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Sustained Growth Promotion of Pasture Fed Steers

ABSTRACT

The major objective of the project was to develop strategies for hormonal growth promotant (HGP) use that achieved accelerated growth rate of steers in northern Australia from between weaning and slaughter. This would provide northern beef producers with the opportunity to reduce substantially the age of turn-off and so target higher value markets. Repeat implantation with HGPs increased annual liveweight gain by up to 40 kg. Factors governing the magnitude of the response in liveweight gain and carcass composition were also defined. These factors included the relative durations of the northern wet and dry seasons, the frequency of implantation and the type of hormone or combination of hormones used. Application of the principles established by the project would allow producers to choose a strategy for HGP use, that suits their geographical location, their management system and their target market.

An independent financial analysis showed that use of three implant per year is profitable in northern Australia on properties where steers can be mustered without excessive cost. Adoption of the technology developed in this project would be of most benefit on properties that practised nutritional management of steers aimed at meeting the age and weight specifications for premium markets.

EXECUTIVE SUMMARY

This MLA project "Sustained growth promotion of pasture fed steers" was conducted in conjunction with a complementary project on sustained growth promotion within the Cooperative Research Centre for the Cattle and Beef Industry (Meat Quality). For the sake of completeness, results from both components of the study are used in the discussion to define the principles contributing to the extent of the anabolic response in growth, carcass composition and meat quality when sustained growth promotion strategies are used with grazing steers in northern Australia. Likewise data from both components were used to evaluate the economic benefits of sustained growth promotion in representative production systems in northern Australia.

Hormonal growth promotants (HGPs) are commonly used in the northern beef production system to increase growth rates of cattle in the final 3-5 months before slaughter. The increased gain is typically 10-20 kg or about an additional 0.1kg/d gain. This short period of implantation suits production systems in the northern hemisphere where cattle are usually fed high energy diets and slaughtered at a young age. In that environment the few months of the implant period is a significant proportion of the animals' post weaning life. In contrast, pasture-finished steers in northern Australia often take at least 3 years post weaning to reach heavy slaughter weights suitable for the Japanese market. Sustained growth promotion throughout the post- weaning period is necessary if the age at which animals are ready for market is to be reduced substantially. An additional 0.1kg/d for 18 months translates to an additional 55kg over an animal's lifetime. This would reduce the age at slaughter substantially, with flow-on benefits for the whole herd. The prevailing perception at the start of this project was that with repeat implantation with HGP's the growth response attenuated and consequently sustained growth promotion was not possible.

The project objectives were:

1. To demonstrate that sustained growth promotion between weaning and slaughter could be achieved.

2. To determine the effect of sustained growth promotion on commercial carcass value.

3. To quantify the magnitude of the response in weight gain and carcass yield so the economic value of sustained growth promotion can be assessed.

The first approach taken was to demonstrate that sustained growth promotion could be achieved over extended periods of time. This was accomplished using the very aggressive strategy of treatment with an HGP every 100 days. The next challenge was to understand the factors governing the magnitude of the improvement in liveweight gain so implantation strategies suitable for the northern Australian beef production system could be developed. Briefly, it was found that an additional 40 kg of liveweight gain could be achieved annually using an HGP every 100 days, provided steers were kept in positive energy balance. Lower annual liveweight responses resulted when steers experienced periods of weight stasis or weight loss during the northern dry season.

The series of experiments conducted in this MLA project and the companion Meat Quality CRC project has allowed elucidation of a number of scientific principles which govern the liveweight response to treatment with anabolic steroids and the impact of that treatment on some

measures of product quality. These are listed below. They provide guidelines that beef producers can use to develop commercial implant strategies specific to particular geographic regions, particular animal management systems and particular market requirements.

- The more frequently steers are reboosted with a new implant the greater the response in liveweight gain.
- Sustained growth promotion can be achieved by repeat implantation with oestrogenic hormones or by alternate treatment with an oestrogen followed by treatment with a combined implant containing both an oestrogen and an androgen. Sustained growth promotion at a reduced rate of response can also be achieved by use of a long acting implant.
- Once an implantation program has been commenced it should be continued through to slaughter.
- Under the pastoral conditions of northern Australia, steers with a single implant containing only an androgen are unlikely to exhibit accelerated growth.
- Greater responses in liveweight gain are achieved when steers are continually in positive energy balance than when they experience periods of weight stasis or weight loss.
- Frequent (every 100 days) treatment with oestrogenic hormones or a twice yearly strategy involving alternate use of a combined implant (oestrogen plus androgen) followed by an oestrogen does not alter carcass composition of steers, provided comparisons are made at the same carcass weight.
- Repeat implantation with implants containing an androgen may lead to a reduction in carcass fatness.
- The more aggressive the implant strategy the higher the likelihood of an increase in meat toughness.

An independent consultant was commissioned to conduct a financial analysis of sustained growth promotion in the northern Australian beef industry. He chose a strategy of three implantations per year, two implants of 100 days duration during the wet season and a 200 day implant for the remainder of the year. The economic benefits of finishing steers off pasture for the domestic, Korean and Japanese markets were assessed. The net increase in return per head, excluding mustering costs, varied between $22 and $33. The strategy would be profitable for many beef enterprises in northern Australia.

This project achieved its objectives. Accelerated growth rates between weaning and slaughter were demonstrated. The effects of repeat implantation on carcass composition and meat quality were defined. An independent financial analysis described the commercial situations where adoption of the technology would be profitable. In addition, the scientific principles that govern the magnitude of the increase in growth rate were established. This understanding means that reasonably accurate predictions can be made about the growth rate, carcass and meat quality responses to treatment in any beef production system where some of the production variables are known. Thus, application of the findings of this project are not confined to environment allocations similar to those under which the project was conducted.

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1 INTRODUCTION

This MLA project “Sustained growth promotion of pasture fed steers” was conducted in conjunction with a complementary project on sustained growth promotion within the Cooperative Research Centre for the Cattle and Beef Industry (Meat Quality). For the sake of completeness, results from both components of the study are used in the discussion to define the principles contributing to the extent of the anabolic response in growth, carcass composition and meat quality when sustained growth promotion strategies are used with grazing steers in northern Australia. Likewise data from both components were used to evaluate the economic benefits of sustained growth promotion in representative production systems in northern Australia.

A number of scientific and industry communications have resulted. These are included in appendices.

2 BACKGROUND TO THE PROJECT

In northern Australia (Qld, NT, north west WA), the beef industry has undergone major changes over the last 10 years. The key developments highlighted by Anon (1997) have been:-

- The increased importance of the north Asian markets of Japan and South Korea for beef exports and the sharp reduction in shipments to the United States and Canada. For example the tonnages of beef exported to the USA halved between 1992 and 1996 while the exports to Asia more than doubled in the 10 years to 1996.
- The rationalisation of meat processing has seen the number of plants in northern Australia fall from 20 in 1985 to 9 in 1996. The contraction has been towards the coast and towards the east.
- An increase in cattle numbers in northern Australia from 11.3 million in 1990 to 12.1 million in 1996. This latter number represents 51% of the Australian herd. The number of steers and non-breeding heifers being prepared for slaughter is 3.15 million. Annual slaughterings are about 2.1 million head.

In contrast to the North American market that uses mainly manufacturing beef from Australia, the Asian markets are demanding beef of specified age, carcass weight and carcass composition. The impact on the production system has seen a need to increase annual growth rates substantially. Access to the Asian markets, in essence, means that cattle must average at least 0.5 kg per day throughout their lives. The likely future adoption of the Meat Standards Australia (MSA) specifications or a derivative of MSA will also demand average growth rates of at least 0.6 kg per day for graded product. No longer will an industry, or an individual grazing company, survive economically producing an unspecified commodity. The challenge for the northern industry is to remain internationally competitive by adopting technologies and innovations that increase the quality of the product without compromising the pressure on the land and pasture resource base.

Anabolic steroids are commonly used in the northern beef production system to increase growth rates of cattle in the final 3-5 months before slaughter. The increased gain is typically 10-20 kg or about an additional 0.1kg/d gain. This short period of implantation suits the production systems in the northern hemisphere where cattle are usually fed high energy diets and slaughtered at a young age. In that environment the few months of the implant period is a significant proportion of the animals’ post weaning life. In contrast, pasture-finished steers in northern Australia often take at least 3 years post weaning to reach heavy slaughter weights suitable for the Japanese market. Sustained growth promotion throughout the post- weaning period is necessary if the age at which animals are ready for market is to be reduced substantially. An additional 0.1kg/d for 18 months translates to an additional 55kg over an animal's lifetime. This would reduce the age at slaughter substantially with flow-on benefits for the whole herd. The perception at the start of this project was that with repeat implantation the growth response attenuated and consequently sustained growth promotion was not possible.

2.1 Growth promotants for steers in Australia

There are now a number of branded hormonal growth promotants registered for use in steers in Australia. There is scope for confusion because the same hormones and combinations of hormones are used in a number of products, i.e., many products are clones of one another.

Growth rate in steers can be enhanced by implantation with oestrogenic compounds (e.g.,oestradiol, zeranol) and combinations of oestrogenic and androgenic compounds (e.g.,testosterone, trenbolone acetate). If the products are classified by their functional hormones rather than their brand names, the list is simplified and the choice of which product to use becomes less confusing (Table1).

Table 1 Implants for steers clasified by functional hormones

Hormone	**Functional life (days)**	**Products**
Zeranol	100	Ralgro
Oestradiol	100	Compudose100, Component S, Synovex S, Progro S
Oestradiol	200	Compudose 200
Oestradiol	400	Compudose 400
Oestradiol+trenbolone acetate	100-150	Component TES, Progro TES, Snyovex Plus, Revalor G, Revalor S

3 PROJECT OBJECTIVES

1. To demonstrate that sustained growth promotion between weaning and slaughter could be achieved.

2. To determine the effect of sustained growth promotion on commercial carcass value.

3. To quantify the magnitude of the response in weight gain and carcass yield so the economic value of sustained growth promotion can be assessed.

4 METHODOLOGY

4.1 Scientific research

4.1.1 Animals and treatments

Experiment 1

One hundred and twelve yearling high grade Brahman steers of initial mean (± sem) liveweight 216 ± 2.6 kg were obtained from the one commercial property in October 1994 and grazed together in the one paddock at Brigalow Research Station near Theodore in Central Queensland. There were initially 120 steers but 8 were removed during the course of the experiment for reasons unconnected with treatment. In December they were randomly divided into four groups on the basis of liveweight so that the mean ± sem liveweight was approximately the same for each group. Groups were then assigned at random to one of the following treatments:

1. Unimplanted controls (n=30).

2. Implanted with 45 mg oestradiol-17β (Compudose® 400, Elanco Animal Health) at the commencement of the experiment and reimplanted 420 days later. (n=27).

3. Alternating treatment with 20 mg oestradiol-17β (Compudose 100®) followed by treatment with 300 mg trenbolone acetate (Finiplix®, Hoechst Roussel Vet) each 105 days for the duration of the experiment. (n=27).

4. Alternating treatment with 20 mg oestradiol-17β (Compudose 100) followed by testosterone propionate each 100 days. In the second 100 day period 353 mg of testosterone propionate (Ropel® pellets, Jurox Pty Limited) was implanted. When no growth response was observed at the end of this implant period and plasma testosterone concentrations were at least 10 times lower than those observed in a previous experiment in which a substantial growth response to treatment with testosterone propionate was recorded (Hunter 1989), the dose was increased to 3525 mg for the fourth period. (n=28).

In each treatment group old implants were removed before new ones were inserted. The experiment was of 540 days duration and there were thus five 105 day implant periods.

June 1995 the steers were transferred to the National Cattle Breeding Station, Belmont, near Rockhampton in central Queensland where they all grazed in the one experiment finished in June 1996. Burdens of the cattle tick (*Boophilus microplus*) were never of sufficient magnitude to warrant treatment of the steers with an acaracide.

Steers were weighed monthly at both experimental sites. A blood sample was collected by venipuncture on a day the steers were weighed nearest to day 55 of each 105 day implant period (period 1, day 42; period 2, day 77; period 3, day 55; period 4, day 42; period 5 day 50). Blood was packed in ice, allowed to clot and sera withdrawn. Sera was stored at –20°C to await analysis of hormone concentration.
At the end of the experiment steers were transported to a local commercial abattoir and routine AusMeat data collected (carcass weight, fat cover at the P8 rump site (Anon 1985)). As the pellets of testosterone propionate were not registered for use in cattle in Australia, permission

was given by the Australian Quarantine Inspection Service for steers treated with testosterone propionate to enter the human food chain. At the time of slaughter it had been 115 days since the testosterone propionate pellets had been surgically removed.paddock until the

Experiment 2

One hundred and forty-eight high grade Brahman yearling steers of initial mean±sem weight 190±2.0 kg were purchased in August 1996 and grazed as one mob at Belmont. In the following October after significant seasonal rainfall they were divided randomly into five treatment groups so that the mean±sem liveweight was approximately the same for each group. Groups were assigned at random to one of the following treatments.

1. Unimplanted controls (n=29).

2. Oestradiol treatment once per year. Implanted with 20 mg oestradiol-17β (Compudose 100) at the beginning of the wet season in October 1996 and treated again with 20 mg oestradiol-17β at the beginning of the next wet season in December 1997. (n=29). Implants were removed after 100 days.

3. Oestradiol treatment all year. Implanted with 20 mg oestradiol-17β in October 1996 and reimplanted with 45 mg oestradiol-17β(Compudose 400) 100 days later in February 1997. This process was repeated with reimplantation with 20 mg oestradiol-17 β in December 1997 and with 45 mg oestradiol-17β in April 1998. (n=30). Old implants were removed before the new one was inserted

4. Androgen and oestradiol treatment once per year. Implanted with 40 mg trenbolone acetate plus 8 mg oestradiol-17β at the beginning of the wet season in October 1996 and treated again with 140 mg trenbolone acetate plus 28 mg oestradiol-17β (Revalor S® at the beginning of the wet season in December 1997. (n=30). Implants were removed after 100 days.

5. Androgen and/or oestradiol treatment all year. Implanted with 40 mg trenbolone acetate plus 8 mg oestradiol-17β at the beginning of the wet season in October 1996 and reimplanted with 45 mg oestradiol-17β 100 days later in February 1997. The process was repeated with reimplantation with 140 mg trenbolone acetate plus 28 mg oestradiol-17β in December 1997 and with 45 mg oestradiol-17β in April 1998. (n=30). Old implants were removed before new ones were inserted.

The duration of the experiment was 636 days. The steers were held in the one paddock throughout the experiment except for two periods during the dry seasons when they were moved to irrigated forage so that positive liveweight gains would be achieved. For nine weeks from July to September 1997 they grazed irrigated pasture and for three weeks in December 1998 they grazed irrigated forage sorghum. Cattle tick burdens were never of sufffcent magnitude to warrant treatment with an acaracide. Steers were weighed monthly. Blood samples from the same 10 animals in each treatment group were collected by venipuncture between days 45 and 55 in 100 day implant periods and at day 50 and at approximately 100 day intervals thereafter in the period between implantation with steroid formulations with a short functional life. The blood was placed in ice, allowed to clot and sera withdrawn and stored at –20^{0}C to await hormone analysis.

4.2 Slaughter and processing

Steers were slaughtered at the end of the experiment using commercial best practice procedures at an export-accredited abattoir. Low voltage electrical stimulation (2 mA for 40s) was applied to all carcasses immediately after exsanguination. Hot carcass weight was measured before chilling. After 24 h in the chiller, sides were quartered at the 12th/13th rib. Eye muscle area and P8 fat depths (Anon 1985) were measured 20 minutes after quartering. Seven cuts were boned-out from the left side of the carcass, trimmed to less than 3 mm fat and weighed. They were eye round, outside flat, knuckle, d-rump, striploin, tenderloin and chuck tender.

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4.2.1 Objective measurements of meat quality

Approximately 15 cm of the *m. longissimus dorsi* from the left side of each carcass, distal to where it was sectioned at the $12^{th}/13^{th}$ rib site, was trimmed of excess fat, weighed, blast frozen and stored at $-20^{o}C$ for subsequent meat quality analyses. The tenderness of cooked samples of *m. longissimus dorsi* was determined by objective measurements using *(a)* a modified Warner-Bratzler shear, and *(b)* instron compression following the established methods of Bouton and Harris (1972*a*, 1972*b*), Bouton *et al* (1975) and Bouton *et al* (1977). The measurements from modified Warner-Bratzler shear force deformation curves were (i) peak force, a measure of total toughness of meat; (ii) initial yield, an index of the myofibrillar contribution to meat toughness (Harris and Shorthose 1988); and (iii) the difference between peak force and initial yield, an index of the contribution of connective tissue to meat toughness (Harris and Shorthose 1988). All Warner-Bratzler measurements were recorded in kg, with higher values indicating tougher meat. Instron compression measurements were recorded to determine differences in connective tissue strength between muscles (Harris and Shorthose, 1988), with higher values indicating tougher meat. All meat quality measurements were made on samples from cooked ($70^{0}C$ for 1 h) 250 g blocks of muscle. Sarcomere length was determined by the method of Bouton *et al.* (1973).

4.3 Chemical and statistical analysis

The concentrations of steroid hormones in sera were determined by radioimmunoassay, oestradiol-17β by the method of Cox *et al.* (1987) and testosterone using a kit (Diagnostic Products Corporation, Los Angles). Data were analysed by ANOVA (Statistical Analysis Systems Institute 1992) with treatment (control vs. implantation) as the fixed effects. Final liveweight, liveweight gain and carcass weight were analysed with initial liveweight as a covariate. Objective measurements of meat quality and subjective eating quality assessments were analysed with carcass weight as a covariate.

4.4 Financial analysis

A financial analysis was undertaken by an independent consultant at the conclusion of the phase of scientific research. The consultant chosen had vast experience with northern Australian beef production systems and experience with integrating technological advances into existing property management. The approach taken by the project leader was to make all scientific information available to the consultant and to give the consultant complete independence to consider how best the technology would suit the northern beef production system and how best to evaluate its economic impact. The consultant's approach and method of the economic assessment of sustained growth promotion strategies are detailed in Appendix

1. On receipt of the consultant's report it was given to an agricultural economist and a beef producer for comment. Both signed off on the rigour of the approach, the validity of the assumptions made and the relevance of the conclusions.

5 RESULTS

5.1 Experiment 1

The pattern of liveweight gain over the 77 weeks of the experiment is shown in Figure 1. The steers treated with Compudose 400 and those treated alternately with Compudose 100 and either of the androgens gained significantly (*P*<0.001) more weight than the unimplanted controls, had significantly (*P*<0.001) heavier final liveweights and significantly (*P*<0.001) heavier carcass weights (Table 1). Treatment differences in dressing percentage and fat depth at the P8 rump site were not significant.

Figure 1: Liveweight gain of steers (experiment 1)

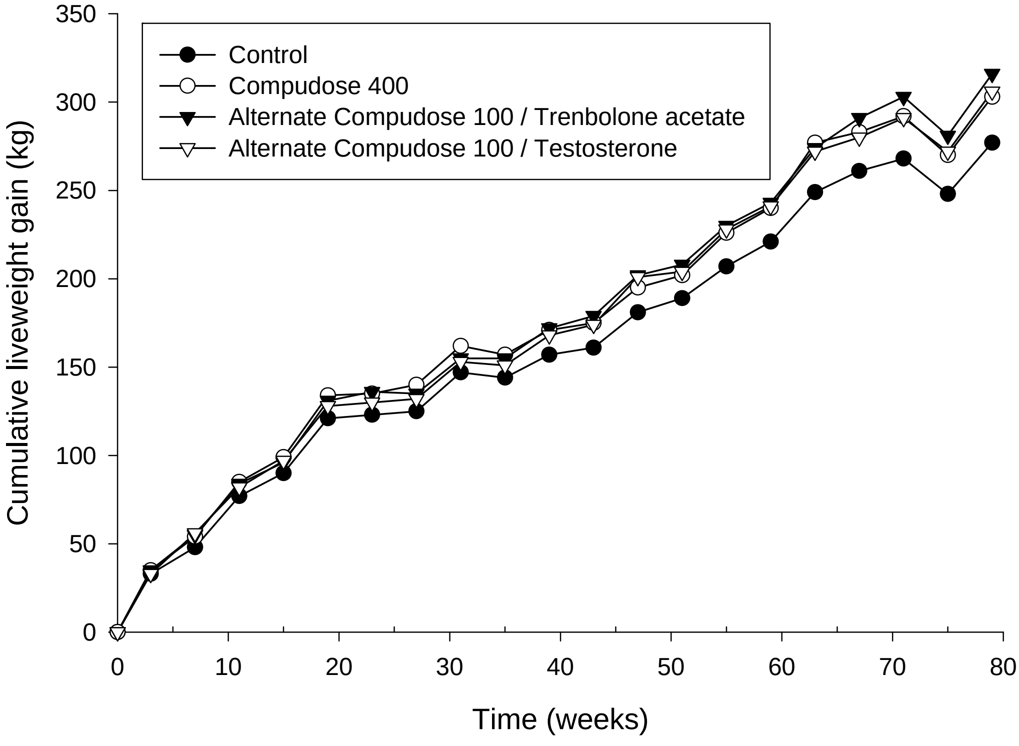


Table 2. The effect of alternate treatment with oestrogenic and androgenic growth promoting homones on weight gain and carcass characteristics of steers. (Experiment 1)
(Data were analysed with initial liveweight[1] or carcass weight[2] as a covariate)

	Control (n=30)	**Oestradiol (400 days) (n=27)**	**Alternate oestradiol/ trenbolone acetate (n=27)**	**Alternate oestradiol/ testosterone propionate (n=28)**	**Signif. of treatment**	**Signif. of covariate**
Final weight[1] (kg)	502 ± 5.4^a	521 ± 6.3^b	540 ± 5.7^b	531 ± 6.1^b	P<0.001	P<0.001
Weight gain[1] (kg)	277 ± 5.4^a	303 ± 6.3^b	316 ± 5.7^b	306 ± 6.1^b	P<0.001	ns
Carcass weight[1] (kg)	267 ± 3.2^a	279 ± 3.8^b	286 ± 3.4^b	280 ± 3.7^b	P<0.001	P<0.001
Dressing %[2]	51.2±0.24	50.9 ± 0.27	50.8 ± 0.25	50.6 ± 0.27	ns	P<0.001
P8 fat depth[2] (mm)	11 ± 0.6	10 ± 0.6	9 ± 0.6	9 ± 0.6	ns	P<0.001

Liveweight gains during the 5 implant periods are shown in Figure 2. During the first 15 weeks steers in the 3 groups treated with oestradiol grew at a faster rate than the controls. In the second 15 week period steers with a Compudose 400 implant grew at a faster rate than steers given a fresh implant of either trenbolone acetate or testosterone propionate. During the third period the highest growth rates were exhibited by steers given a new Compudose 100 implant. A new Compudose

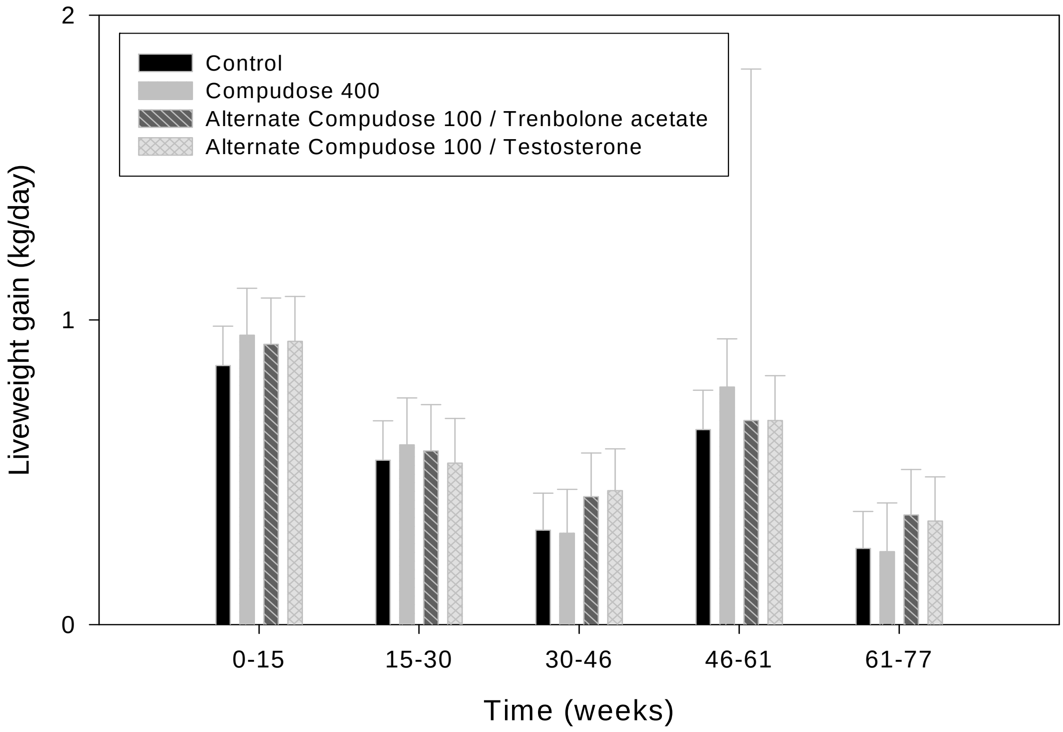


Figure 2: Liveweight gain of steers in each of the 5 implant periods (experiment1)

400 implant was administered during the fourth period and steers in this group gained more weight than their contempories given a new androgen implant. The growth responses in the final period were similar to those in period 3 when the fastest growth rates were by steers given a new Compudose 100 implant.

The mean±sem concentration of testosterone in sera of steers implanted with 353 mg testosterone propionate in the second implant period was 0.4 ± 0.04 ρg/ml. In period 4 when 10 times that dose was implanted, the serum concentration was 0.7± 0.08 ρg/ml. Testosterone concentration was below detectable limits in these two groups in other implant periods and in all other groups throughout the experiment. The mean concentration of oestradiol 17-β in serum of steers implanted with the 100 day implant containing 20 mg oestradiol 17-β varied between 6.1 and 9.6 ρg/ml. The mean concentration in steers implanted with 45 mg oestradiol 17-β in a 400 day implant decreased from 10.1 ρg/ml 55 days after implantation to 3.5 ρg/ml 270 days after implantation.

5.2 Experiment 2

Steers that were administered a 100 day implant during the wet season followed by a 400 day implant for the remainder of the year gained significantly (*P* <0.01) more weight and were significantly (*P* <0.01) heavier at slaughter than unimplanted controls (Table 2). The differences in weight gain and final liveweight between steers treated with oestradiol alone or a combination of oestradiol plus trenbolone acetate during the wet season were not significant. The weight gains and final liveweights of steers that received only one 100 day implant during the wet season were intermediate, but not significantly different, from the controls and those steers subjected to the more aggressive implant strategy.

Table 3. The effect of four strategies of growth promotion on growth rate and carcass characteristics of steers. (Experiment 2)

(Data were analysed with either initial liveweight[1] or carcass weight[2] as a covariate)

	Control (n=29)	**Oestradiol (wet season) (n=29)**	**Oestradiol/ oestradiol (all year) (n=30)**	**Trenbolone acetate + oestradiol (wet season) (n=30)**	**Trenbolone acetate + oestradiol/ oestradiol (all year) (n=30)**	**Signif. of treatment**	**Signif. of covariate**
Final weight[1] (kg)	506± 7.2[a]	522 ± 8.7[ac]	532 ± 7.9[bc]	516 ± 7.3[ac]	535 ± 6.1[bc]	P<0.01	P<0.001
Weight gain[1] (kg)	287±4.9[a]	303 ± 6.8[ac]	313 ±5.9[bc]	297 ± 7.0[ac]	316 ±6.7[bc]	P<0.01	ns
Carcass weight[1] kg	266 ± 4.0	272 ± 5.1	281 ± 4.1	273 ± 3.7	271 ± 3.2	ns	P<0.001
Dressing %[2]	52.2±0.01	52.6±0.01	52.3 ±0.01	52.8 ± 0.02	50.8 ± .01	ns	P<0.001
P8 fat depth[2]	10.1± .68	10.3±0.61	8.6 ± 0.51	8.9 ± 0.68	9.6 ± 0.74	ns	P<0.05
Eye muscle area[2]	71 ± 1.3	68 ± 1.3	70 ± 1.1	70 ± 1.2	70 ± 1.6	ns	P<0.001
Wt of 7 muscles[2] (kg)	9.7± 0.12	9.8 ± 0.08	9.7 ± 0.08	9.7 ± 0.07	9.6 ± 0.09	ns	ns

The patterns of liveweight change are shown in Figure 3. Steers implanted twice a year maintained their liveweight gain advantage over the controls throughout the experiment. Steers implanted only once a year grew more rapidly when the implant was intact, but that liveweight advantage was eroded during the remainder of the year to the extent that their liveweight was similar to the controls at the time of implantation the next year. Carcass weight was not significantly affected by treatment.

The effect of steroid treatment on some measures of carcass composition and some objective measures of meat quality were examined after adjusting the data to a common carcass weight. These analyses indicated that steroid treatment *per se* had no significant effect on carcass yield or carcass fatness (Table 3). Similarly, objective measures of meat toughness/tenderness and concentration of intramuscular fat were not significantly affected by steroid treatment.

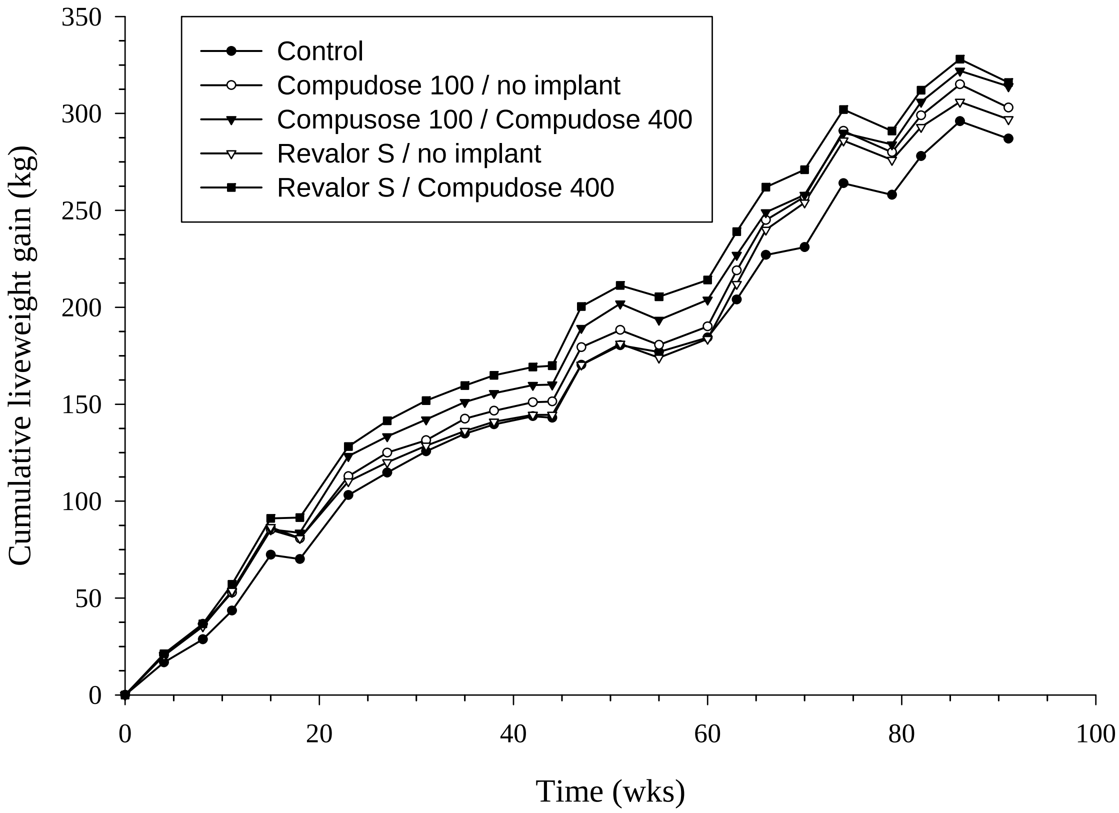


Figure 3: Liveweight gain of steers (experiment 2)

Table 4. The effect of four strategies of growth promotion on objective measurements of meat quality of the *Longissimus dorsi*. (Experiment 2)

(Data were analysed with carcass weight as a covariate)

	Control (n=29)	**Oestradiol (wet season) (n=29)**	**Oestradiol/ oestradiol (all year) (n=30)**	**Trenbolone acetate + oestradiol (wet season) (n=30)**	**Trenbolone acetate + oestradiol/ oestradiol (all year) (n=30)**	**Signif. of treatment**	**Signif. of covariate**
Sarcomere length (μm)	1.8 ± 0.02	1.8 ± 0.03	1.8 ± 0.02	1.8 ± 0.02	1.8 ± 0.02	ns	ns
pH	5.6 ± 0.02	5.4 ± 0.17	5.6 ± 0.01	5.6 ± 0.01	5.6 ± 0.02	ns	ns
Peak force (kg)	6.3 ± 0.45	5.9 ± 0.21	6.2 ± 0.29	6.2 ± 0.18	5.9 ± 0.24	ns	ns
Initial yield (kg)	3.6 ± 0.12	3.6 ± 0.12	3.5 ± 0.14	3.6 ± 0.10	3.5 ± 0.14	ns	ns
PFIY (kg)	2.7 ± 0.41	2.4 ± 0.16	2.7 ± 0.21	2.6 ± 0.17	2.4 ± 0.16	ns	ns
Compression (kg)	2.0 ± 0.05	2.0 ± 0.04	2.0 ± 0.05	2.1 ± 0.05	2.0 ± 0.03	ns	ns
Cooking loss (%)	22.5 ± 0.30	22.7 ± 0.27	22.4 ± 0.25	21.9 ± 0.31	22.2 ± 0.27	ns	ns
Intramuscular fat (%)	1.7 ± 0.14	1.7 ± 0.17	1.8 ± 0.14	1.6 ± 0.15	1.5 ± 0.13	ns	ns

6 SYNTHESIS OF RESULTS AND CONCLUSIONS

The approach taken in this programme was initially to demonstrate that sustained growth promotion could be achievedfor extended periods of time. This was accomplished using the very aggressive strategy of treatment with an HGP every 100 days. The next challenge was to understand the factors governing the magnitude of the improvement in liveweight gain so implantation strategies suitable for the northern Australian beef production system could be developed. The series of experiments conducted in this MLA project and the companion Meat Quality CRC project has allowed elucidation of a number of scientific principles that govern the liveweight response to treatment with anabolic steroids and the impact of that treatment on some measures of product quality. These are listed below. They provide guidelines that beef producers can use to develop commercial implant strategies specific to particular geographic regions, particular animal management systems and particular market requirements.

- The more frequently steers are reboosted with a new implant the greater the response in liveweight gain.
- Sustained growth promotion can be achieved by repeat implantation with oestrogenic hormones or by alternate treatment with an oestrogen followed by treatment with a combined implant containing both an oestrogen and an androgen. Sustained growth promotion at a reduced rate of response can also be achieved by use of a long acting implant.
- Once an implantation programme has been commenced it should be continued through to slaughter.
- Under the pastoral conditions of northern Australia, steers with a single implant containing only an androgen are unlikely to exhibit accelerated growth.

- Greater responses in liveweight gain are achieved when steers are continually in positive energy balance than when they experience periods of weight stasis or weight loss.
- Frequent treatment with oestrogenic hormones or a twice yearly strategy involving alternate use of a combined implant (oestrogen plus androgen) followed by an oestrogen does not alter carcass composition of steers, provided comparisons are made at the same carcass weight.
- Repeat implantation with implants containing an androgen may lead to a reduction in carcass fatness (Tudor *et al.* 1992).
- The more aggressive the implant strategy the higher the likelihood of an increase in meat toughness.

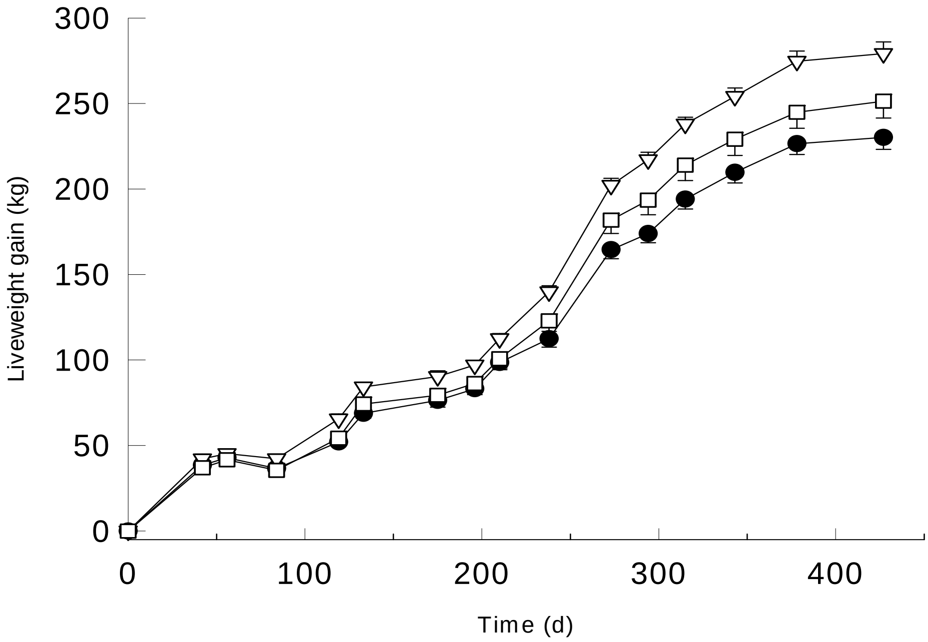
The experimental results on which these principles are summarised below.

6.1 Frequency of implantation and growth rate response

Table 5 collates the additional annual liveweight gain that has been observed in separate experiments in the MLA and CRC projects when the growth rate of steers implanted once, twice or four times per year were compared with the growth rates of unimplanted controls. In all these experiments, steers went through the normal northern Australian seasonal conditions of wet and dry seasons. It is clear that the annual liveweight response to implantation was highest when implantation was more frequent.

Table 5: Effect of frequency of implantation on additional annual liveweight gain of steers

Implantation frequency	Additional annual gain
4 times a year (4x 100 day implants)	**30 kg**
2 times a year (1x 100 day and 1x 400 day)	**18 kg**
1 time a year (1x 400 day implant)	**11 kg**



5. Figure 4: Liveweight gain of steers. • Control, □ Compudose 400, ∇ Repeat Compudose 100

This effect is also obvious from an experiment at Belmont in which steers were treated with Compudose 100 every 105 days, or treated once with Compudose 400 or left as untreated controls. In that experiment, steers remained in positive energy balance through use of irrigated pasture during periods when they would have lost weight on dryland pasture. Over the 420 days of the experiment the anabolic response to the 4 implant strategy was twice that of treatment with a long acting implant (Figure 4).

6.2 Repeat implantation or alternate treatment with different products

Experimentation under northern Australian grazing conditions has conclusively shown that repeat implantation with Compudose achieves sustained growth promotion provided steers are in positive energy balance. Implants containing only an androgen alone (trenbolone acetate or testosterone) are not useful for alternate use with oestrogenic implants. We have found that both trenbolone acetate (Figure 2, implant periods 2 and 4) and testosterone propionate do not promote growth at the growth rates typical of northern Australian pastoral conditions. This is in contrast to their effect on growth rate of steers fed high-energy diets. There is evidence from the scientific literature that while androgenic implants promote growth accelerated gains in steers already gaining at >1 kg/d (Hale and Oliver 1973: O'Kelly 1985) they are ineffective when gains are less than 0.6-0.8 kg/d (Hale and Oliver 1973; Edwards *et al.*1979).

Alternate implantation with a combination of both an oestrogen and an androgen, followed by implantation with an oestrogen alone does achieve sustained growth promotion. (Figure 3).

6.3 Continuous v interrupted implant strategy

Once an implantation programme has commenced it should be continued. In experiment 2 above, the liveweight advantage of steers implanted only in the wet season with a 100 day implant was eroded by the commencement of the next wet season. Steers implanted with a 100 day implant in the wet season and a 400 day implant for the remainder of the year continued to out-perform their unimplanted counterparts. This is shown in Figure 5 which contain subsets of the data from Figure 3.

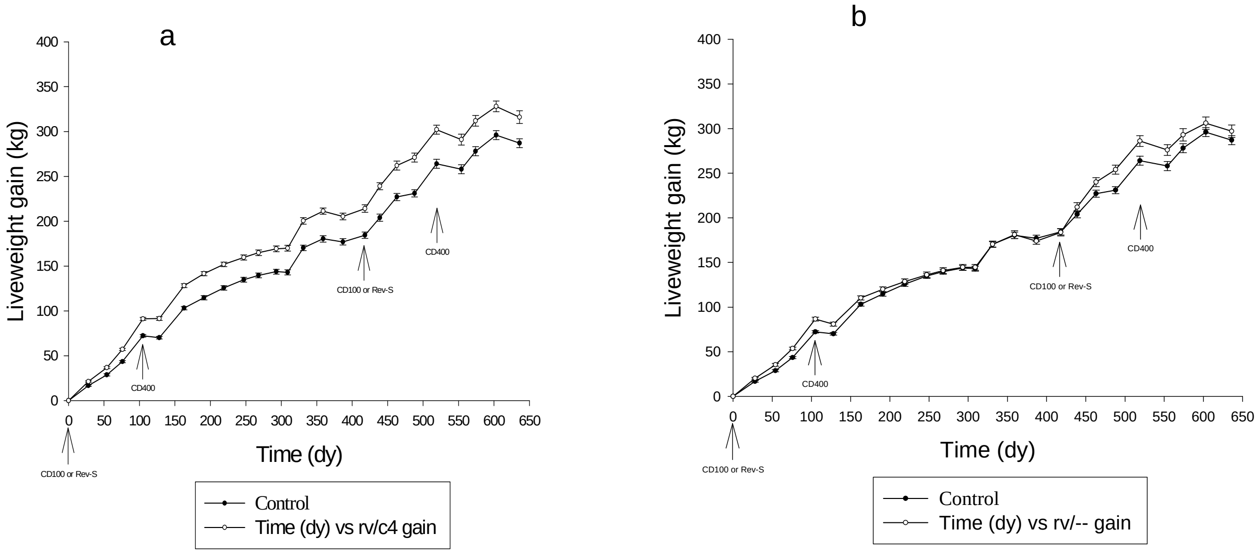


Figure 5: Liveweight gain of steers implanted for the whole year (a) or implanted only for 100 days in the wet season (b)

6.4 Nutritional status and anabolic response

The magnitude of the anabolic response is greatest when steers are on a moderate to high plane of nutrition. Consequently the liveweight gain responses will be greatest in years with long growing seasons or in situations where supplementary feed is provided during the dry season. Table 6 shows the additional annual liveweight responses to sustained growth promotion strategies that were recorded in the MLA and CRC projects in situations of continuous growth and situations where growth was arrested in the dry season.

Table 6: The effect nutritional status on the annual anabolic response

Implant frequency	Nature of growth	Additional annual liveweight gain (kg)
4 implants per year	Continuous growth	37
4 implants per year	interrupted 1 dry season	29
4 implants per year	interrupted 2 dry seasons	26
1 implant per year	continuous	18
1 implant per year	interrupted	11

6.5 Sustained growth promotion and carcass composition

It was shown that treatment with Compudose every 100 days throughout the experimental programme did not alter the fatness of carcasses compared at the same carcass weight. Steers treated repeatedly with Compudose were fatter at slaughter because they were heavier and more mature, not because the hormone altered the ratio of fat to lean. Likewise, a twice yearly implant strategy of Compudose 100 or Revalor in the wet season, followed by Compudose 400 for the remainder of the year had no effect on carcass fatness when comparisons were made at the same carcass weight (Table 3). It is well established that androgen treatment of steers results in leaner carcasses. In an experiment in northern Australia, repeat implantation with Revalor (trenbolone acetate plus oestradiol) decreased the depth of P8 rump fat of steers (8mm vs 12 mm) (Tudor *et al.* 1992). Although it was not measured in this experimental programme, it seems reasonable to conclude that repeat implantation with products containing trenbolone acetate are likely to decrease carcass fatness.

6.6 Sustained growth promotion and eating quality

Laboratory measurements of meat tenderness could not detect differences in tenderness/toughness between steers implanted once or twice a year and steers that were not implanted. Only when 4 implantations per year were used was a small increase in toughness detectable (Table 7). This decrease in tenderness was confirmed by consumer tasting. MSA evaluation showed that consumers had a slight but distinct preference for steaks from non-implanted steers (Table 8). In this CRC experiment (4 implantations per year) steers were slaughtered on the same day which means that the implanted steers were substantially heavier and probably at a more advanced state of maturity. The MSA ossification scores (Table 8) provide evidence that the heavier implanted steers were physiologically more mature than their unimplanted counterparts. Whether the association between sustained growth promotion and a decrease in eating quality in pasture fed steers in northern Australia is of practical significance is debatable because it is unlikely that steers would routinely be implanted 4 times per year.

Table 7: Effect of frequency of implantation on Warner-Bratzler shear force (kg) of muscle.

Implantation frequency	Control	Implanted	Reference
1 long acting implant per year	5.1	5.5	Hunter *et al*. (2000a)
2 implants per year	6.3	6.2, 5.9	Hunter *et al.* (2001)
4 implants per year	4.3 4.7 6.0	4.8* 5.4* 6.3	Hunter *et al.* (2000b)

*Statistically significant difference, P<0.05,

Table 8: Meat Standards Australia eating quality of steers implanted with Compudose 100 every 100 days

	Control	Implanted
Tenderness	50	44**
Flavour	52	49**
Juiciness	50	47**
Overall acceptability	50	46**
CMQ4	50	46**
Ossification	150	166**

*Statistically significant difference, P<0.01

6.7 Financial analysis

A strategy of three implantations per year, two of 100 days duration during the wet season and a 200 day implant for the remainder of the year was modelled to determine the economic viability of the strategy. The economic benefits of finishing steers off pasture for the domestic, Korean and Japanese markets were assessed. The net increase in return per head, excluding mustering costs, varied between $22 and $33 (Appendix 1). The strategy would be profitable for many beef enterprises in northern Australia.

6.8 Conclusion

Sustained growth promotion is a useful new technology for the northern beef industry. Annual liveweight gain responses of greater magnitude than those being currently recorded by industry through HGP use have been achieved. Sustained growrth promotion is not a replacement for HGP strategies already in use, but rather is an additional strategy for producers who want further increases in annual liveweight gain and younger age of turn-off at a particular market weight. It is likely to be a profitable strategy on properties where and mustering costs do not exceed $5 per head, on the assumption that cattle are mustered solely for the purpose of implantation (Appendix 1). Handling solely for hormonal treatment would not be the norm as at least one implantation could be combined with a routine muster for other husbandry purposes.

7 SUCCESS IN ACHIEVING OBJECTIVES

The contract with MRC had the following as the objectives:

To demonstrate that sustained growth promotion between weaning and slaughter can be achieved.

To determine the effect of the strategy on commercial carcass value.

To quantify the magnitude of the response in weight gain and carcass yield so the economic value of the strategy can be assessed.

Details given in previous sections of this report support the assessment that the objectives of this project, as set initially, were met. The complementary CRC project and the development of the MSA consumer tasting programme not only permitted additional experiments to be conducted, but also provided the opportunity to have eating quality of beef assessed by consumers in a structured and scientifically meaningful way. Thus value was added to the MLA project. This was not envisaged when the MLA project commenced. In addition a financial assessment by an independent consultant was commissioned. This was not in the contractual arrangements between MRC and CSIRO.

8 IMPACT ON MEAT AND LIVESTOCK INDUSTRY

Before the commencement of this project, the support of the major manufacturers and marketers of HGP’s in Australia was achieved. They were enthusiastic about their proposed role in assisting with industry adoption of any useful technologies. They have been kept informed of progress throughout. Towards the end of this project representatives of Elanco Animal Health, Probeef Australia, Intervet and QDPI extension service met with programme managers from MLA and the principal investigator from CSIRO to plan a technology transfer strategy for the results of this project. It was decided that the sustained growth promotion strategies should be integrated into a communication and education package on the use of HGPs in the Australian beef industry. The target audience in the first instance will be beef producers, with other segments of the beef supply chain being included in second phase communication.

The potential impact of the sustained growth promotion technology on the northern beef industry is substantial as annual liveweight gains can profitably be increased by up 40 kg. However it is preferable that sustained growth promotion not be used in isolation, but rather as a component of an overall improved management package aimed at reducing age of turn-off and meeting the specifications for higher value markets. Other components of improved management could include superior genetics and better nutritional management, linked to market end points. Haug (1996) demonstrated increased profitability of northern beef production enterprises that increased throughput of animals by substantially reducing age of turn-off. Sustained growth promotion is one of a smorgasbord of technologies available to assist the beef producer who wants to achieve the specifications for a premium market on time.

9 CONCLUSIONS AND RECOMMENDATIONS

This project has achieved its objectives. Accelerated growth rates have been demonstrated from between weaning and slaughter. The effects of repeat implantation on carcass composition and meat quality have been defined. An independent financial analysis has shown the commercial situations where adoption of the technology would be profitable. In addition, the scientific principles that govern the magnitude of the increase in growth rate have been established. This understanding means that reasonably accurate predictions can be made about the growth rate, carcass and meat quality responses to treatment in any beef production system where some of the production variables are known. Thus, application of the findings of this project are not confined to environmental locations similar to those under which the project was conducted.

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11 APPENDICES

APPENDIX 1 FINANCIAL BENEFIT OF HGP TREATMENT OF PASTURE FININSHED STEERS IN NORTHERN AUSTRALIA

Prepared by: SILLAR ASSOCIATES April, 2000

A1. INTRODUCTION

The use of hormonal growth promotants (HGPs) to increase liveweight gain and reduce the age of turn-off of steers is widespread in the northern Australian beef industry. A CSIRO northern beef industry survey[1] indicates that 50% of surveyed properties currently use HGPs. This is substantially more than the 18% usage reported a decade ago (Northern Beef Industry Survey 1990[2]).
For beef cattle on pastures, steers, rather than any other class of animal, are the recipients of HGPs (*Fig 1.1*). HGP usage varies between regions although perhaps not as markedly skewed to 'finishing' regions as might be expected. (*Fig 1.2*).

Figure 1.1
% of Properties Using HGPs on Class of Animal in Northern Australia (source: Bortolussi et al)

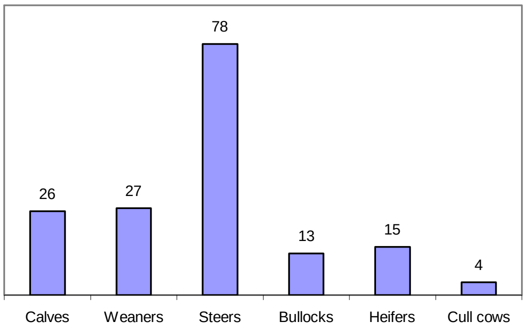
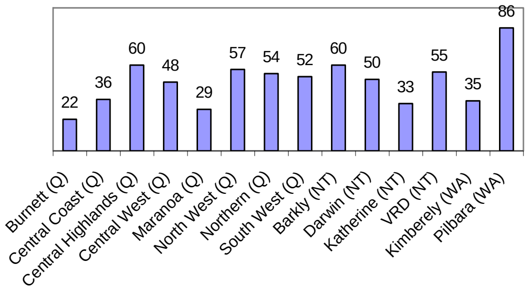


Figure 1.2
% of Properties Using HGPs by Region in Northern Australia (source: Bortolucci et al)



1 G. Bortolussi et al (1999) Report on the Northern Australian Beef Industry Survey. CSIRO Div. Tropical Agriculture
2 P.K.O'Rourke et al (1990) North Australian Beef Producer Survey. MRC

For cattle entering feedlots, HGP treatment at induction is common practice unless EU markets (which ban the use of growth promotants) are specifically targeted. For pasture finished animals in northern Australia, recent research conducted by R.A. Hunter *et al.* [3] suggests possible strategies for optimising growth from the use of HGPs on steers being finished for specific markets. This document analyses the likely financial return from a number of HGP treatment strategies for steers being grown-out and finished under different pasture/nutritional regimes in northern Australia.

A1.2 REGISTERED HGPs ON THE AUSTRALIAN MARKET

A range of HGP products is available on the Australian market. Steers or heifers respond to the use of HGPs but require different product formulations. Different products are designed to have a different functional life (e.g. 100, 200 or 400 days) although the efficacy of longer acting products is never as good as the shorter acting products. HGPs comprise two groups of hormones: oestrogenic (female) and androgenic (male). Australian registered products include oestrogenic only formulations or an admixture of oestrogentic and androgenic hormones. Formulations for the treatment of heifers contain more androgenic hormone. Australian registered HGP products classified by component hormone and functional life are shown in *Table 1*.

Table 1: **Component Hormone and Functional Life of Various HGPs Registered in Australia**

Hormone	**Functional Life (days)**	**Target Animal**	**Product**
Oestradiol	100	steer	Compudose 100 Component S Progro S Ralgro Steerex Synovex S
Oestradiol	200	steer	Compudose 200
Oestradiol	400	steer	Compudose 400
Oestradiol + trenbolone acetate	100-150	steer	Component TES Progro TES Synovex plus Revalor G and S
Oestradiol + testosterone	?	heifer	Implus Synovex H

A1.3 BIOLOGICAL RESPONSE OF STEERS TO HGPs

[3] Hunter, RA, McCrabb, GJ, Burrow, HM (1999) Sustained growth promotion, carcass and meat quality of steers slaughtered at three liveweights Aust. J. Exp. Agric. **39**, 000-000
Hunter, RA, Magner, T, Allingham,PG (1999?) Sustained growth promotion, carcass characteristics and meat quality of steers treated with oestradiol-17ß

- For HGPs to be effective animals need to be in positive energy balance. During periods when animals are around liveweight maintenance or in a liveweight loss situation, growth promotion with HGPs does not work.

- HGP implantation improves live weight gain and increases lean:fat ratio. Market specifications for P8 fat and marbling need to be considered and may require withholding HGP treatment in the final finishing phase to achieve some market fat specifications with particular breeds and classes of animals.

- Provided the steers remains in positive energy balance (e.g. daily live weight gain > 0.6kg/day), HGPs will improve growth throughout the whole period from weaning to slaughter.

- The frequency of HGP implantation affects the response. Maximum daily gain with high lean:fat ratios are achieved for the 50 to 70 days after implantation. After 70 to 120 days the effect of the implant becomes minimal and the lean:fat ratio of the animal returns to normal. High-dose HGP products designed to have a long, 400-day functional life (e.g. Compudose 400 ®) do not achieve as high an overall growth rate as repeated administration of low-dose products designed to have a short, 100-day functional life (e.g. Compudose 100 ®) provided the animals remain in positive energy balance.

- For the typical interrupted growth pattern of steers grazing unsupplemented pasture in northern Australia, destined for markets requiring more than one year to finish, an HGP strategy of treating steers only at the beginning of the first wet season with one implant of 100-day functional HGP is ineffective and the weight advantage is lost by the end of the second wet season. To optimise weight gain in this situation requires a 2 or 3 dose/yr strategy whereby 1 or 2 short-acting implants are made during the wet season followed by a long-acting implant at the beginning of the dry season.

- Some undesirable side effects may occur in cattle implanted with HGPs such as preputial prolapse or 'tipping' (tip of penis protruding from sheath) and increased incidence of male characteristics which may reduce market value at auction. The incidence of these side effects is negligible in a well managed program.

Two recent trials have measured the quantum of liveweight gain and carcase change in HGP treated steers in central Queensland. (see results reproduced in *Appendix A and B*). For the purpose of this financial analysis, a simplified summary of the biological response in these two trials is shown in *Table 2*.

Table 2: Increased liveweight of steers at slaughter repeat treated with 100-day functional life HGP for three markets

Market	Months implant effective	No. of implants	Nutritional Regimes	
			Continual growth liveweight advantage (kg)	Interrupted growth liveweight advantage (kg)
Domestic	7	2	30	30 *
Korean	15	4	49	36
Japanese	22	6	60 **	47

* Trial gains measured over Dec/Jul period during which growth interruption does not normally occur.

** Imputed from interrupted growth trial data pro-rata to Korean lwgt gain differential.

'Interrupted' growth in these data represent the growth which occurs on buffel grass growing on Brigalow soils in the Emerald district and therefore a good quality tropical pasture capable of delivering 180 kg/year liveweight gain.

A1.4 COMMERCIAL APPLICATION ISSUES

Implant Operation

All currently registered HGPs are administered as ear implants and implanted cattle are legally required to be permanently identified with a triangular earmark in the off ear. The implanting operation generally requires the animal to be constrained in a head-bale.

The task requires some care and to avoid infection the implant gun needs to be kept free from contamination. In a commercial situation, constrained by availability of labour and time imperatives, implant failures and infections have been estimated at between 2% and 15% by cattlemen familiar with the use of HGPs in northern Australia.

The time taken to administer one implant is likely to vary substantially depending upon the yard design and availability of labour. Given a separate person is available for pushing-up cattle and a modern veterinary crush is used, it is estimated that diligent HGP implanting and ear-tagging could be expected to take, on average, 45 to 60 seconds per animal. At casual labour costs of say $15/hour the labour cost of an HGP implant is assumed to be 25 cents/implant.

Mustering Difficulty and Cost

Mustering difficulty and cost, particularly on large northern beef cattle properties, is likely to be an impediment to HGP treatment strategies to maximise biological response. Obviously, the mustering impediment will vary substantially depending upon the nature of the country, size of paddocks, use of mustering aids (e.g. laneways, traps/spears) and herd management (e.g. segregation of steers by age group). Survey data (*Fig 1.1*) suggests that on some properties, particularly in the extensive areas, animals are treated with HGPs when they are routinely mustered (e.g. branding, weaning).

As a generalisation, on better-pastured growing-out and finishing country, paddocks are likely to be smaller and the attendant impediment to mustering less. However, unless steers require dipping for ticks during the wet season, routine mustering is unlikely to occur at the beginning of, during, and at the end of, the northern wet season which are the optimum times for HGP treatments. An important HGP usage dilemma for many property owners will therefore be whether the benefit in terms of animal response is sufficient to warrant a special muster. From the point of view of a generic analysis of the financial return from HGP treatment of steers, the variability in the cost of mustering is too great to enable a definitive answer. A break-even cost of mustering for the purpose of HGP treatment is presented.

The Nature of the Farm Business Benefit of HGP Treated Steers

From a holistic farm business perspective, the two possible beneficial outcomes from HGP treatment of steers are:

(a) heavier and more valuable carcases produced over the same period of time as untreated animals, or

(b) earlier turn-off to meet a specified market weight and an attendant release of a forage resource.

These outcomes are not necessarily mutually exclusive.

These outcomes raise questions about: (a) target market specifications and likely penalties for overweight cattle, and (b) the net feed resource consumed with and without HGP treatment and the opportunity cost of the surplus forage realised from the earlier turnoff.

Market Specification Issues

Maximum weights do not apply to carcases destined for the Japanese grassfed fullsets but do apply to Korean grassfed quarter beef and the domestic market standard carcase. (see *Appendix C*). Thus to evaluate an HGP program for an enterprise targeting the Japanese grassfed market, the benefits can be simply registered as more carcase beef from an essentially 'resource neutral' situation. For the maximum-weight-specific Korean and domestic markets, faster growing animals must be turned off earlier to hit market specifications and the attendant whole-farm benefit of an HGP program realised as the incremental return from the surplus forage resource.

Net Feed Resource Surplus

When HGP treatment results in steers being turned-off earlier it generates a surplus of cattle feed which might be used for other purposes or preclude the purchase of feed which otherwise would have been required. In this case, in terms of evaluating the potential financial benefit of HGP treatment, it is important to know firstly, the quantity of the forage resource made available by an earlier turn-off and, secondly, if and how the farm business utilises the generated surplus feed resource.

(a) Quantity of surplus forage

The author is not aware of any documented information on the quantity of surplus forage generated by HGP treatment. Here a method for estimating the potential feed surplus is proposed. For each of the considered HGP treatment strategies, a feed surplus estimate is made and translated into an increase in carrying capacity. (see *Appendix D*)

Basically, in terms of beef cattle nutrition, feed energy intake is channeled into either *production* or *maintenance*. A reasonable assumption in the context of 'with' and 'without' HGP treatment is that the energy required for *production* will be constant (given the same end-weight), but *maintenance* energy requirement will vary according to the time taken to reach the target weight. *Table D.1, Appendix D* shows the total, and maintenance, energy requirements of animals slaughtered for three target markets (Domestic, Korean and Japanese) given different annual average, whole-of-life liveweight gains[4]. Given the annual equivalent liveweight gain of cattle for a fixed market end-weight, incremental maintenance energy (i.e. with and without HGP treatment) is derived by plotting maintenance energy requirement and against liveweight gain from *Table D.1*. Applying the total energy required to finish one animal at the respective studied nutritional levels (e.g. 'interrupted' or 'continuous' growth on buffel grass), the number of extra animals which could be finished in the system has been calculated as shown in *Table 3*.

(b) Farm business utilisation of surplus feed

Whether or not a farm business is able to exploit the marginal increase in carrying capacity is a moot point. *Table 3* shows that carrying capacity of a HGP treated mob could be theoretically increased by 2.2 to 4.8% for the considered array of markets and nutritional regimes. No survey data is available to indicate how, or if, producers exploit HGPs in this way.

It is suggested that if a producer knew the magnitude of the likely carrying capacity increase before HGP treatment, then it is more likely that the producer would up-front commit more cattle to a finishing paddock. It is speculated that where maximum weights apply to a market specifications (e.g. Domestic and Korean) there is a greater incentive to realise the benefit of HGP treated mobs with an input of additional cattle. It is assumed, for this analysis, that surplus feed would be utilised with an input of additional purchased steers, rather than an increase in breeder cow herd in a mixed breeding/finishing enterprise because, in practice, the 'bullock' paddock is finite and stocking rate cannot be marginally increased or decreased without new fencing.

Table 3: Estimated Carrying Capacity Increase as a Result of HGP Use

	Domestic		Korean		Japanese	
	IG*	CG**	IG	CG	IG	CG
Age animal start HGP (mths)	15	15	15	15	15	15
Age at sale (mths)	22	22	30	25	37	32
Avg. annual equiv. LWG before HGP use (kg/yr)	230	230	186	238	179	211
Avg. annual equiv. LWG with HGP use (kg/yr)	285	285	215	293	204	266
% of life on HGP	32%	32%	50%	40%	59%	53%
Avg. annual equiv. LWG whole-of-life (kg/yr)	247	247	201	260	194	240
Maintenance energy not needed due to earlier turnoff (MJ)	1500	1500	1500	1300	2000	1500
Lifetime total energy required to produce animal (MJ x 1000)	32.0	32.0	53.8	51.0	72.3	67.0
Proportional increase in no. animals carried due to HGP	**1:21 (4.8%)**	**1:21 (4.8%)**	**1:36 (2.8%)**	**1:39 (2.6%)**	**1:36 (2.8%)**	**1:45 (2.2%)**

* IG = ' interrupted growth', that is no dry season supplementation

** CG = 'continuous growth', that is with dry season supplementation of buffel grass pasture

A1.5 CONSIDERED HGP IMPLANTATION STRATEGY

[4] Source: R.A. Hunter. Note: "whole-of-life average liveweight gain" refers, in this case, to the weighted average annual liveweight gain of animals before and after they were on HGP treatment.

The liveweight gains used in this analysis are based on the 'Duckpond' trial in the Central Highlands of Queensland. In this trial HGP was repeated every 105 days throughout the year. The financial analysis in this report assumes a '3-implant' strategy involving two 100-day implants in November and February and a 200-day implant in May and repeated in the second year, depending upon the market. This strategy is assumed to achieve essentially similar results to the 'Duckpond' trial response.

A number of alternative strategies could be envisaged depending upon the management circumstances of individual properties. For example, where mustering is more difficult, a '2-implant' strategy could be envisaged involving one 100-day implant in November followed by a 400-day implant in February. A 2-implant strategy would produce a lower liveweight gain than a 3-implant strategy. Other possible strategies involving treatment of calves at branding or treatment of weaned cattle at the beginning of the first dry season have not been considered.

A1.6 FINANCIAL ANALYSIS

Approach

HGP treatment of steers involves a relatively minor change in farm management and asset base and therefore can be evaluated using a partial budget technique, rather than a whole farm budget. A partial budget involves the evaluation of the marginal cost of steers being HGP treated compared with the marginal benefits therefrom.

Steers produced off grass for three markets (Domestic, Korean and Japanese) are considered using one implantation strategy of two wet season 100-day implants, followed by one 200-day dry season implant. For steers targeting the domestic market, only two wet season implants are applied. For cattle targeting the Korean market, 4 implants are costed (2 in first wet season, 1 during the dry season and 1 in the last wet season). For the Japanese market six implants are considered comprising 2-1-2-1 implants respectively over the wet-dry-wet-dry seasons. Steer production under two nutritional regimes ('interrupted' growth = no dry season supplementation and 'continuous' growth = dry season supplementation) has been analysed.

The marginal benefits of HGP treatment include: (a) increased revenue from the increased carrying capacity resulting from an earlier turn-off and (b) interest saved due to an earlier turn-off date. The marginal costs include: (a) reduced revenue due to some implant failures, (b) the cost of the implant and its application, the interest on the capital borrowed to buy extra cattle to utilise the additional carrying capacity.

Another major marginal cost, but one which is likely to vary substantially under different farm management structures is the cost of special musters required for timely application of HGPs. The wide variation in mustering costs in northern herds make it pointless to develop a generic financial model for HGP useage. In this analysis a net return on the marginal investment <u>excluding</u> the cost of mustering is generated. A break-even cost of mustering in generated for each implantation scenario.

Standard assumptions made are: (a) interest rate 10%pa, (b) sale and purchase price of steers is \$1.30/ kg LW net of transport and market costs, (c) cost of implants \$1.50 and \$3.50 each for 100-day and 200-day implants respectively, (d) yard labour cost on implanting and eartagging is \$0.25 each, and (e) HGP failure rate 2%. These are considered to be 'good operator' values for the northern cattle industry.

Results

Partial budgets for six grass finishing scenarios are shown in *Appendix E*.

A summary of results is shown in *Table 4*. For the range of HGP treatment scenarios considered, this analysis shows that in the least profitable HGP situation (Japanese ox on interrupted growth pasture) mustering costs have to be greater than $5.06 per head per muster to make HGP treatment unprofitable. In the most profitable situation (domestic steer production) the cost of mustering has to be greater than $13.18 per head per muster before treatment becomes unprofitable. For the Korean steer production the profitability is between the Japanese ox and the domestic steer.

However, an important assumption is that the producer will utilise the extra carrying capacity realised by an earlier turn-off of HGP treated steers by actually putting more stock on at the beginning of the finishing period. If this is not done then the net benefits are substantially reduced for all scenarios (*Table 4*) and the break-even cost of muster falls dramatically, ranging from $1.32/head/muster for the Korean, continual growth scenario to $2.76/head/muster for Japanese ox, continual growth scenario.

Table 4: Financial Return from HGP Implantation of Steers in Northern Australia

Scenario	**Net change in return (added returns – added costs excl. mustering)** ($/head)	**Net change in return as % of additional costs \1** (%)	**Cost of each muster at which HGP implantation breaks even** ($/head)	**Net change in return as % of additional costs if benefit of increased carrying capacity is NOT utilised \1** (%)
Domestic steer; interrupted & continual growth	$26.35	516%	$13.18	79%
Korean steer; interrupted growth	$25.41	238%	$6.35	77%
Korean steer; continual growth	$22.34	212%	$5.59	60%
Japanese ox; interrupted growth	$30.35	176%	$5.06	60%
Japanese ox; continual growth	$33.36	197%	$5.56	109%

\1 without mustering costs

A1.7 CONCLUSIONS

Utilising the extra carrying capacity brought about by earlier turn-off of quicker growing HGP treated steers is the cornerstone to fully exploiting the commercial profitability of the technology. This requires an up-front decision to increase stocking rate in grow-out and finishing paddocks. This evaluation suggests the level of stocking rate increase which should be possible using HGPs on steers under a number of finishing scenarios for steers on buffel pasture with and without dry season supplementation in northern Australia. In the future, producers armed with knowledge of the possible increases in stocking rates should be better able to take full commercial advantage of the technology.

The indicative rate of return, before mustering costs are brought to account, is high. However, if the potential increase in carrying capacity is not utilised then the rate of return, before mustering costs, is much lower and, in some cases, the incremental benefits may not justify the incremental cost of special musters for HGP implantation.

Questions remain about other HGP treatment strategies not considered here. For example, treatment of calves at branding and weaner animals at weaning in the first dry season followed by the 3-dose/year strategy which has been the basis of this analysis or strategic use of 400-day HGP implants may improve the practicality of the technology