ESTIMATING RETURNS FROM INVESTMENT INTO BEEF CATTLE GENETIC TECHNOLOGIES IN AUSTRALIA

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INTRODUCTION

The Australian community has for several decades now made investments aimed at improving productivity and profitability in beef cattle through genetic technologies. These technologies include importation of new genetic material, breed change and crossbreeding, and within-breed selection. Investments into these technologies have included research and development programs, extension/implementation programs and importation (R, D, E and I). Meat and Livestock Australia recently commissioned an economic analysis of Return on Investment (ROI) for genetic technologies for the Australian beef industry. The study aimed at estimating the costs and benefits of beef cattle genetic improvement activity (all reported here in $AU), across Australia, with a focus on the period 1970 to the present. We here briefly report on this study.

INVESTMENT INTO RESEARCH, DEVELOPMENT, IMPLEMENTATION / EXTENSION AND IMPORTATION

Investors into beef cattle genetics were invited to provide data on the level of their investment (cash and kind). The investors approached included breed societies, service providers, state Departments of Agriculture, CSIRO, CRC, and universities. Investments included measurement and recording costs, genetic evaluation charges, and importation costs carried by breeders, together with research and extension projects conducted by a range of organizations. As far as possible, total community costs were estimated.

The costs can be summarized:

- The total cumulative Net Present Value (NPV) of investments is $340m (using a discount rate of 7%)
- This represents an average annual investment (NPV) of $8m (for the period 1963 to present). The level of investment is estimated to have peaked in 1985 at c. $19m.

Using a conservative estimate of annual gross income for the industry of $3.5bn, the total annual investment into genetic improvement research, development and extension represents 0.23% of annual income.
ESTIMATING RETURNS

Four avenues to improved returns were evaluated – infusion of *Bos indicus* genetic material into sub-tropical and tropical northern Australia, within-breed selection, cross-breeding in the temperate herd, and changes in breed composition of southern herds towards breeds which command market premiums for particular markets.

**Infusing Bos Indicus.** Since 1950 (but especially since about 1970) there has been a steady increase in the proportion of cattle in northern Australia that are *Bos indicus* or *Bos indicus*-infused.

This has been principally through use of Brahman cattle and their derivatives, and has been a response to the superior adaptation of *Bos indicus* in the production environments of northern Australia. To estimate the value of these benefits the following data were used:

- The northern cow population has been c. 5 million head for most of the period 1950 to present, although it has risen during the last decade. The proportion of *Bos indicus* has risen from 5% in 1970 to approximately 85% during the 1990’s.
- The value in terms of improved profit resulting from replacing a British breed cow with an Indicus cow. This was estimated at $110 per cow per year (this estimate derives from consultation with industry personnel, and is conservative) (Burrow, pers. comm.)

From this, the cumulative NPV of infusing indicus genes was estimated to be approximately $11bn, of which $10.2bn has been earned since 1970. Equilibrium Displacement Model (see below) results suggest that the community benefit totals 3 times this, or $31bn.

**Selection.** To estimate industry and community returns from selection, an Equilibrium Displacement Model (EDM) was used (Zhao *et al.*, 2000). This approach is widespread in economic evaluations of technologies in agricultural and other systems.

This takes estimates of reductions in cost-of-production as inputs, and then using detailed knowledge of beef industry structure, markets, supply/demand relationships and price flows, calculates benefits to industry and the community as a whole. Previous EDM evaluations of technology improvements in sectors of the Australian beef industry have shown that total community benefits are approximately 3 times those captured by producers.

Genetic trend data was derived from BREEDPLAN EBVs after translation of these to EBVs for beef herd profit traits using BreedObject (Barwick *et al.*, 2001). Genetic trends in profit traits were converted to changes in cost-of-production using gross margin budget models for each of the major production system x target market combinations used in producing beef in Australia – covering grass- and grain-fed production, and the range of domestic and export markets.

Genetic trends in cost-of-production were then aggregated using estimates of the proportions of cattle from each production system x target market combination, of the proportions of the various breeds, the proportions of animals that have been evaluated through BREEDPLAN, and the estimated genetic lag between evaluated and non-evaluated cattle.

Inputs to the EDM were estimated at successive 5-year intervals, so that the cumulative effects of selection could be modelled. Also, the full benefit flow from all genetic change that has occurred to date (but not all of which has yet flowed through the commercial population) was included.

Using this approach, the cumulative NPV of community returns from selection is estimated at $944m. Of this, one-third or $315m is estimated to have accrued to farmers.
Crossbreeding in southern Australia. This impact was also evaluated using the EDM approach. Crossbreeding, whether through use of crossbred cows, or more simply by using a different breed of bull, delivers benefits from heterosis, which impact on cost-of-production. The gross margin impact of these crossbreeding systems was estimated for a range of southern production system x target market combinations, based on previous crossbreeding research projects (Parnell et al., 1992).

ABARE (Australian Bureau of Agricultural and Resource Economics) statistics provide data on the proportion of cattle in southern Australia that are crossbred. This has risen from very low levels in 1970 to around 40% in 2000. From this data, the benefit from crossbreeding in southern Australia is estimated at $255m, or $85m on-farm.

Changing breed mix in southern Australia. During the 1990’s there has been a significant shift in breed composition of the southern herd, with producers increasing their use of Angus and Angus-cross cattle in response to market premiums for particular markets. These premiums mean that there are on-farm and community benefits from this breed change. The benefits were estimated using the following assumptions:

- the proportion of the southern herd that is Angus or Angus-influenced has risen from 9.5% to 22% since 1990,
- the premium per animal slaughtered is estimated at $25.

Using these values, the on-farm benefit from changing breed composition during the 1990’s in southern Australia was estimated to be $88m (community benefit of $265m). Other longer-term changes in breed composition in the southern herd were not evaluated, primarily due to lack of data. Crossing with European breeds in Australia is also certain to have had some impact, although their proportion of the seedstock sector remains modest (Sillar et al., 2001).

The impact of importation within breeds. Most cattle breeds in Australia regularly access overseas gene pools of their respective breeds, particularly the large North American populations. Because many of the Australian progeny of these animals enter genetic evaluation, it is possible to estimate the value of the genes of the imported animals. This value is included in the genetic trends used to calculate cost-of-production changes.

The cost of importation was harder to estimate, because no organization maintains records of importation that distinguish beef from dairy, but based on information from AQIS (Australian Quarantine Inspection Service), from breed societies and from semen sellers, importation costs were estimated to total approximately $27m NPV.

SUMMARY OF THE RETURN ON INVESTMENT
Over all sources, the return from genetic technologies since 1970 was estimated to be $11bn on-farm and $33bn to the community at large, against a total investment estimated at $350m. The on-farm benefits represent an extra $9 170 for each of the approximately 40 000 specialist and non-specialist cattle producers in Australia the last 30 years.

MARGINAL BENEFITS ~ THE DIFFERENCE BETWEEN ANNUAL INVESTMENT AND ANNUAL RETURNS
The estimates above summarise the historical picture, which shows a healthy return to the community (including the on-farm sector) from the total investment in R, D and E/I. Also of
interest (especially to producer levy-payers) is the current picture with respect to marginal benefit. An attempt was made to estimate this. The annual increment in returns from Bos indicus infusion was hard to estimate – each 1% increase in proportion of Bos indicus is estimated to be worth $4.9m on-farm (and therefore $14.7m to the community). It is not known with any accuracy whether this proportion is still increasing. The annual increment of income from genetic improvement within breeds is estimated at $1.3m on-farm (or $4m community value). Recent advances, including genetic information on carcass, fertility and feed efficiency traits, selection indexes and mate selection tools, are in the “pipeline” and therefore annual benefits from selection are expected to grow. Each 1% increase in crossbreeding in the southern herd is estimated to be worth an extra $0.12m on-farm ($0.36m community). The change to Angus is estimated to be worth $1.25m on-farm ($3.75m for the community) for each 1% increase. The current trend is estimated at 1% increase in Angus composition per year.

In summary, the current annual level of investment into R, D and E is estimated at $9.5m, and the total on-farm value of the annual increment in returns from beef cattle genetics is $7.6m (community value $22.7m).

CONCLUSION
Investment into beef cattle genetic improvement in Australia via research, development, genetic evaluation and importation has been highly profitable, showing a benefit : cost ratio of 46:1 over the last 30 years. The biggest contribution to this high benefit : cost ratio has been the infusion of better-adapted Bos indicus genetic material into the sub-tropical and tropical herd.

Current rates of growth of the benefits are much closer to the total annual investment. It is known that there is much scope to achieve much faster rates of genetic gain. The real challenge for the industry, and all its components is now to ensure that the infrastructure of knowledge, tools and technologies for genetic improvement is used as effectively as possible to achieve faster rates of genetic gain coupled for profit, coupled with making best use of the range of breeds and crosses available.

REFERENCES

