential production and financial benefits to enhance the efficiency of supplementation, whether this be in the dry or the wet season

4.4.2.2 Methodology

Nine pen studies and one grazing experiment were conducted at Swan's Lagoon and Rocklea research stations. Experimental details and treatments are outlined in Table 10.

Table 10 Experimental details for studies on new feed additives or different feeding levels

Expt No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
4/2	Fat and energy additives for molasses urea dry season supplements	July-Sep 1989 Swan's Lagoon	Pen 72 d	84 Brahman cross weaner steers	M8U native pasture hay + *ad lib.* molasses + 8% urea M8U + 100 or 200 g/kg rice pollard M8U + 20 or 40 g/kg cotton oil M8U + 50 mg/kg monensin M8U + 30 g/kg Isoplus (food acid)
4/3	Fat and protein containing supplements for molasses based diets	Sep-Dec 1989 Swan's Lagoon	Pen 64 d	80 Brahman cross weaner steers	M8U molasses + 8% urea and NP hay *ad lib.* M4U (molasses + 4% urea)*ad lib.* + 1 kg/day NP hay. M4U + 250, 500 or 1000 g/kg rice pollard. M4U + 310 or 620 g/kg whole cottonseed (WCS). M4U + 200 g/kg CSM ± 310 g/kg WCS. M4U + 50 mg/kg monensin.
4/4	Nutrient additives and level of avoparcin with cottonseed meal based dry season supplement	July-Sep 1990 Swan's Lagoon	Pen 79 d	96 Brahman cross weaner steers	UPP5 NP hay *ad lib.* + 40 g urea + 500 g CSM/day. UPP5 + 70 or 150 mg avoparcin/day. UPP (40 g + 350 g/kg) + 35 mg avoparcin/day. UPP (40 g + 200 g/kg) + 35 mg avoparcin/day. (Treatments 1 to 4 feed twice weekly). UPP5 + 100 g/d safflower oil (on hay). UPP5 + 5 or 10 g/day yeast additive (Yeasacc).
4/8	A yeast additive to cottonseed meal based dry season supplements	Sep-Dec 1990 Swan's Lagoon	Pen 42 d	48 Brahman cross weaner steers	NP hay + 650 g/day of 1:8:4 mix of urea, CSM and crushed sorghum + 0, 5, 10 or 15 g/day yeast product (Yeasacc).
4/7	Nutrient additives to boost liveweight performance	July-Sep 1991 Swan's Lagoon	Pen 72 d	84 Brahman cross weaner steers	CSM NP hay + 0.5 kg/day cottonseed meal. CSM + 1 g/day Niacin. CSM + 100 g/day Siromin (mineral mix). CSM + 15 g/day yeast product. NP + 0.5 kg/day copra meal. NP + 100 g/day Saltmin (1:1:1:0.2 of urea, DAP, salt and sulph amm.) ± 100 g/day cottonseed meal.
4/9	Frequency of feeding and additives to grain supplements	June-Sep 1991 Swan's Lagoon	Pen 72 d	84 Brahman cross weaner steers	NP hay *ad lib.* + 3.5 kg CSM/weekly. NP hay *ad lib.* + 3.5 kg grain + 10 g virginiamycin/weekly. NP hay *ad lib.* + 3.5 kg 40% crude protein pellets/weekly. NP hay *ad lib.* + 0.5 kg grain/day ± 5 g virginiamycin/day. NP hay *ad lib.* + 0.5 kg grain/day + 10 g yeast additive (Diamond V). NP hay + molasses + 6% urea + 100 mg/kg monensin *ad lib.*
4/10	Graded levels of grain in a molasses urea mixture	Sep-Nov 91 Swan's Lagoon	Pen 65 d	72 Brahman cross weaner steers	NP hay *ad lib.* + grain *ad lib.* + monensin. NP hay *ad lib.* + M4U + monensin + 25% by weight grain. NP hay *ad lib.* + M4U + monensin + 50% by weight grain. NP hay *ad lib.* + M4U + monensin. NP hay *ad lib.* + weekly 10.5 kg grain + 20 g virginiamycin. NP hay *ad lib.* + daily 1.5 kg grain + 10 g virginiamycin.
4/12	Comparison of whole white cottonseed and cottonseed meal as supplements for weaner steers	Sep-Dec 1992 Swan's Lagoon	Pen 70 d	60 Brahman cross weaner steers	NP hay *ad lib.* + 1.75 kg CSM/twice weekly ± 3.15 kg whole cottonseed. NP hay *ad lib.* + 1.58, 3.15 or 6.30 kg WCS/twice weekly.
4/13	Effect of previous nutrition on the response to protein supplementation by weaner steers.	Oct-Dec 1992 Rocklea	Pen 130 d	52 Brahman cross weaner steers	Pre-experimental (60 days): Nil supplement 500 g/day cottonseed meal Experimental (70 days) rhodes grass hay *ad lib.* + nil, 250, 500, 750, 1000, 1250 or 1500 g CSM/day
4/14	Responses to protein supplementation by cattle grazing wet season pastures	March-Sep 1993 Rocklea	pen/grazing 100 d	20 Santa Gertrudis weaner steers	Nil, 300, 600, 1200 or 2000 g/CSM/day.

4.4.2.3 Results

Adding high fat content supplements to molasses based supplements

Although molasses contains sucrose, potentially, with high intakes of molasses based supplement, animals could become glucose deficient. Fat supplements tend to be glucose sparing in their metabolism as glucose is a precursor with fat synthesis. Also fats tend to be anti-protozotic and feeding fat supplements could reduce rumen protozoan populations.

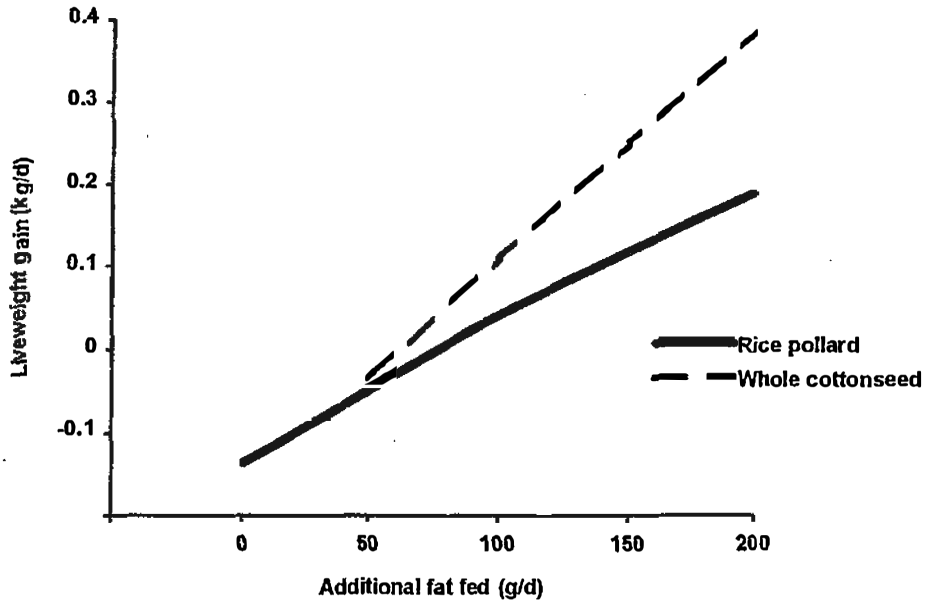
Rice pollard and whole cottonseed

These are 2 commonly available sources of combined fat and protein supplements. Two experiments (4/2 and 4/3) established a response curve of supplement intake and liveweight gain (Figure 4).

The response curve of supplement level and liveweight gain indicated that the addition of higher levels of whole cottonseed may have increased liveweight gain further. The growth responses were largely accounted for by an improvement in the animal's conversion of feed into gain, this being due to both the additional energy and protein in rice pollard and presumably due to an improvement in rumen fermentation due to the presence of fats (protozoan effect). Whole cottonseed is the more viable proposition as it is half the cost of rice pollard. For an extra 9c/day in feed cost, the addition of 620 g/day of whole cottonseed increased liveweight gain from -0.1 to 0.4 kg/day.

Of steers fed M4U alone, 10% bloated whilst no cases were seen in steers fed M4U plus monensin, rice pollard or whole cottonseed.

Figure 4 **Liveweight gain when weaner steers were fed molasses based diets and a fat containing supplement**



Cotton oil

Cotton oil at the rate of 20 or 40 g/kg of mixture was added to M8U (Expt 4/2). Liveweight gain was reduced and the higher levels of cotton oil appeared detrimental.

Isoplus

Isoplus is a proprietary mixture of volatile fatty acids produced by Eastman Kodak and was added at the rate of 30 g/kg to M8U. There was no effect on liveweight gain.

Reducing supplement costs by using the rumen modifier, avoparcin

An alternative strategy to that of boosting liveweight gain in the dry season by adding a rumen modifier to supplements, may be reducing the cost of supplements by feeding less providing liveweight gain does not suffer (Expt 4/4). The equivalent of 70 mg/day avoparcin incorporated into a urea/CSM supplement increased liveweight gain from 0.04 to 0.11 kg/day. However by reducing the amounts of both avoparcin and CSM fed twice weekly, cost savings could be made without jeopardising liveweight performance. The basic supplement cost of $1.26/week for 3.5 kg CSM could be reduced to $0.56/week when 1.4 kg/week CSM and 250 mg/week of avoparcin were fed.

Rumen modifiers to increase growth rate

The addition of 50 mg monensin/kg mixture of M4U increased liveweight gain from -0.10 to 0.04 kg/day whilst the addition of 50 mg/kg to M8U over 72 days increased liveweight gain from 0.06 to 0.14 kg/day (Expt 4/2). There was only a minor increase in supplement intake and a reduction in roughage intake resulting in a marked improvement in feed conversion ratio.

Yeast products

A dried yeast culture, (Yea-Sacc® Rhone Poulenc), of *Saccharomyces cerivistae* was incorporated into supplements because of claims that it will increase fibre digestion. There was no increase in liveweight gain when Yea-Sacc was included in a 40 g urea and 500 g cottonseed meal/head/day mix (Expt 4/4). In another study (Expt 4/8), the supplement was changed to 40 g urea, 400 g cottonseed meal and 200 g sorghum/head/day to boost rumen degradable energy supply and Yea-Sacc included at 0, 5, 10 and 15 g/head/day. There was an increase in liveweight gain from 0.06 to 0.12 kg/day at the 15 g/head/day level but not at the 5 or 10 g/head/day. However at this dose rate, Yea-Sacc was not cost effective.

In a third pen experiment (4/9), 10 g/day of a yeast additive (Diamond V) was added to a 0.5 kg grain supplement. Liveweight gain was increased from 0.14 kg/day to 0.19 kg/day but again the response was not cost effective.

Safflower oil

Oils are energy dense supplements which may boost performance at low levels of feeding. The addition of safflower oil at 100 g/head/day on native pasture hay caused a depression in liveweight gain (Expt 4/4). This was due to the oil reducing hay intake.

Vitamins and minerals

Both of these are essential for bodily functions and niacin (nicotinic acid - part of the vitamin B group) has been shown to boost growth rates in steers. In a pen feeding experiment, the addition of Niacin (1 g/day) to 0.5 kg/day of cottonseed meal had no effect on liveweight gain or feed intake (Expt 4/7).

In another pen feeding experiment, 100 g/day of a mineral mix added to 0.5 kg/day cottonseed meal supplement stimulated feed intake by 20% and caused an increase in liveweight gain from 0.17 kg/day to 0.23 kg/day (Expt 4/7).

Alternate protein sources

Copra meal

Copra meal has become available in north Queensland and could be a viable protein supplement alternative to cottonseed meal. Two pen studies were conducted to assess its performance relative to cottonseed meal.

In the first pen study (Expt 4/6), radical weaners were provided an isonitrogenous supplement of either 63% crushed sorghum, 15% cottonseed meal, 10% rice pollard, 4% dried molasses, 1% urea and 7% minerals and vitamins or 48% crushed sorghum and 30% copra meal and the rest the same. Liveweight gains of the two supplements were similar.

In a second pen study (Expt 4/7) using Brahman cross weaner steers, copra meal and cottonseed meal supplements provided at 0.5 kg/day produced similar growth rates and hay intakes. The conclusion of these studies was that copra meal could be substituted for CSM in supplements for weaners.

Whole cottonseed

Whole cottonseed (WCS) is a ginning by-product and producer experience is that WCS is a satisfactory drought feed. However high prices for WCS in recent years suggest that a protein meal such as cottonseed meal (CSM) may be of better value as a supplement for low quality roughage. A pen study (Expt 4/12) examined the effect of WCS and CSM/WCS mixtures on liveweight and feed intake performance. Palatability of WCS fed alone as a supplement was low whereas supplements of CSM and CSM/WCS mixtures were readily consumed and gave the highest feed intakes. Both CSM and WCS were effective as supplements to reduce liveweight loss and gave similar responses when similar amounts of supplement protein were provided. Therefore, on a basis of per unit weight, CSM had about twice the value of WCS in this pen study.

Infrequent feeding of supplements

Managerially, it is desirable to have cost effective supplements which can be fed infrequently to reduce labour and transport costs. The rumen modifier, virginiamycin, has been reported to minimise problems associated with infrequent feeding of grain. In one pen experiment (4/9), 5 g of virginiamycin added to a 0.5 kg/day grain supplement increased liveweight gain of weaners from 0.14 to 0.26 kg/day compared with grain alone. However when the equivalent supplement was fed weekly (3.5 kg grain), there were no obvious health problems but liveweight gain was considerably reduced (0.02 kg/day).

In a second pen experiment (4/10) where 10.5 kg grain plus 10 g virginiamycin was fed weekly, steers maintained liveweight with no obvious health problems on *ad lib.* native pasture hay. By feeding the same amount of grain overall but on a daily basis (1.5 kg grain + 5 g virginiamycin/day), steers gained 0.23 kg/day. Weekly feeding of grain depressed roughage intake by 26% and may largely explain the differences in liveweight gain.

Under the conditions of these experiments, virginiamycin added to a grain supplement allowed it to be fed weekly without obvious health problems, but liveweight gain was depressed.

Adding grain to a molasses urea supplement

There is increasing interest in using higher levels of paddock feed supplements as a means of production feeding steers to meet higher priced market specifications. An experiment (4/10) examined more cost effective supplements than feeding grain alone in the paddock. The addition of crushed grain at 25% or 50% *ad lib.* to a standard M4U - 5% CSM mixture increased liveweight gain from 0.45 to 0.74 and 1.06 kg/day respectively compared with 0.91 kg/day for *ad lib.* grain. The M4U/CSM mixture containing 50% grain produced a 16% higher liveweight gain than *ad lib.* grain with a 30% reduction in feeding costs.

Exploiting compensatory gain through wet season supplementation

Compensatory growth in cattle is a natural phenomenon in northern Australia where cattle lose weight in the dry season followed by a wet season where relatively high growth rates occur. Work from the UK in lambs suggests that when compensatory growth is occurring, nitrogen requirements are higher and animals may respond to higher nitrogen intakes. Therefore it may be possible to exploit compensatory growth during the wet season and thus increase annual growth rates by providing wet season supplementation with nitrogen. Two studies were performed to test these concepts, a pen study mimicking a dry season followed by a wet season (Expt 4/13) then a wet season grazing study using protein supplementation (Expt 4/14).

In the pen study (Expt 4/13) Brahman cross weaner steers were subjected to 2 different planes of nutrition during a preliminary feeding period such that liveweight changes were -8 or + 10 kg over 60 days. Then they were fed low quality rhodes grass hay and supplemented with 7 levels of cottonseed meal from 0 to 1500 g/day. Previous nutrition had no effect on subsequent growth. Control animals gained 0.12 kg/day and this was increased by 0.36 kg/day with 250 g/day of cottonseed meal. Subsequent increments of cottonseed meal resulted in a linear growth response and for every kg of cottonseed meal fed, growth rate was increased by 0.44 kg/day. The response relationship derived indicated that cottonseed meal supplementation offers an economically viable strategy to increase growth rates.

In a follow-up grazing study (Expt 4/14), Santa Gertrudis weaners were supplemented, from February to June, with 5 levels of cottonseed meal from 0 to 2000 g/day. The main response period occurred between weeks 6 and 11 when pasture conditions had dried off markedly. The supplement response relationship was linear, and within the range of supplements used growth rate was increased by 0.47 kg/d for every kg of cottonseed meal fed. Supplement intake had no effect on subsequent performance of steers when fed a high concentrate feedlot ration.

4.5 Task 5 Increasing returns from steers by transferring to finishing country at various ages.

4.5.1 Background

Land suitability and pasture types tend to determine whether country is used for breeding or finishing. The current industry situation is that steers, after being held on the breeding property for 12-24 months, are moved to finishing pastures at 1½ to 2½ years of age and turned off by 4½ years of age. There is a number of reasons for this of which the proportion of breeders in the herd of origin is a consideration. Having a herd which contains proportionally more older, growing cattle reduces the overall risk factor in droughts because breeders and weaners tend to be high risk groups. However, developments in breeder herd management such as self mustering and nutritional care for very young weaners have increased survival rates of breeders and young weaners. Also, with the trend towards tighter specifications for carcases especially age at slaughter, finishers of cattle will need to reassess purchasing policies to ensure that age and quality criteria are met. However there is no objective information on the optimum age (both production and economic) at which to transfer cattle to finishing pastures to meet premium market specifications.

4.5.2 Objective

To determine the optimum age at which to transfer steers from breeding country to higher quality growing and finishing pastures.

4.5.3 Methodology

Four experiments were conducted transferring cattle from northern spear grass pastures to finishing pastures in central or southern Queensland. Cattle were transferred either as weaners, yearlings or as two-year-olds. A fifth experiment looked at the effect of transferring cattle within the inland Burnett. Experimental details are summarised in Table 11.

Table 11 Details of experiments conducted in Task 5

Expt. No.	Title/Objective	Time/Place	Type of Study	Animals	Treatments
5/1	Transfer of yearling steers to improved pasture.	Sept 1987-June 1990 Swan's Lagoon /Brigalow	Grazing 4 y	72 Brahman cross yearling steers	1. Native pasture at Swan's Lagoon to turn-off at 4½ years (April 1990) 2. NP at Swan's Lagoon + year 3 dry season supplement and turn-off at 4 years (Dec. 1989) 3. NP at Swan's Lagoon; at 18 months (Sep. 1987) transferred to improved pasture at Brigalow and turn-off at 3½ years (July 1989)
5/2	Transfer of steers as weaners, yearlings or as 2-year-olds to finishing pastures.	July 1990 - May 1994 Swan's Lagoon, 'Berrigurra', Blackwater 'Barmount', Marlborough	Grazing/ feedlot 4 y	110 Brahman crossbred weaner steers	1. Native pasture at Swan's Lagoon to turn-off at 4½ years (May 1994) 2. NP at Swan's Lagoon + HGP and supplements in dry seasons 1 and 3, turn-off at 3½ years (April 1993) 3. NP at Swan's Lagoon, transferred as weaner, yearling or 2½ year old to improved pastures, finished in feedlot at 3½ years (June 1993)
5/3	Transfer of steers as weaners or yearlings to finishing pastures	July 1992 - Sept 1994 Swan's Lagoon, Brigalow	Grazing 2 y	60 Brahman crossbred weaner steers	1. Native pasture at Swan's Lagoon to turn-off at 4½ years 2. NP at Swan's Lagoon and transferred as weaners or yearlings to improved pastures at Brigalow
5/4	Transfer from growing to finishing pastures at 6, 18 or 30 months of age	Nov 1990 - October 1994 'Ida Creek' Bowen; 'Bronte' Gayndah	Grazing 4 y	3 drafts of 120 Brahman weaner steers per draft	1. Transferred at 6-12 months of age (weaners) to finishing pastures. 2. Transferred at 18 months of age (yearlings) to finishing pastures. 3. Transferred at 30 months of age to finishing pastures.
5/5	Transfer from growing to finishing pastures as weaners or as 2-year-olds	Oct 1990-Feb 1992 'Redmount' and 'Wanora', Monto	Grazing 2½ y	120 Santa Gertrudis weaner steers	Transferred to finishing pastures as • Weaner (6-12 months of age) - October 1990 • 2-year-old (27-33 months of age) - July 1992 • 2-year-old (30-36 months of age) - September 1992

4.5.4 Results

In an initial experiment (5/1), yearling steers (18 months old) transferred to improved pastures at Brigalow Research Station reached turn-off weight (> 320 kg carcase weight) some 9 months earlier (July 1989) than those steers grown out on native pasture at Swan's Lagoon (April 1990). However supplementation with cottonseed meal/sorghum mixtures in the final dry season at Swan's Lagoon allowed steers on native pastures to reach turn-off weights in December 1989, 4 months earlier.

In a second experiment (5/3), weaner steers were either retained at Swan's Lagoon on native pasture or moved to improved pastures at Brigalow in July 1990. By December 1994, those

retained at Swan's Lagoon were 309 kg whilst their transferred counterparts were 540 kg, a difference of 148 kg.

Experiment 5/2 examined the effect of retaining steers at Swan's Lagoon, either supplemented or not supplemented, or transferring steers as either weaners, yearlings or two year olds to sown grass pastures at 'Berrigurra', Blackwater. The final result was confounded by drought in central Queensland. The supplemented group grazing native pasture at Swan's Lagoon was the first to reach target weight at 42 months of age in April 1993, followed by the transferred groups which had to be finished in a feedlot (45 months - June 1993); the native pasture controls finished in May 1994 at 55 months. Although the final result was confounded by the poor season, of the transferred animals, those transferred at weaning reached target weight sooner.

Another experiment (5/4) reinforced these trends. Steers on native pastures at 'Ida Creek', Bowen were transferred to 'Bronte', Gayndah as weaners or as yearlings or as 2-year-olds. At 42 months of age, steers transferred as weaners or yearlings were 75 and 55 kg heavier than those transferred as 2-year-olds. All of those transferred as weaners and 90% of those transferred as yearlings were slaughtered one year earlier than those transferred at 30 months of age. Steers transferred as yearlings needed to be a minimum liveweight of 240 kg at transfer to finish by 3½ years.

A final experiment (5/5) assessed transfer to finishing country as weaners or at two different times as two year olds, the first in July before winter weight loss occurred or in September. Transferring as weaners to finishing country resulted in a 6 month reduction in age of sale whilst transferring 2-year-old steers in July rather than September resulted in a 30 kg heavier sale weight when sold the following February.

As a general rule, the younger the cattle at transfer, the quicker they reached their turn-off weight, reflecting the longer period of better nutrition. However this was not always true as drought conditions sometimes reduced liveweight gain on finishing pastures. An economic analysis suggests the profitability of transfer at different ages will depend upon the ownership of the cattle. Where the same person owns the breeding and finishing country, the younger the transfer to finishing country, the more profitable the operation. Where there are 2 operators involved, it is more profitable for the store producer to sell weaners or yearlings if there is more than a 10c or 15c/kg increase respectively in price over that of 2½-year-old stores. For the store buyer, a maximum of 30c/kg extra can be paid for either weaners or yearlings over that of 2½-year-old stores to break even.

4.6 Task 6/7 Economic evaluation and technology transfer

4.6.1 Objective

To develop financially sound management packages based on the findings of Tasks 1 to 5.

4.6.2 Methodology

Technology transfer of the project has been done by media releases and field day addresses (see section 11), publications both in scientific journals and research station annual reports (see section 12) and the development of a management package based on a hard copy format. The technological input for the package was from a number of sources including the results from DAQ.065. Its development was through consultation with primarily the task leaders plus input from other members of the project team. A draft form was presented at a workshop in March 1994 at Rockhampton. Interested participants included extension officers and several consultants. As a result of the workshop, the management package concentrates on the final year of finishing (Task 2) although it contains elements of all of the other tasks.

4.6.3 Results

4.6.3.1 Media releases

47 articles have appeared in provincial and rural newspapers and magazines (see Section 11.1).

4.6.3.2 Field Days

There have been addresses at 20 field days, producer meetings or industry sponsored days.

4.6.3.3 Scientific Papers

21 papers have appeared in journals and conference proceedings.

4.6.3.4 Producer Demonstration Sites (PDS)

A number of PDS sites contain elements developed within DAQ.065 viz:

'Pajingo', Charters Towers - Improving cattle growth rates with supplementation and HGPs.

'Molongle', Ayr - Improving cattle growth rates with supplementation and HGPs.

'Meadowbank', Mt Garnet and 'Mt Hope' - Supplementation of steers for finishing during drought.

'Reedy Creek', Collinsville - Molasses supplements to fatten steers.

'Gaythorn', Miriam Vale - Improving weaner growth from 6-12 months.

Monto - Paddock feeding of grain.

Miriam Vale - Meeting market specifications.

Esk - Reducing turn-off age.

Esk - Improving weaner growth.

Gympie - Weaner supplementation.

4.6.3.5 Display material.

At Beef 94 various aspects of task areas on meat quality were highlighted and formed part of the MRC display. The same display was used at Bundaberg's Agro Trend (May 1994), Gympie Show (May 1994), Richmond Field Days (June 1994) and Ayr Show (June 1994).

Stratcom (Strategic Marketing & Communications) were commissioned by Cheetham Rural Pty Ltd to produce promotional material for their range of feed supplements. The material provides cattle producers with research information, advice and managerial guidelines to help them to use production feeding as an option to meet Asian and domestic market specifications. The research information was provided by the DAQ.065 project team who feature in the handout material and a video (Appendix 1).

4.6.3.6 Media releases and field days - see Section 11

4.6.3.7 Management package

A copy of the booklet 'Meeting beef markets - nutritional and managerial opportunities' is enclosed with this final report.

The package is directed at cattle producers looking to improve the profitability of their cattle enterprise by targeting new or different markets. Similarly producers with a significant proportion of turn-off stock not achieving a targeted market may wish to evaluate various feeding options in an attempt to reduce this 'tail'. To do these things, producers require market specification information, nutritional and managerial options available to meet these specifications and the means of evaluating any possible changes. The package was developed to help producers through the process of decision making.

The package contains a pathway to follow and the expected performance data of animals under various nutritional regimes. The package is in 4 sections.

- It establishes the property's current cattle growth and turn-off patterns. A visual representation of the annual growth pattern puts into perspective which market options are worth considering and what additional growth has to be achieved to meet these markets.

- It describes the various cattle markets. The criteria used in specifying carcases are reviewed, product specifications for some of our more important markets are given and various aspects of meat quality are examined. Overlays with broad weight and age specifications for the various markets are provided for use with the growth patterns established. When the two are put together, producers can quickly see which markets are open to them and where extra growth performance is required to meet these market options.

- It provides expected performance of cattle under a variety of feeding conditions including feeding supplements on pasture, performance modifiers, lotfeeding, forage crops or pasture improvement.

- It demonstrates how to evaluate new managerial strategies to reach chosen markets. Short term feeding strategies can generally be evaluated with the use of a simple break even analysis. More complex strategies, or strategies resulting in a change in turn-off age, will require whole farm profitability and cash flow analyses to fully evaluate their ramifications.

5. Success In Achieving Objectives

5.1 Task 1 Increasing returns from the marketing of cull cows and heifers

Objective *To develop nutritional and managerial strategies to improve the marketability of cull cows*

The experiments in Task 1 have concentrated largely on developing response relationships to supplementing grain for a range of practical circumstances.

Key issues identified were:

- lactating cows utilise dietary energy about 50% more efficiently than dry cows.

- for finishing cows and calves, it is more effective to wean the calf and feed it separately.

- younger cows respond more efficiently to supplementation.

- supplementary concentrates give much larger growth responses on poor pasture than on good pasture although naturally the overall growth rate is much less.

- data derived from DAQ.065 make it possible to make reasonable predictions of the likely effects of supplementary concentrates and weaning on carcase gain in the cow and its likely profitability.

We believe that our technology has been successful in achieving, profitably, the objective of this task.

5.2 Task 2 Increasing the nett value of steers and surplus heifers by supplementation during the last 12 months pre-slaughter

Objective *Identify preferred methods to increase liveweight and ensure that target liveweight is achieved during the final 12 months pre-slaughter*

The experiments aimed to find ways to reduce age of turn-off (ie. increase growth rate), to increase the proportion of carcases meeting target market specifications, and to increase profitability. Monitoring of commercial lot-feeding operations producing a range of carcases from local trade to heavy export gave a good basis for evaluating lot-feeding as a commercial option for producers. The costs involved in lot-feeding, the benefits such as increased carcase weight, better finish and fat colour, and more consistent product, have been well documented. Selection for high growth rate on pasture or in feedlot was not detrimental for meat quality. Constraints to performance such as unsuitability of cattle and poor diet control were documented. The data generated in the project made it possible to evaluate the likely profitability of a lot-feeding operation on its own. Also using this information in conjunction with herd models, the impact of introducing lot-feeding into an existing production system could be determined on herd structures, throughput and profitability of a property.

Supplementation of grazing cattle was an effective way to improve growth rate and carcase quality making it possible to more accurately target market specifications and to avoid the carryover of unfinished cattle at the end of the growing season. Most of the supplementary feeding experiments used grain (concentrates) as the supplement. Feeding grain to grazing cattle increased growth rate and carrying capacities and carcase gain. The response by the individual animal depended particularly on pasture quality (greatest on poor pasture) and on animal size (least in mature animals).

The profitability of supplementation depended mainly on efficiency of growth response, grain prices and premiums for higher-priced market specifications. Response data collected across a wide range of pasture conditions and classes of cattle, along with market specifications and prices, and descriptions of the target cattle, made it possible to give reasonable predictions of the likely profitability of supplementation under particular circumstances.

Increasing growth rate made the attainment of most carcase specifications easier and increased the proportion of carcases meeting the targeted specifications. The most likely causes of failure of carcases to meet premium specifications were age, rump-fat depth and fat colour. Lotfeeding for 5-6 weeks reduced the fat colour score by >1 unit (10 point scale). In one case this reduction shifted all unacceptable animals (60%) into the acceptable range. However, the range of fat scores within a group is often wide, and the magnitude of any reduction is likely to depend on the size of the initial score, the condition (fatness) of the animal, and its growth rate in the feedlot. Feeding grain to grazing cattle apparently did not influence fat colour, although some intermediate effect might be expected. Currently there is no practical way to assess individual fat scores pre-slaughter, but knowledge of the historical fat colour scores of cattle from the same origin may be useful in determining the likely benefits of a short period of lotfeeding.

5.3 Task 3 Maximising annual growth rate of steers and surplus maiden heifers to reduce age of turn-off

Objective *To identify potential opportunities to increase weaning to slaughter liveweight gains of steers and surplus heifers and to establish techniques to realise these opportunities*

All of the criteria of target growth rate, market suitability, acceptable product quality and economic viability were never fully achieved by all cattle at any site on either native or improved pasture. However, each pasture type had successful management strategies to ensure that most cattle reached premium specifications.

The most successful technologies of achieving the target of a 300 kg carcase at 2½ years of age on forages or improved pastures were:

- hormonal growth promotants on sown grass - legumes pastures.
- grain ration feeding on sown grass or sown grass - legumes pastures.
- sown grass pastures followed by fodder crop.
- feedlotting.

Where target growth rates were not achieved it was due either to insufficient supplementation or to drought.

The most successful technologies to reach the 300 kg carcase target at 3½ years of age on native pastures were:

- low levels of protein or molasses based supplements, generally the first dry season following weaning plus strategic use of HGPs.
- high levels of protein or molasses based supplements given each dry season in some form of strategic rotation in combination with strategic growth promotants.
- grain based supplements in combination with hormonal growth promotants either on native pasture or legume augmented native pasture.
- legume augmented native pastures plus wet season phosphorus and hormonal growth promotants.
- sown grass - legume inclusions into native pasture followed by fodder crops or feedlotting.

Target growth rates were never achieved on native pastures alone. This occurred at all sites investigated.

This task further quantified and demonstrated the benefits of improving nutrition and its associated impact of significantly reducing turn-off age and the resultant improvement in product quality, in particular, improved meat colour and tenderness and often whiter fat colour. This project has added significantly to the knowledge of product quality and has built upon previous initiatives by CSIRO and QDPI (DAQ.052)

In a number of research experiments the technology was found to be unprofitable often due to the low gross returns given the turn-off constraints of the experiment. This restricted the capacity to sell animals when prices were at premiums.

The task has contributed to the following project objectives:

(1) Establish nutritional strategies to increase annual liveweight gain of cattle fed a basal pasture diet by an integrated use and timing of supplements and growth enhancers between weaning and slaughter.

(2) Ensure that carcases produced can be consistently targeted to a wide range of markets.

5.4 Task 4a Early weaner diets

Activities within the task identified that molasses and grain based supplements were equally effective for radical weaners and that the quality of the early weaner diet had little effect on the long-term performance of cattle. The treatment of young weaners with a probiotic had little impact on their early life performance or internal parasitic burdens.

We demonstrated that early weaners grew faster than steers weaned later but they were still lighter by 3-8% at 3½ years of age due mainly to initial weaning weight differences.

5.5 Task 4b New feed additives or feeding levels for the standard protein meal or molasses based supplements evaluated for weaners in their first year post-weaning

A number of feed additives were tested under conditions which simulated dry season environments. There was no clear benefit to adding probiotics, niacin or safflower oil to a urea/CSM supplement. A yeast product increased liveweight but the increment did not warrant the additional cost.

By adding the rumen modifier, avoparcin, to a cottonseed meal supplement, feed costs could be reduced by 25% because less cottonseed meal was required to maintain liveweight. Also the addition of whole cottonseed or the rumen modifier monensin to molasses/urea supplements would significantly boost liveweight gain. Our results show that production feeding costs can be reduced by 30% by using a molasses/urea/cottonseed meal and grain mix instead of straight grain. The feeding of grain in the paddock could be safer when virginiamycin is added. This permitted weekly feeding and so reduced labour costs. Virginiamycin also significantly increased liveweight gain in grain based supplements.

Both cottonseed meal and whole cottonseed were effective as supplements to reduce liveweight loss of young steers and gave similar responses when similar amounts of supplement were added. Also copra meal could be substituted for CSM in weaner supplements. Higher levels of protein meal feeding than had previously been recommended were appropriate for increased growth rate.

5.6 Task 5 Increasing returns from steers by transferring to finishing country at various ages

Objective *To determine the optimum age at which to transfer steers from breeding country to better quality growing and finishing pastures*

The experiments did not really allow a full assessment of different ages to establish the optimum age to transfer steers. Drought conditions prevented the movement of one group and caused the abandonment of another experiment. However, transferring steers to finishing country as weaners or yearlings resulted in an 8-12 month reduction in age at slaughter.

The experiment did highlight the potential of production feeding systems for finishing cattle on pasture, as steers subjected to this regime on northern spear grass pastures reached turn-off weights at a similar age to that of steers transferred to finishing country as weaners.

5.7 Task 6/7 Economic evaluation and technology transfer

Objective *To develop financially sound management packages based on the findings of Tasks 1 to 5*

One management package based on a hard copy format has been developed. It concentrates on the findings of mainly Task 2 with inputs from Task 1, 3 and 4.

6. Intellectual property

We believe that the project contains information that should be widely used by the beef industry and that there is no need to protect the considerable creative effort that has gone into this project. The project has no products capable of being patented, or products that will lead to the development of trademarks or designs. However, copyright which arises with the creation of this Final Report, The Experimental Collection and The Collection of Producer Monitoring Sites, should be protected by both the Meat Research Corporation and the Queensland Department of Primary Industries.

7. Progress in, or recommendations for, commercial exploitation of the results of the project

We believe that very little commercial (ie financial) gain to MRC can be made from the project. If anything, distribution of The Experimental Collection, The Collection of Producer Monitoring Sites and the management package 'Meeting Beef Markets - Nutritional and Managerial Opportunities' should be on a cost recovery basis.

8. Impact on the meat and livestock industry

We believe that the uptake of knowledge from this project and its inclusion in beef production systems can have a marked impact on the beef industry, both from the cattle production sector as well as the research sector. The critical issue is not so much the individual pieces of technologies, but rather the underlying principles of how to target particular markets and what are the technological cost effective options to achieve this target. Technology from the project can contribute to this. One is living in a fool's paradise if one thinks that all cattle can eventually reach and be paid on premium price specification because the market forces within the processing

industry tend to tighten schedules in oversupply situations and relax them when premium product is scarce. Adoption of knowledge from this project can lead to:

- more cost efficient production on farm
- more efficient marketing of livestock
- better quality product on the market

From the research side of the beef industry, the project provides a good platform for future research. The project has provided a comprehensive overview of responses to nutritional inputs in the endowed and intermediate zones, identifies a number of gaps in research knowledge and forms the basis for developing new work in improving nutritional efficiency of grazing beef cattle in northern Australia.

9. Total funding and MRC contribution

	QDPI/CSIRO[1]	Co-operators' properties[2]	MRC[3]	Total
	$	$	$	$
1989/90	350,000	30,000	151,907	531,907
1990/91	385,000	50,000	269,342	704,342
1991/92	425,000	60,000	266,803	751,803
1992/93	497,000	30,000	236,032	763,032
1993/94	520,000	10,000	148,851	678,851
1994/95	474,000	5,000	30,511[4]	509,511
TOTAL	**2,651,000**	**185,000**	**1,103,446**	**3,939,446**

1 Salaries, infrastructure, support staff, cattle
2 Wages, infrastructure, cattle
3 Includes $15,000 capital item in 1989/90, the rest is operating funds
4 On receipt and acceptance of final report by MRC

10. Conclusions and Recommendations

There are 3 issues that need to be considered:

- What needs to be put in place so that the information generated from this project is widely used by industry.
- What gaps need to be filled in existing technology.
- How does any of the proposed research mesh in with existing programs such as the MRC project, DAQ.100 and the Growth and Nutrition program of the Meat Quality CRC.

One of the aspects of contract research is that as soon as the contract is completed, the project team tends to fragment and move to the next contract. Thus the dissemination of results from the completed contract becomes of less a priority unless there has been an inbuilt milestone addressing technology transfer.

The technology arising from this project should be widely distributed throughout the cattle industry as there is no material capable of being commercialised. Our definition of industry includes producers, extension officers, consultants, and agribusiness (bankers, agents) and scientists. Throughout the project, there has been reporting, in different styles, to each of these groups. However the bottom line of successful technology transfer from this project is the use of DAQ.065 generated technology by cattle producers.

Recommendation 1. *The final report to MRC should be widely distributed.*

Recommendation 2. *50 copies of the Collection of Experiments, bound and indexed, should be distributed to libraries, extension officers and consultants throughout Queensland, Northern Territory and Western Australia.* To make it a more workable document, the Collection of Experiments needs to be indexed. This task of indexing and distribution could be completed within 4 months of approval.

Recommendation 3. *The employment of a professional scientific paper writer should be investigated to speed up the publication process.* There are potentially 30 scientific papers from 8 authors which need to be published within 2 years. Realistically, 2 papers per year per scientist into a scientific journal, given current project commitments, is achievable which leaves a shortfall.

Recommendation 4. *That a review on several technical aspects be commissioned and that this be the responsibility of the appropriate task leader.* There is a need to take a deep breath and say "Where are we now?" in particular areas. It is difficult to plug the gaps in technology unless the team has an understanding of the current situation. Reviews that need to be done include:

- production feeding on native pasture as an alternative to feedlotting or transferring steers for finishing
- early weaner management - diets and performance
- finishing cull cows

Recommendation 5. *There is a need for MRC to gauge the value and success of the management package and if considered useful, to develop others specifically for early weaner management, production feeding and management of cull cows.* Having reviewed the management package it would also become apparent additional technology is required to improve the accuracy of predicting performance of cattle under different conditions.

Recommendation 6 *is that MRC commission a series of field trials which contain replicated treatments to validate our results in different native pasture communities.* There is a need to broaden the extrapolation of the data by field testing in native pasture communities other than that in which it was developed eg. Aristida/Bothriochloa, Mitchell grasslands, for procedures such as production feeding, topping-off steers with grain and finishing cull cows. Whilst PDS sites have been touted as the vehicle for this, these sites tend to lack experimental precision. Also this approach is not within the spirit of PDS as it pre-empts the content and direction of the site.

Recommendation *7 is that MRC convene a workshop to develop a future strategy for cattle nutrition research.* It is timely, with the development of NAP3, to bring together a number of key people, in tropical and subtropical cattle nutrition to integrate any future MRC supported work with existing programs such as the Growth and Nutrition program of the Beef CRC. This workshop should address issues such as:

- What are the limiting nutrients that prevent cattle expressing maximum productivity under northern Australian conditions?
- What strategies need to be put into place to rectify this?
- How can any proposed work be integrated with existing programs.

This workshop should be convened before December 1995 so that recommendations can be built into NAP3.

Recommendation 8 *is that any future work, where possible, should reflect an understanding of the nutritional limitations of the base pasture as well as the nutritional requirements of the experimental animal.* The project made little attempt to link the animal's nutritional requirements with the quality and quantity of the feed resource available and had the base pasture in each experimental site been quantified in an appropriate manner possibly by applying the Grasp model, then the extrapolation of our results to different situations may have been enhanced.

Recommendation 9 is that without pre-empting the outcome of the workshop there are a number of nutritional strategies worthy of pursuit.

(i) *Understanding the cause of and capitalising on compensatory gain.* The earlier in an animal's life that one has to outlay money for nutritional inputs, the longer it takes to recover it particularly if compensatory growth erodes the treatment advantage. Therefore there is a need to minimise risk. We produced some exciting results in animals undergoing compensatory gain. In experiment 4/13, over the range of intakes examined, the conversion ratio of cottonseed meal to increased liveweight gain was very

low at 2.3:1 suggesting an economic response to protein supplementation when animals are undergoing compensatory gain. These results suggest that there are possible ways to exploit supplementation programs in compensating animals thereby increasing economic efficiency.

(ii) *Sharpen up the predictability of the performance of animals under different conditions.* Our results demonstrate, particularly with animals lotfed or topped off with grain in the paddock, that certain animals make a profit whereas others make a loss. Why is this and what are the contributory factors? If the non-performers can be prematurely identified, the profitability of production can be increased.

(iii) *Investigate further the responses to wet season supplementation.* Experiment 4/14 demonstrated that there was a linear response in liveweight gain during the wet season with supplement levels up to 2 kg/day of cottonseed meal and growth rate was increased by 0.47 kg/day for every kg of cottonseed meal fed. This supports the contention that our wet season pastures are inefficient in providing protein to the animals even though these pastures tend to be relatively high in protein and digestibility at this time of the year. Correcting this could make dramatic changes to wet season liveweight gains.

(iv) *There is a need for the development of an easily measured index of protein status in the animal to indicate when animals are likely to respond to supplementation.* The application of Near Infra-red Reflectance Spectroscopy which is used in the USA to relate composition of faecal samples from grazing animals to diet quality, may prove useful.

(v) *What effect does previous management of cattle have on feedlot performance?* One experiment with cull cows had to be prematurely terminated because of their poor performance in the feedlot. A contributory factor may have been lack of handling beforehand.

(vi) *What impact does radical weaning of heifers have on their subsequent reproductive performance?* The work of Doogan *et al.* (1991)[6] demonstrated that growth during the first dry season had a large bearing on subsequent reproductive performance. Radical weaning may be counterproductive for subsequent fertility of the early weaned heifer.

Recommendation 10 is *that a review of all component research on product quality attributes ie meat tenderness be conducted jointly by MRC and Meat Quality CRC.* Component research should be reviewed to determine the impact of each factor, biological or managerial, in the production, processing and retailing sectors on consumer product acceptability. Upon identification of the key factors, further research or extension areas could be targeted.

11. Media coverage

11.1 Media Articles

Date	Article	Source
March 1991	Improved coastal pasture lifts steer performance	Various outlets
	Weaning age best for promotant use	Queensland Country Life
June 1992	Improved pasture opens beef marketing options	Rockhampton Morning Bulletin
	Improved pasture boosts prime beef	Queensland Country Life
July 1992	Major DPI cattle purchase	Queensland Country Life
April 1993	Targeting specific market vital to successful feedlot	Queensland Country Life
June 1993	Research aims to give Central Coast graziers advantage	Gladstone Observer
	Better pasture gives 200 day advantage	Rockhampton Morning Bulletin
August 1993	Trial aims to improve cull heifer returns	Rockhampton Morning Bulletin
	Culled heifers return may rise	Rockhampton Morning Bulletin
September 1993	Improved pasture reduces turn-off time	Queensland Country Life

[6] Doogan, VJ, Fordyce,G, Shepherd, RK, James, TJ and Holroyd, RG (1991). *Aust J Exp Agric* **31**:139

	Culled heifers return may rise	Brahman News
October 1993	Bankers check feedlots	Rockhampton Morning Bulletin
	Beef talk	Queensland Country Life
November 1993	Trial challenges grainfed effects on tenderness	Farmer & Grazier
	Trial contests reasons for meat tenderness	Queensland Country Life
December 1993	Better nutrition key to reaping market rewards	Queensland Country Life
February 1994	Dry season supplementation pays NQ finishers.	Beef Improvement News
March 1994	Heifer feeding trials promising	Australian Stockfarmer
	Heifers match steers in trial	Farmer & Grazier
	Hundreds expected on leucaena tour.	Queensland Country Life
April 1994	Supplements boost turn-off weights	Queensland Country Life
June 1994	Marbling confusion still rife	Australian Farm Journal
August 1994	Carcase trial challenges current payment system	Queensland Country Life
	Trial endorses heifer product quality	Queensland Country Life
September 1994	Equal rights hit the beef industry	Rockhampton Morning Bulletin
November 1994	Study tries to pinpoint the results of spaying	Central Queensland News
	DPI spaying options under close scrutiny	The Central Telegraph
December 1994	Is spaying heifers a waste of time	Queensland Country Life
	Industry-bypassing cull cow profit opportunities	Queensland Country Life
	Trial evaluates cow spaying options	Mackay Bush Telegraph
	Improved cull cows offer opportunities for profit	Mackay Bush Telegraph
	Spaying females for no growth increase	The Queensland Farmer
January 1995	Industry by-passing cull cow opportunity	Today's Feedlotting Farmer
	Value adding cull cow profit in north Queensland	Beef Improvement News
	Better marketing for cull cows	Central Telegraph
	Cull cow profits missed	Milnes PRIME BEEF
	Trial finds age the key to beef quality	Rockhampton Morning Bulletin
February 1995	Age, not breed, influence on tenderness trial	Queensland Country Life
	Tender beef aim of grazing trial	Mackay Bush Telegraph
	Improved pastures turn-off better beef in CQ trial	The Queensland Farmer
	Better pastures can lead to younger, more tender beef	Beef Improvement News
March 1995	Stress behind meat inconsistency	Queensland Country Life
	Could I make more money from cull cows	Northern Muster
	Money in surplus heifers?	Northern Muster
	Production feeding with high grade Brahmans	Northern Muster
June 1995	Heavy cattle needs behind DPI trials	North Queensland Register

11.2 Field Days

Date	Event
September 1988	Swan's Lagoon Open Day - Improving liveweight gain and supplement efficiency
August 1991	Discussion/Field Tour - Brigalow Research Station. Focus - QDPI extension staff and commercial representatives - nutritionists. Growth, nutrition and meat quality.
April 1992	Brian Pastures Research Station Open Day - cattle nutrition (feeding grain for profit, feeding early weaners), results from producer field sites.
May 1992	Field day - 'Rowanlea', Calliope. Focus - Cattle producers. Steer productivity from native pasture or native pasture - sown pasture mixture.
August 1992	'Barmount' Field Day - Feeding grain for profit.
March 1993	Feedlot information day - Brigalow Research Station. Focus - Beef Industry.
October 1993	Agribusiness Field Day, Brigalow Research Station for bankers, consultants and agents - Project results presented.
November 1993	Meat Profit Day at Gympie. Topics covered were growth pathways for different markets, profitability of paddock grain feeding and achieving the desirable age of turn-off for *Bos indicus* cross animals in respect to meat quality.
February 1994	BIA Goondiwindi branch meeting Gunn Rural Management - managerial and operational staff at TBC, Rockhampton
April 1994	Beef 94 - Contribution to MRC display; property tour of 'Cedar Park' - leucaena production.
June 1994	'Fletcherview', Charters Towers - production feeding 'Balanda Park', Home Hill - supplementation
July 1994	'Molongle', Gumlu - production feeding Dairy Festival, Monto
October 1994	Meat Profit Day at Townsville - production feeding of cattle
November 1994	Delegates of the USA Citizen Ambassador Program at TBC, Rockhampton. 'Balanda Park', Home Hill 'Moselle', Richmond - Supplements to boost liveweight gain
May 1995	NQ Beef Expo, Townsville - Cattle growth rate and meat quality

12. Publications

12.1 Publications in journals or conference proceedings

Burrow, H.M., Gulbransen, B., Johnson, S.K., Davis, G.P., Shorthose, W.R. and Elliott, R.F. (1991). Consequences of selection for growth and heat resistance on growth, feed conversion efficiency, commercial carcase traits and meat quality of zebu crossbred cattle. *Aust. J. Agric. Res.* **42:** 1373-1383.

Gulbransen, B. (1990) - Using supplementary grain to increase the marketability of culled cows. *Proc. Aust. Soc. Anim. Prod.* **18:** 228-231.

Holroyd, R.G. (1994). Developments in improving growth rates of beef cattle. *Annual Conf. Qld. Div. AVA,* Feb. 1994 pp59-67.

Jeffery, M., James, T., Loxton, I. and Bourne, A. (1993). Increasing meat production and returns from cull cows. 1. Poor conditioned, non-pregnant cows. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p11A

Jeffery, M., James, T., Loxton, I. and Ryan, T. (1993). Increasing meat production and returns from cull cows. 2. Poor conditioned, pregnant cows. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p12A.

Jeffery, M., James, T. and Loxton, I. (1993). The effect of grain feeding on growth rates and carcase attributes of grazing steers in central Queensland. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p4A.

Jeffery, M., James, T., Loxton, I. and Shepherd, R. (1993). Changes in intermuscular fat colour in steers fed a feedlot ration for varying lengths of time. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p7B.

Lindsay, J.A. (1992). In: Sullivan M.T. 'Changing beef markets - should North Queensland producers change management to meet them?' *Proc. Aust. Soc. Anim. Prod.* **18:** 56-57.

Lindsay, J.A., McLennan, S.R., Kidd, J.F. and Kendall, I.E. (1989). Effects of fat containing supplements on performance of beef cattle fed molasses based diets. *Recent Advances in Animal Nutrition in Australia 1989*, (ed. D.J. Farrell), University of New England, p29A.

Lindsay, J.A., Kendall, I.E., Gelling, B.A. and Mayer, R.J. (1990). Effects of monensin sodium and avoparcin on the liveweight gain of steers during the north Queensland dry season. *Proc. Aust. Soc. Anim. Prod.* **18:** 513.

Lindsay, J.A., Kidd, J.F., Kendall, I.E., Gelling, B.A. and Mayer, R.J. (1990). A comparison of three rumen modifiers added to a cottonseed meal supplement and fed to growing beef cattle. *Proc. Aust. Soc. Anim. Prod.* **18:** 514.

Lindsay, J.A. and Laing, A.R. (1995). Crop by-product - Molasses In 'A users guide to drought feeding alternatives'. Proceedings of a workshop. University of New England, July 1995 (in press).

Loxton, I.D. (1994). Influence of growth pattern, nutrition and compensatory growth on meat quality in northern Australia. In 'The Growth and Development Workshop' (S.R. McLennan and D. Hennessy, editors), Meat Quality CRC, University of New England, Armidale, September 1994.

Loxton, I.D., Holroyd, R.G., Blight, G.W., James, T.A., Mullins, T.J. and Jeffery, M.R. (1992). Protein supplementation and growth enhancer strategies in successive years to maximise growth of Brahman cross steers grazing sown grass pastures on brigalow lands. *Proc. Aust. Soc. Anim. Prod.* **19:** 43-45.

Loxton, I., Martin, P.R. and James, T.J. (1993). The determination of pasture feed quality in central Queensland. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p3A.

Loxton, I.D. Shorthose, W.R., Holroyd, R.G., Blight, G.W., James, T.J., Jeffery, M.R., Neill, A.R., Martin, P.R., Fordyce, G., Lindsay, J.A. and Clarke, M.R. (1993). The influence of animal nutrition on the quality of meat from *Bos indicus* crossbred steers in northern Australia. In *'Meat 93'*, The Australian Meat Industry Research Conference, Gold Coast, October 1993 (CSIRO), Session 8B pp1-6.

McLennan, S.R. and Poppi, D.P. (1995). Effects of previous nutrition on the response to protein by weaners. *Ann. Zootech.* **44** (Supp): 358

Sinclair, S.E. (1993). Liveweight gains observed for steers grazing different commercial systems that target the Japanese grass fed market. *Recent Advances in Animal Nutrition in Australia 1993*, (ed. D.J. Farrell), University of New England, p1A.

Sinclair, S. and Gulbransen, B. (1992). Carcase traits of *Bos indicus* x *Bos taurus* steers produced for the Japanese market. *Proc. Aust. Soc. Anim. Prod.* **17:** 95.

Strachan, D.B., Yang, A. and Dillon, R.D. (1993). Effect of grain feeding on fat colour and other carcass characteristics in previously grass-fed *Bos indicus* steers. *Aust. J. Exp. Agric.* **33:** 269-273.

Taylor, K.M. and Gulbransen, B. (1990). Feeding grain for profitable finishing of grazing steers. *Proc. Aust. Soc. Anim. Prod.* **18:** 388-391.22.

Yang, A., McLennan, S.R., Armstrong, J., Larsen, T.W., Shaw, F.D. and Tume, R.K. (1993). Effect of short-term grain feeding on bovine body-fat colour : a cautionary note, *Aust. J. Agric.* **44:** 215-220.

12.2 Publication Schedule

Expt No.	Title	Principal Investigator	Published to date[1]	Proposed publication/ deadline[2]
Task 1	**Increasing return from marketing of cull cows and heifers**			
1/1	Utilisation of supplementary energy in cow/calf production	B Gulbransen	Brian Pastures Annual Report 1990 p32	AJEA December 1996
1/2	Effect of quality of basal forage on substitution rates and on carcase weight gains of cows and calves supplemented with grain-based concentrates	B Gulbransen	Brian Pastures Annual Report 1991 p31	AJEA December 1996
1/3	The effect of supplementing cull cows with grain-based concentrates during lactation and/or post weaning	B Gulbransen	Brian Pastures Annual Report 1991 p31	AJEA December 1996
1/4/1 1/4/2	Effect of time of slaughter and nutritional regimes on the value of cull cow calf units and the yields of saleable meat from lactating cull cows	M Jeffery	Brigalow Annual Report 1991 p52; 1992 p30; Rec. Adv. In Anim. Nutrit. (1993) p12A.	AJEA June 1997
1/5	The effect of nutritional regimes on the growth rates, carcase attributes, yield of saleable meat and value of non-pregnant cull cows	M Jeffery	Brigalow Annual Report 1992 p36; Rec. Adv. In Animl Nutrit. (1993) p11A.	AJEA June 1997
1/6/1 1/6/2	The effect of nutritional regimes and carcase weight on the growth rates, carcase attributes, yields of saleable meat and values of non-pregnant cull cows	M Jeffery	Brigalow Annual Report 1993 p37; 1994 p21	AJEA June 1996
Task 2	**Increasing the nett value of finishing steers and surplus maiden heifers by supplementary feeding during the last 12 months pre-slaughter**			
2/1	Using grain to top off steers in the	B Gulbransen	Brian Pastures Annual	AJEA June 1996

[1] All experimental reports have been included in DAQ.065 Final Report.

[2] Date first draft sent to journal.

Expt No.	Title	Principal Investigator	Published to date[1]	Proposed publication/ deadline[2]
	paddock		Report 1990 p33.	
2/2	Consequences of selection for growth and heat resistance on growth, feed conversion efficiency, commercial carcase traits and meat quality of zebu crossbred steers	B Gulbransen	Brian Pastures Annual Report 1990 p34 AJAR (1991) 43:1373	Nil
2/3	Effect of grain feeding on fat colour and other carcase characteristics in previously grass-fed *Bos indicus* steers	D Strachan	AJEA (1993) 33:269	Nil
2/4	Evaluation of feedlotting strategies to produce suitable animals for Australian domestic grainfed and Japanese grainfed markets			
2/4/1	- Australian domestic steers and heifers	S Sinclair	DAQ.065 Final Report	AJAR June 1996
2/4/2	- Shortfed market - Japan	S Sinclair	DAQ.065 Final Report Aust. Soc. Anim. Prod. (1992) 19:95	AJAR June 1996
2/4/3	- High quality grainfed - Japan	S Sinclair	DAQ.065 Final Report	AJAR June 1996
2/5/1 2/5/2	Energy supplementation to increase the nett value and improve meat quality of finishing steers for the Korean market	M Jeffery	Brigalow Annual Report 1991 p47; 1992 p42. Rec. Adv. In Anim. Nutrit. (1993) p4A	AJEA March 1996
2/6	The effects of grain feeding for varying lengths of time in a feedlot on liveweight gain and carcase and meat attributes of *Bos indicus* steers	M Jeffery	Brigalow Annual Report 1992 p49. Rec. Adv. Anim. Nutrit. (1993) p7B	AJEA June 1996
2/7	Effect of short-term grain feeding on bovine body fat colour	S R McLennan	AJAR (1993) 44:215	Nil
2/8	Effect of roughage quality on responses to supplementary grain	B Gulbransen	Brian Pastures Annual Report 1992 p30	AJEA June 1997
2/10	Utilisation of whole cottonseed by cattle fed native pasture hay	B Gulbransen	Brian Pastures Annual Report 1992 p29	AJEA June 1997
Task 3	**Maximising annual growth rates of steers and surplus maiden heifers to reduce age of turn-off**			
3/1	Monensin and avoparcin as additives for molasses urea supplements	J Lindsay	Swan's Lagoon Annual Report 1989 p33; 1990 p34; 1991 p54. Aust. Soc. Anim. Prod. 18:513; 19:57.	AJEA June 1996 (combine with 3/2) ASAP July 1996
3/2	Trenbolone acetate and oestradiol plus dry season supplements	J Lindsay	Swan's Lagoon Annual Report 1990 p40; 1991 p57; 1992 p73	AJEA June 1996 ASAP July 1996
3/3	Trenbolone plus cottonseed meal in the dry season	J Lindsay	Swan's Lagoon Annual Report 1991 p60; 1992 p77; 1993 p83	AJEA June 1996 ASAP July 1996
3/4	Levels of cottonseed meal or grain plus HGP	J Lindsay	Swan's Lagoon Annual Report 1992 p83; 1993 p88; 1994 p85	AJEA - Dec 1996 (combined with 3/11) ASAP - July 1996
3/5	Improving the lifetime growth of cattle	B Gulbransen	Brian Pastures Annual Report 1992 p28	?
3/6	Maximising liveweight gains of *Bos indicus* cross cattle grazing improved pastures on brigalow lands using supplementation in successive years	I Loxton	Brigalow Annual Report 1990 p44; 1991 p37; Aust. Soc. Anim. Prod. 1992, 19:43	Nil
3/7/1 3/7/2	Maximising annual liveweight gains of buffel-Seca pastures to achieve a reduction in turn-off age of steers	I Loxton	Brigalow Annual Report 1990 p49; 1991 p44; 1992 p55; 1993 p49; 1994 p48	AJEA December 1996
3/8	Evaluation of nutritional strategies on liveweight gains and carcase and meat characteristics of surplus heifers from weaning to slaughter	M Jeffery	Brigalow Annual Report 1993 p37; 1994 p27	AJEA December 1997
3/9	Comparison of liveweight gain, carcase parameters and meat attributes of surplus maiden heifers either left entire, surgically spayed or immunologically spayed	M Jeffery	Brigalow Annual Report 1993 p45; 1994 p42	AJEA or AVJ June 1996
3/11	High intake supplements and HGPs to boost liveweight gains	J Lindsay	Swan's Lagoon Annual Report 1992 p93; 1993 p92; 1994 p92	AJEA - December 1996 Combine with 3/4

3/12	Pasture feed quality in central Queensland	I Loxton	Brigalow Annual Report 1992 p62; 1993 p58; Rec. Adv. Anim. Nutrit. 1993 p3A	ASAP July 1996 Trop. Grassl. December 1995

Field Research Sites

3/10/1	Homebred steer production system utilising sown lucerne pastures	S Sinclair	DAQ.065 Final Report Rec. Adv. Anim. Nutrit. 1993 P1A	AJAR December 1995.
3/10/2	Homebred steer production system utilising improved native pastures and sown pastures	S Sinclair	DAQ.065 Final Report	This paper will contain elements from 3/10/1, 3/10/2, 3/10/3, 3/10/4, 3/10/5, 3/10/6, 3/10/7, 3/10/10 and 3/10/13
3/10/3	Homebred steer production system utilising sown pastures and leucaena	S Sinclair	DAQ.065	
3/10/4	Homebred and purchased steer production system utilising annual medics, and stylos, in native pasture	S Sinclair	DAQ.065 Final Report	
3/10/5	Homebred and transferred steer production systems utilising sown pastures with forage crops and grain supplementation	S Sinclair	DAQ.065 Final Report Aust. Soc. Anim. Prod. (1992) 19:95	
3/10/6	Homebred steer production system utilising improved native pastures, sown pastures and forage crops	S Sinclair	DAQ.065 Final Report	
3/10/7	Steer production system utilising sown pastures with grain supplementation	S Sinclair	DAQ.065 Final Report	
3/10/8	Animal productivity following grazlan treatment of brigalow regrowth	I Loxton	DAQ.065 Final Report	Nothing planned
3/10/9	Animal productivity from improved pastures at a subcoastal site in CQ	1 Loxton	DAQ.065 Final Report Proc. Meat 93 Conference	AJEA December 1996
3/10/10	Homebred steer production system utilising sown pastures and leucaena	S Sinclair	DAQ.065 Final Report	
3/10/12	Homebred steer and heifer production system utilising grain feeding strategies to target the local trade (domestic) market	S Sinclair	DAQ.065 Final Report	Nothing planned
3/10/13	Homebred steer production system utilising native and sown pastures	S Sinclair	DAQ.065 Final Report	
3/10/14	Productivity and carcase characteristics of *Bos indicus* cross steers targeted for the Japanese grassfed market and finished on either native pasture (with or without legume augmentation), sown pastures and leucaena	S Sinclair	DAQ.065 Annual Report	

Task 4(a) Early weaner diets and growth rates

4/1	Growing out young weaners from 2 months of age	J Lindsay	Swan's Lagoon Annual Report 1990 p43; 1991 p65; 1992 p87	AJEA June 1997 (combine with 4/6 and 4/11)
4/5	Assessing diets for early weaned calves	B Gulbransen	Brian Pastures, Annual Report 1990 p32; 1991 p32	AJEA June 1997
4/6	Reducing post weaning stress and growing out from 70 kg at weaning	J Lindsay	Swan's Lagoon Annual Report 1990 p45; 1991 p67; 1992 p89; 1993 p107	AJEA June 1997 (combine with 4/1 and 4/11)
4/11	Comparison of grain and molasses for radical weaners	J Lindsay	Swan's Lagoon Annual Report 1992 p91; 1993 p104; 1994 p108	AJEA June 1997 (combine with 4/1 and 4/6)

Task 4(b) New feed additives or feeding levels for the standard protein meal or molasses based supplements for weaners in their first year post weaning

4/2	Fat and energy additives for molasses urea dry season supplements	J Lindsay	Swan's Lagoon Annual Report 1989 p42	ASAP 1996 or 1998 or Rec. Ad. Anim. Nut. 1997
4/3	Fat and protein containing supplements for molasses based diets	J Lindsay	Swan's Lagoon Annual Report 1989 p44. S. McLennan PhD Thesis (1983); Rec. Adv. Anim. Nut. (1989)	None planned

			p29A	
4/4	Nutrient additives and level of avoparcin with cottonseed meal based dry season supplements	J Lindsay	Swan's Lagoon Annual Report 1990 p47	ASAP 1996 or 1998 or Rec. Adv. Anim. Nutrit. 1997
4/7	Niacin, minerals and a yeast additive to boost performance	J Lindsay	Swan's Lagoon Annual Report 1991 p69	ASAP 1996 or 1998 or Rec. Adv. Anim. Nutrit. 1997
4/8	A yeast additive to cottonseed meal based supplements	J Lindsay	Swan's Lagoon Annual Report 1991 p72	ASAP 1996 or 1998 or Rec. Adv. Anim. Nutrit. 1997
4/9	Frequency of feeding and additives to grain supplements	J Lindsay	Swan's Lagoon Annual Report 1992 p93	ASAP 1996 or 1998 or Rec. Adv. Anim. Nutrit. 1997
4/10	Graded levels of grain in a molasses urea mixture	J Lindsay	Swan's Lagoon Annual Report 1992 p96	ASAP 1996 or 1998 or Rec. Adv. Anim. Nutrit. 1997
4/12	Comparison of whole white cottonseed and cottonseed meal as supplements for young steers fed low quality roughage	R Dixon	Swan's Lagoon Annual Report 1993 p114	ASAP 1998
4/13	Effect of previous nutrition on the response to protein supplementation by weaner steers	S.R. McLennan	Ann. Zootech 44 (Supp): 358	
4/14	Responses to protein supplementation by cattle grazing wet season pastures	S.R. McLennan	DAQ.065 Final Report	AJEA June 1996 combined with 4/13

Task 5 Increasing returns from steers by transferring to finishing pastures at various ages

5/1	Transfer of yearling steers to improved pastures	I Loxton	Swan's Lagoon Annual Report 1989 p39; 1990 p37. Brigalow Annual Report 1990 p29	AJEA Dec 1996 (combine 5/1 - 5/5)
5/2	Transfer of steers as weaners, yearlings or as 2-year-olds	J Lindsay	Swan's Lagoon Annual Report 1991 p63; 1992 p87; 1993 p96; 1994 p96. Aust. Soc. Anim. Prod. 1992 19:57.	AJEA Dec 1996 (combine 5/1 - 5/5)
5/3	Transfer of steers as weaners or yearlings to finishing pasture	J Lindsay	Swan's Lagoon Annual Report 1993 p100; 1994 p100. Brigalow Annual Report 1994, p58.	AJEA Dec 1996 (combine 5/1 - 5/5)
5/4	Transfer from growing to finishing pastures at 6, 18 or 30 months of age	R Tyler	DAQ.065 Final Report	AJEA Dec 1996 (combine 5/1 - 5/5)
5/5	Transfer from growing to finishing pastures as weaners or as 2-year-olds	R Tyler	DAQ.065 Final Report	AJEA Dec 1996 (combine 5/1 - 5/5)