Appendix 10: Calculating Impact 1.01 – Genetic parameters for use in BREEDPLAN

There are strong theoretical relationships between the proportion of variation of a genetic trait explained by a marker or group of markers, the associated heritabilities and tradeoffs with other traits, the resulting accuracy levels of Estimated Breeding Values (EBVs) for those traits, the use of that information in generating rates of genetic gain in the herd, and the $ index which measures the expected value of that gain to a commercial producer.

At the start of the Beef CRC, less than 10% of variance across all economically important traits in Australian beef cattle was explained, giving an accuracy of BREEDPLAN $index EBVs of around 20%. This results in genetic gain per year of about 0.2 across the whole national herd, which is valued at about $2.00/cow/year (Banks 2012). This gain increases slowly, by about 2%/year, through better selection of more valuable bulls. This ongoing rate of genetic improvement is due to outcomes from past R&D investments.

At the start of the CRC, typically about 30% of the national herd used BREEDPLAN registered bulls in mating (bulls with EBVs), leaving 70% of the herd using non-BREEDPLAN bulls (Farquharson *et al.* 2003). There are approximately 13 million beef breeding cows in Australia. It takes 5 years from when seedstock producers use new genetics in their breeding decisions to when superior progeny become available to commercial producers who use BREEDPLAN bulls. It takes a further 5 years for superior progeny to become available to commercial producers who use non-BREEDPLAN bulls (Farquharson *et al.* 2003). Their rate of genetic gain is lower than the $2/cow/year, often some 20% lower, because it is based on what happened 5 years ago in the part of the industry that uses BREEDPLAN registered bulls. By 2030/31 it is predicted that the average $ index value will be $2.91/cow/year for the proportion of the national herd using BREEDPLAN registered bulls, and $2.64/cow/year for the proportion of the national herd using non-BREEDPLAN registered bulls. The average $ index value is predicted to be $2.72/cow/year.

Not only are there past R&D impacts to account for; there have also been parallel R&D investments occurring outside the CRC. In the last few years, Meat and Livestock Australia has funded Beef Information Nucleus (BINs) projects that are aimed at increasing the amount of phenotypic measurement undertaken by the seedstock sector and so increasing the amount of data used for calculating EBVs. By June 2012, these projects are expected to begin delivering increased rates of genetic gain, with the objective of doubling the value of the aggregate $index to over $4/cow/year by 2030/31. The proportion of the herd that uses BREEDPLAN registered bulls is also expected to rise to around 40% by 2030/31, but will not change much in the short term. Therefore, for the 30% of the herd that uses BREEDPLAN bulls, the rate of genetic gain rises by 5% per year from $2/cow/year in 2011/12. For the remaining 70% of the herd, the rate of genetic gain rises by 5% in 2016/17. By 2030/31 it is predicted that by adding in the information from the BINs, the average $ index value will be $5.05/cow/year for the proportion of the national herd using BREEDPLAN registered bulls and $4.16/cow/year for the proportion of the national herd using non-BREEDPLAN registered bulls. The average $ index value is predicted to be $4.43/cow/year.

The value of the genetic improvement due to increased accuracies of 30% from the genomic prediction equations is detailed in Appendix 11.

However, the CRC has also been undertaking phenotypic recording (prior to and independent of the BINs) through its own progeny testing programs required to underpin CRC research to improve carcase, meat quality, feed efficiency, body composition, male and female reproductive traits. This activity has been an integral component of outputs 1.01, 1.05, 2.01, 4.01 and 4.02, as well as from follow up analyses in the current CRC of data from past CRC projects and various industry validation activities. This has created improved knowledge of the heritabilities of individual traits and genetic correlations between traits e.g. more accurate correlations among fertility traits and all other feed efficiency and body composition traits in northern and southern Australia. The CRC's contribution is the improvement in traditional selection due to improved accuracy of these traits for the breeding objective (the $ index). We have little knowledge of the exact contribution but we assume an overall improvement in accuracy from 0.30 (available from the genomic prediction equations) to 0.35. This improvement would apply to all BREEDPLAN users because the more accurate genetic correlations will be routinely implemented in all BREEDPLAN runs, and it is different in speed of adoption because breeders do not need to DNA test or take any other action for their cattle to get this benefit.

Given that this new data has been generated and incorporated into BREEDPLAN since 2006/07, there will be a predicted one-off shift in $ index value in 2011/12 for users of BREEDPLAN registered bulls, from $2.00 to $2.33/cow/year, then a steady 5% increase until 2013/14, a one-off increase in 2014/15 to $4.05/cow/year, then a continuation of 5% improvement out to 2030/31. For users of non-BREEDPLAN registered bulls, the same pattern will occur, but lagged by 5 years. By 2030/31 it is predicted that by adding in the information from the CRCs phenotypic recording and analyses, the $ index value will be $8.85/cow/year for the proportion of the national herd using BREEDPLAN registered bulls, and $6.93/cow/year for the proportion of the national herd using non-BREEDPLAN registered bulls. The average $ index value is predicted to be $7.60/cow/year. We assume no additional increase in adoption of BREEDPLAN.

The impact attributable to the phenotypic recording and analysis of the Beef CRC is the value of the shift to more accurate EBVs, over and above ongoing genetic improvement due to the BINs and the genomic prediction equations. Net benefits across the whole herd begin at around $1.5m/year in 2011/12 and rise to $6.8m in 2019/20. The undiscounted sum is $32.4m. However only 15 years of benefits are able to be counted in the Impact Tool. Genetic progress is very slow to become apparent in industries like the cattle industry, which have long biological lags and multiple tiers of producers who choose to access genetic improvements in different ways. Thus, there are many benefits still arising and growing after 2019/20. The undiscounted sum of this last 10 years of benefits is $101.5m.

The calculations made above assume a steady state national herd and no supply response or consequent price impacts.