Research and development of trial Brahman BREEDPLAN Tenderness EBV^{M}

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Introduction

The recently completed SmartGene for Beef project (for full report see www.agbu.une.edu.au/smartgene.php++) identified significant effects of the GeneSTAR tenderness markers on meat tenderness as recorded by the objective measure of shear force. These results have allowed us to further develop the concept of combining EBVs (i.e. phenotypic and pedigree data) and gene marker information into a single marker-assisted EBV. The Brahman breed was chosen to develop the first trial BREEDPLAN EBV for meat tenderness because of its large involvement in the Beef CRC projects and the level of industry uptake of GeneSTAR marker testing. These marker-assisted EBVs will be denoted by **EBV^{M}** to indicate that DNA marker information has been used in the computation of the particular trait EBV. These trial Brahman Tenderness EBV^{M} represent a first for the Australian beef industry, and a significant advancement in genetic evaluation in this country. The methodology, developed at AGBU to incorporate DNA marker information into BREEDPLAN, will be used on other traits and in other breeds in the future.

Data

The computation of the new trial tenderness EBV^{M} used three different sources of data. The first was the phenotypic records of shear force (SF) from meat samples from the eye muscle of carcases measured through the Beef CRC 1 and 2 pedigreed breeding programs (N = 1995). Shear force is a mechanical measure of meat tenderness where a blade is pulled up through a piece of cooked meat and the maximum force required is recorded. The second source of data used was the GeneSTAR tenderness marker results (i.e. 'star' results for each of the 4 markers). Marker results were available on the CRC1 and CRC2 Brahmans (genotyped through the SmartGene Project) and also industry tested animals that had their results submitted to the Brahman NBRS database (N = 4729). The third source of data was flight time records on animals in the CRC projects and also a small number of recently recorded industry animals (N = 4737). Flight time is an objective measure of an animal's temperament. Results from the Beef CRC showed that flight time was both heritable and (moderately) genetically correlated with shear force, thus representing a potential genetic indicator trait for meat tenderness.

Methods

The 3 sources of data, along with available pedigree and management group information, were combined into a single EBV for meat tenderness. To include the DNA marker information firstly the effects of each of the markers (i.e. T1, T2, T3, T4) on shear force, specifically for Brahmans were estimated using models (and datasets) developed as part of the SmartGene Project. These

* AGBU is a joint venture of NSW DPI and the University of New England

estimated effects were combined into a prediction equation and applied to each animal's gene marker results. List below in Table 1 are the estimated effects of the 4 tenderness markers and Figure 1 shows the genotype frequencies in Brahmans.

Table 1. Estimated size of effects (and standard errors) of the 4 tenderness markers on shear force in Brahmans

Marker	Size of effect in kg SF/star
T1	**-0.139** (0.041)
T2	**-0.087** (0.105)
T3	**-0.234** (0.054)
T4	**-0.032** (0.040)

The results show the effects of the four markers differ. Marker T3 has an estimated effect almost as large as the other markers put together, and Markers T1 and T2 have intermediate effects. The gene frequencies of the 4 markers in the Brahman population also differ. The frequency of the desirable form of the T2 marker is extremely low whereas that of T1 exceeds 60%. The different estimated size of the marker effects means that animals with the same total number of stars will have different EBV^{M}.

Given the significance of the T1 and T3 markers, both had to be genotyped for an animal to be included in the analysis.

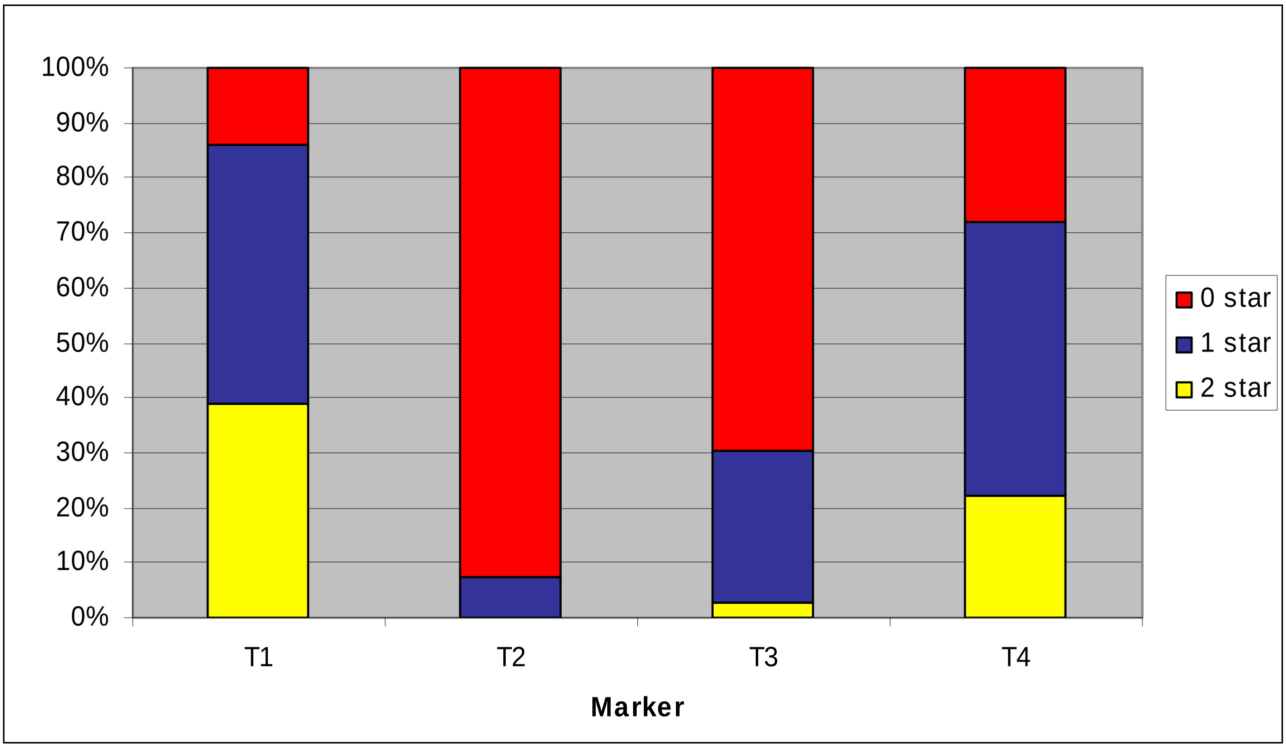

Figure 1: Estimated genotype frequencies for GeneSTAR tenderness markers in Australian Brahman

Results

A total of 22052 animals (those with records and their ancestors) had trial tenderness EBV^M computed with a mean of 0.02 and a range of -0.98 to +1.36 kg. The units of the tenderness EBV^M are kg of shear force and therefore the lower (i.e. more negative) the EBV^M the lower the shear force and thus the more tender the meat. Listed in Table 2 are sires with tenderness EBV^M accuracies greater than 80%. The spread in the tenderness EBV^M is almost 2 kg SF between the highest (less tender) and the lowest (more tender) EBV^M sires. Sires used in the Beef CRC projects were a random sample of the Brahman breed. However, the large spread generated is mainly the result of the large number of progeny recorded (N=16 to 68) for actual shear force on each of these sires, and the contribution of the other sources of information (i.e. markers and flight time) is minimal. If shear force records are not available the EBV^M have a much lower spread and very much lower accuracies (as seen in the 128 sale bull list). Figure 2 shows the expected accuracy of an EBV^M from different combinations of data.

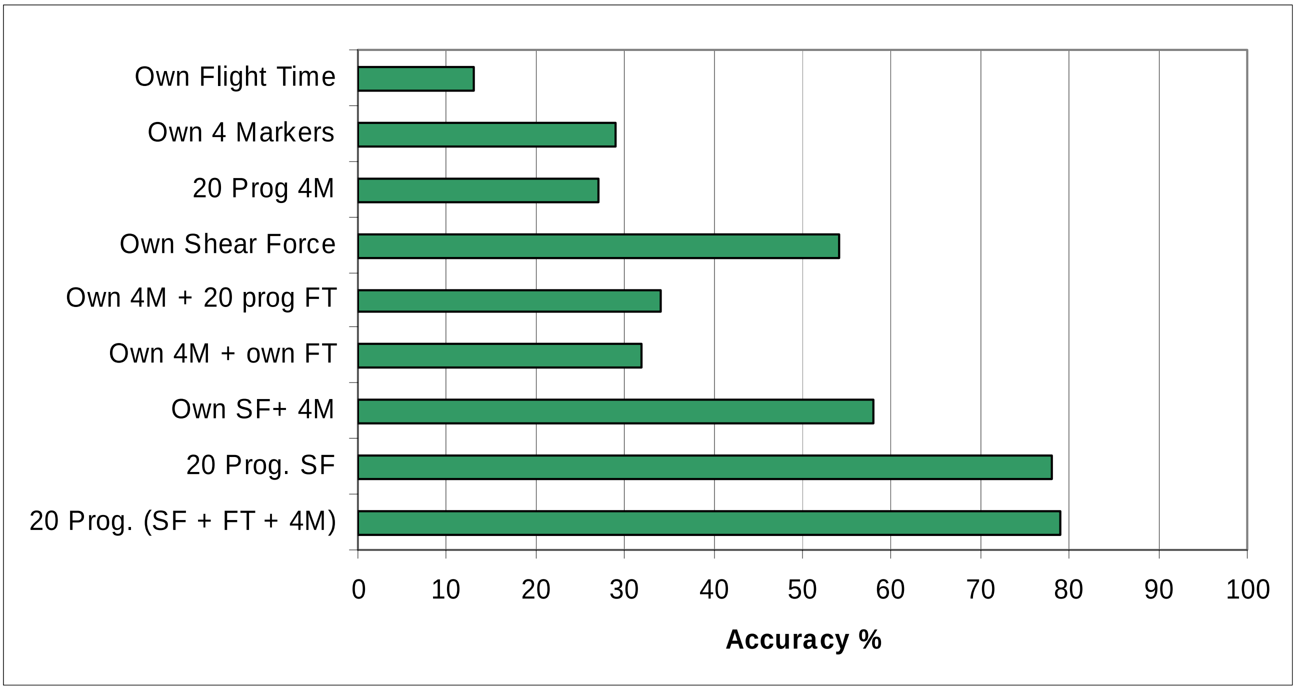

Figure 2. Expected accuracy of tenderness EBV^M from various levels of data recording

The other important output from this analysis is the new Brahman flight time EBV. While the measuring of flight time has some benefits in predicting genetic differences in tenderness it also has a stand-alone role in its ability to predict genetic differences in temperament. The new trial Brahman flight time EBVs are measured in seconds (i.e. time to break 2 light beams approximately 2 m apart when exiting a crush) and the higher (i.e. longer time) EBVs reflect animals of better temperament compared to lower or negative EBVs representing shorter exiting times and poorer temperament. The sires listed in Table 2 also had progeny recorded for flight time and range of the FT EBV was from -0.49 sec to +0.63 sec. Note we could not find any effect of the GeneSTAR tenderness markers on flight time.

Table 2. High accuracy trial Brahman BREEDPLAN Tenderness EBVs

	Tenderness			Flight Time		GeneSTAR				
Sire ID	EBV^M	Acc.	Nprog SF	EBV	Acc.	T1	T2	T3	T4	Total
LAN4405MM	**-0.77**	81	31	0.18	82	1	0	1	1	3
BEL71/95M	**-0.50**	84	31	0.63	85	1	0	0	.	1
MKR3/840M	**-0.50**	83	25	0.37	79	2	0	0	1	3
CBV96-6822	**-0.34**	82	27	-0.04	83	1	0	0	1	2
JFK1926M	**-0.33**	81	26	-0.13	85	1	0	1	0	2
WAV916263M	**-0.26**	85	33	-0.15	84	2	0	0	1	3
BEL510/97M	**-0.21**	81	28	0.35	81	2	0	1	1	4
LAN3795M	**-0.17**	81	29	-0.32	80	2	0	1	0	3
WAV4866M	**-0.17**	84	36	0.10	80	1	.	.	.	1
BEL79/96M	**-0.13**	86	40	0.08	87	2	0	0	0	2
TTS983511M	**-0.12**	80	16	-0.12	86	1	0	1	2	4
TTS922382M	**-0.08**	86	49	-0.01	86	1	0	0	1	2
TTS973273M	**0.07**	83	41	0.11	81	2	0	0	1	3
JDH818/7M	**0.09**	89	51	0.05	88	2	0	0	2	4
TTS025M	**0.17**	84	35	-0.12	83	2	0	0	0	2
WAV4989M	**0.17**	82	41	0.14	78	2	0	0	2	4
TTS922415M	**0.30**	87	51	-0.01	87	1	0	0	2	3
WAV5576M	**0.39**	85	47	-0.23	85	2	0	0	1	3
HCC91/9M	**0.60**	81	26	0.07	83	1	0	0	2	3
JDH61/9M	**0.79**	83	42	-0.32	82	1	0	0	1	2
LYN1660/7M	**0.84**	82	27	-0.16	82	2	0	0	0	2
LAN6066M	**0.90**	84	32	-0.03	89	2	0	0	0	2
TTS922197M	**0.92**	89	68	-0.13	88	0	0	0	0	0
LAN4461MM	**1.10**	87	75	-0.20	87	1	0	0	0	1
LAN4999MM	**1.23**	83	37	-0.49	86	2	0	0	1	3

Contribution of gene markers to EBV^M

As described previously the markers are included in the prediction of the tenderness EBV^M by using the estimated effects of the markers and the individual's marker results. The relative contribution of the markers to the EBV^M depends on the estimated effect of each marker and its gene frequency in the breed. For example, if a marker has a reasonable size effect but is at high gene frequency (i.e. most animals are 2*) then this marker in this particular breed will be explaining very little of the differences between animals and therefore will have little contribution to differences in EBV^M between animals. Therefore to generate EBV^M with high accuracies from marker data alone will require finding markers (likely to require several) that explain a large amount of the genetic variation of a trait. In Brahmans, the GeneSTAR tenderness markers cumulatively explained an estimated 8% of the genetic variation of shear force.

Note: Once an animal's genotype has been established there is no benefit for that animal in testing relatives. This is different to recording phenotypic information, like flight time, where the records on relatives (i.e. sire, dam, half sibs and progeny) can be of considerable benefit in increasing the accuracy of the EBV.

Using these new EBV^M

The methodology developed to compute the new EBV^M is such that they can be used just like any other EBV. That is they predicted expected differences between animals for their progenies performance for the trait. And because the computation has optimally used all 3 sources of data the tenderness EBV^M is what selection should be based on. It would be incorrect to use the EBV^M as well as the number of stars or flight time records.

The emphasis placed on the tenderness EBV^M when making selection decisions will depend on individual producer's markets (i.e. importance of meat tenderness), and of course all other traits affecting profitability should not be ignored.

Future research

This new trial tenderness EBV^M is only the start to a new chapter in the genetic evaluation of beef cattle in Australia. Important research is underway to determine if tenderness is genetically correlated with other economically important traits. Early indications, using Brahman BREEDPLAN EBVs, are that the tenderness markers are having no substantial effects on any of the published EBVs. CRC2 research has also shown few antagonisms between shear force and other traits, but research is continuing to assess female lifetime reproductive performance and cow survival. Therefore, to include tenderness EBV^M into your breeding program optimally they should be included into a selection index, and this will require the determination of the economic value of tenderness and estimates of genetic correlations with all other traits.

The other important development is the ever-expanding capacity to genotype animals for large numbers of potential markers and therefore the increasing opportunity to explain greater amounts of genetic variation. However, to fully utilize this capacity the Australia beef industry needs to record more phenotypes on animals with a DNA sample, particularly for traits difficult to record in industry. Efforts to do this are currently underway. Although there are theoretical predictions of completely replacing phenotypic records with large panels of markers (called SNP chips) in the future, this appears to be some way off for the beef industry. The current experience from the dairy industry, where the phenotypes used are the highly accurate EBVs of well proven sires, is that the accuracies of EBV^M derived from only DNA marker information are likely to be, at best, 70%. This is unlikely to be achieved in beef where, unlike the dairy industry, we must work with relatively few phenotypes of modest heritability and accuracy.

Possible actions for Brahman seedstock breeders

- Determine how important meat tenderness is to clients production/market system
- Assess cost effectiveness of measures
- Do DNA tenderness marker testing of selection candidates in your herd
- Flight time record all weaners (i.e. bulls, heifers and steers)
- If high accuracy tenderness EBV^M for sires are required, then progeny test for shear force

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