RELATIONSHIPS BETWEEN CARCASS AND BEEF QUALITY AND COMPONENTS OF HERD PROFITABILITY IN NORTHERN AUSTRALIA

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SUMMARY

This paper presents an overview of a project established to examine a pivotal issue in Australian beef cattle genetic improvement: *"Can we change carcass and beef quality attributes by selection without unduly compromising key fitness traits like reproductive performance and adaptation to harsh environmental stressors?"* Industry outcomes from the project are targeting multiple traits and multi-faceted strategies for improving carcass and beef quality, feed efficiency, female fertility and adaptation to tropical environments, and use of tools such as Estimated Breeding Values (EBVs), genetic (DNA-based) markers, ultrasound scanning and meat processing and cattle management strategies. Results to the questions being asked by the project will be available by 2006. **Keywords**: beef cattle, carcass and beef quality, feed efficiency, female fertility, genetic markers

BACKGROUND

Results from the Cooperative Research Centre (CRC) for the Cattle and Beef Industry (Meat Quality - CRCI) indicate that traits such as retail beef yield percentage (RBY%), intramuscular fat percentage (IMF%) and residual feed intake (RFI) are heritable and will respond to selection (Reverter *et al*., 2003a; Robinson and Oddy, 2003). However, moderate to strong antagonistic genetic relationships exist between RBY% and RFI on the one hand and IMF% and fat thickness on the other. Higher yielding, more efficient (low RFI) animals produce progeny that are leaner and marble less than progeny of lower yielding, less efficient animals (Reverter *et al*., 2003b; Robinson and Oddy, 2003). Hence, selection to improve RBY% or RFI is likely to reduce fat deposition throughout the body. Studies from humans and rats (Frisch, 1984) and tropical breeds of cattle (O'Kelly *et al*., 1988) suggest a minimum fat cover may be necessary for puberty and conception. Selection of beef cattle for increased RBY% or improved RFI that results in reduced fat cover in breeding females may therefore reduce female fertility. Such relationships may be stronger in harsh environments and in *Bos indicus* breeds that suffer from lactational anoestrus (Frisch *et al*., 1987). A specifically designed breeding program was implemented to generate experimental progeny to quantify the hypothesised relationships. This paper describes the experimental design and methods applied to experimental data collection.

[2] AGBU is a joint venture of NSW Agriculture and the University of New England

EXPERIMENTAL DESIGN

The main genetic relationships to be estimated are those among steer feed efficiency, carcass and meat quality attributes and female performance traits. Design aspects of the project include:

- Use of two tropically adapted breeds (Brahman and Belmont Red/tropically adapted composite), representing extremes of breed difference amongst tropically adapted breeds for carcass and beef quality, adaptation and male and female fertility traits;
- A target of 2,400 progeny per breed was the minimum to estimate genetic relationships within each breed; this represents 20-30 progeny per sex for each of 40-50 sires per breed;
- Inclusion of sires for experimental design reasons as well as nomination of sires by collaborating breeders. Sires nominated by CRC were selected primarily on divergence for EBVs for RBY% and IMF%. Secondary selection criteria included known heterozygosity for gene markers identified in CRCI, EBVs for scrotal size or days to calving and, in Brahman sires, whether they were prominent sires within the breed. Also considered was the ability of a sire to genetically link the project to other projects (e.g. CRCI straightbreeding and crossbreeding projects) and to industry data (e.g. Brahman BREEDPLAN herds). Most sires nominated by the collaborators were young, unproven bulls;
- Allocation of animals to artificial inseminations, natural service joinings and management groupings to ensure genetic linkage of progeny across management groups, and as much balance as possible in the representation of sire progeny over linked groups. Environments for measuring heifer/cow performance traits were chosen to represent the range encountered by each breed, also recognising that the expected range for performance includes harsher (e.g. greater tick and worm prevalence) environments for Brahmans than for Belmont Red/tropically adapted composites.

BREEDING PROGRAM AND MEASUREMENT OF EXPERIMENTAL PROGENY

All artificial insemination and natural mating programs to generate the 4,800 pedigreed experimental calves on 11 properties in Queensland and NT over 4 years are complete. Three calf crops have been weaned on those properties and delivered to CRC control, with weaning of the fourth calf crop to occur in mid-2003. Steer progeny are allocated to one of 5 growout properties in Central Queensland and NSW on the basis of sire, weaning weight and age. They are grown at pasture on those properties and finished in the CRC's experimental feedlot, "Tullimba" in northern NSW, where individual feed intakes are recorded using automatic feeders. Steers are slaughtered at an average live weight (within cohort) to achieve target carcass weights of 320 kg. Complete carcass and beef quality attributes are measured according to the protocols described by Perry *et al.* (2001). Heifer progeny are reared under a range of extensive environments at 4 research stations in Queensland (Toorak, Julia Creek; Swans Lagoon, Ayr; Belmont, Rockhampton and Brian Pastures, Gayndah) and are measured each 4-12 months during the growing phase, particularly for traits associated with puberty and resistance to environmental stressors. All heifers join the breeding herds at ~2 years of age, where collection of reproductive data continues until they have had the opportunity to rear at least 2 calves to weaning.

USE OF GENE MARKERS ASSOCIATED WITH PRODUCTIVE TRAITS

Research in CRCI identified a number of genetic markers potentially useful for improving productivity in industry herds. Experimental progeny generated in the project require DNA-fingerprinting to determine sire parentage. It was decided to use a suite of "known" DNA markers to determine sire, in lieu of non-informative markers used by commercial fingerprinting services. Although not a specific outcome of the project, the phenotypic and genetic information generated on experimental progeny will also provide a

valuable resource for detection or validation of gene markers for feed efficiency, female fertility and adaptation to stressors of tropical environments. A panel of 23 DNA markers was selected for the dual purpose of assigning sires to all calves and testing DNA markers associated with production traits. Markers were selected on the criteria that: i) each had at least 4 alleles; ii) they could be amplified simultaneously with other DNA markers; and iii) they were associated to marbling, tenderness, RBY% or resistance to ticks or worms. Calves from the first 3 calf crops were genotyped using the panel of markers. However due to a number of technical problems not yet completely identified, the use of those 23 genetic markers for production and resistance traits has not allowed a reliable parentage determination for our experimental animals. Considerable development of the process is still required to turn the idea into commercial reality.

RESIDUAL FEED INTAKE

Before embarking on extensive research into feed efficiency in tropically adapted cattle, an assessment of the relative economic importance of feed intake traits to northern cattle breeders was undertaken (Barwick and Johnston, unpublished data). The study also considered whether RFI was a useful trait for breeders of tropical cattle. This followed from earlier studies suggesting that measures of feed efficiency in the tropics should be based on restricted, low quality diets rather than the unrestricted, high quality diets used in RFI tests (Frisch and Vercoe, 1984). Findings from the recent unpublished study include:

- The importance of the RFI measure of feed efficiency is similar in steers in the tropics to that in temperate (domestic market) systems, but may be of quite low importance in cows in the tropics.
- Feed efficiency measures for northern Australia will need to be inexpensive and will likely best involve indirect measures in combination with some amount of RFI testing (Archer *et al*., 2003).

Based on these results, all steers in the project are now being finished on high energy diets at the CRC's "Tullimba" cattle research facility near Armidale NSW, where individual feed intakes of a standard finisher ration offered *ad-libitum* are recorded using automatic feed intake recorders (see Bindon, 2001)

FEMALE FERTILITY TRAITS

Ultrasound scanning is being used to measure fatness attributes and ovarian activity in all heifers to determine factors affecting cyclicity. Subjective reproductive tract scores are also being recorded to determine their value as an on-farm tool to assess cyclicity. As heifers achieve weights of 200 kg, they are scanned and scored each 1-2 months until the first *corpus luteum* (CL) is detected, when they are deemed to have reached puberty. All heifers join the breeding herd at an average age of 2 years, where they are joined for 12 weeks in multiple-sire joining paddocks with bulls of the same breed at a bull:female ratio of 3%. Reproductive data are recorded on all females until they have had the opportunity to rear at least 2 calves to weaning. Scanning continues through joining to determine: i) timing of first CL for heifers that had not reached puberty at start of joining; ii) early pregnancies and possibly embryonic losses and iii) return to cyclicity of lactating females. Regular scanning of such large numbers of females is already offering substantial improvements in our understanding of the basic biology of female fertility.

OTHER KEY RELATIONSHIPS AND ANALYSES

The project is also targeting other key relationships that are potentially very important for genetic improvement programs and evaluation of management options, but which require new or additional data to quantify or confirm them. These include:

- Phenotypic and genetic relationships of flight time (a measure of temperament) and feed efficiency with carcass and beef quality attributes and female fertility traits;
- Genetic relationships between plasma insulin-like growth factor (IGF1) concentration measured at different stages of an animal's life and feed efficiency, carcass attributes and female fertility traits;
- A comparison of the effect of method of hanging carcasses (Tenderstretch *vs.* Achilles-hung) on carcass and beef quality and especially on genetic parameters for beef tenderness;
- Complete economic analyses to examine the economic impact of changed genetics and/or management practices on herd profitability.

INDUSTRY OUTCOMES

Final results will not be available before 2006. Experimental data are currently being analysed to provide preliminary results to industry and will be used to produce EBVs for the sires for existing BREEDPLAN traits and new traits. Industry outcomes are targeting multiple traits, multi-faceted strategies and industry economics to improve carcass and beef quality, feed efficiency, female fertilityand adaptation to tropical environments. Tools being developed include EBVs, gene markers, ultrasound scanning and meat processing and cattle management strategies that will impact on most sectors of the Australian beef industry. The results will have flow-on benefits to cattle breeders worldwide.

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