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Multi-breed Data for Maternal Traits

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Abstract

Why was work done: This project was done to provide BREEDPLAN with additional maternal trait data to assist beef producers more accurately exploit the benefits of crossbreeding in Multibreed programs. Maternal performance of eight different cow genotypes was compared. The cows were bred from Angus and Hereford dams by Angus (Ang), Hereford (Her), Limousin (Lim) and Simmental (Sim) bulls, creating 8 genotypes at the Department of Primary Industries, Hamilton, Vic. and Struan Research Centre S.A. These cows were joined to Shorthorn (Short), Charolais (Char) and Limousin (Lim) bulls. The resultant production data will be used by BREEDPLAN to provide additional information to assist producers make more appropriate and accurate breeding management decisions. This project has generated data from mature cows and on Shorthorn and Charolais crossbred calves that will expand the Breedplan Multibreed data base and assist producers choose breeding stock that more accurately and consistently meet market targets.

Benefits to industry. Currently BREEDPLAN provides multi-breed EBVs to compare Angus, Hereford/poll Hereford, Limousin and Simmental breeds. This project has generated data that will assist BREEDPLAN include Charolais and Shorthorn breeds. The results will also provide additional crossbreed maternal trait data that can be included in BREEDPLAN analysis which will ultimately be used by industry. The results from this project reinforce the benefits of cross breeding and the appropriate use of different breeds to tailor production systems.

Executive Summary

This project was done to provide BREEDPLAN with additional maternal data that will assist producers choose breeding stock that more accurately and efficiently meet market targets. It will provide BREEDPLAN with additional data that can be used to expand Multibreed EBV's. Maternal trait data from progeny of eight different cow genotypes were compared and submitted for genetic analysis. The objective was; - By 30 June 2007: Collect maternal trait data for genetic analysis to enhance multi-breed EBVs, from progeny of Fl multi-breed females.

The cows originated from the Multibreed project, the data from which was used by Breedplan to develop initial Multi-breed EBV's. The cows were bred in 1998, 1999 and 2000 from Angus and Hereford dams by Angus (Ang), Hereford (Her), Limousin (Lim) and Simmental (Sim) bulls (22 bulls of each breed), creating 8 genotypes (Ang, Her, Ang x Her, Her x Ang, Lim x Ang, Lim x Her, Sim x Ang and Sim x Her) at the Department of Primary Industries, Hamilton, and SARDI Struan Research Centre S.A,. These cows were joined by AI and to BREEDPLAN recorded Shorthorn (Short), Charolais (Char) and Limousin (Lim) bulls from spring 2003. BREEDPLAN Shorthorn and Charolais backup bull were also used. In 2003 a small number (28) of these cows at Struan were also joined to a BREEDPLAN recorded Angus backup bull. The resultant maternal trait and production data will be used by BREEDPLAN to provide additional information to assist producers make more appropriate and accurate breeding management decisions.

A total of 331 different females were used in the project with 764 joinings over 2 years, producing 667 calves. Cow fertility, ease of calving, birth weight, calf growth rate and liveweight at weaning were measured. Additional post weaning data of scanned eye muscle, P8 and rib fat, and IMF% were also collected by an accredited BREEDPLAN scanner, as well as slaughter data and MSA carcass data that was collected from Struan slaughtered cattle.

Advantages in production traits were shown to result through the use of different cow dam and cow sire breeds, and, as could be expected, individual cowbreed influenced all traits. There was no cow breed by calf sire breed interaction, indicating that regardless of cow breed, any effects of calf sire breed will be additive.

Cow dam breed (Angus or Hereford) affected most traits. Generally the cows from Angus dams were more productive than cows from Hereford dams, having lighter calves at birth, but faster growing and heavier calves at weaning. There was no difference in calving difficulty. Because cows from Angus dams were lighter, they produced more kgs of calf per kg of cow liveweight at weaning, and would therefore be considered to be more efficient. Whilst Simmental sired cows produced heavier and faster growing calves, in terms of the weight of calf produced per kg of cow, there was not a great deal of difference between cows sired by Angus, Limousin or Simmental, those sired by Hereford tended to be the least efficient in those terms.

The effect of individual cow breed varied, depending upon trait measured. The cross bred cows were generally heavier apart from the Her x Angus cows, and the Angus were the lightest. The Lim x cows had a larger eye muscle area which was reflected in their progeny. The Sim x Ang had the heaviest weaners, but in terms of calf liveweight per kg of cow liveweight they were no better than the Angus cows. The Sim x Ang cows were also the leanest, and had the highest calving difficulty score. There was little difference between the other breeds with this trait.

There was very little difference between the 8 individual breeds in terms of fertility. There was no difference in calving to calving interval or calf birth date. However the Lim x Angus had a higher calving and weaning percentage

Whilst we could only measure the effects of hybrid vigour between the Hereford, Angus and their reciprocal crosses, the advantage due to hybrid vigour could be seen in most traits measured, including, the liveweight and growth traits, as well as the carcass fatness traits.

We need to be cautious when comparing the calf sire breed data. The project aimed to examine maternal differences between the cow breeds, and the analysis has done that. The project was not set up to compare calf sire breeds. However, the 200 day weaning weight of the Charolais was significantly higher than those of the other calf sire breeds, and when the mean of the EBVs of the sires used in comparison to the breed average is considered the weaning weight increased compared to the other breeds.

The fact that there was no interaction between calf sire breed and cow breed in any trait indicates that regardless of the terminal sire breed she is joined to will affect her progeny traits in a complementary way.

The immediate impact of these results on the beef industry would be an awareness of differences in maternal traits of cows derived from different dam and sire breeds and would allow producers to make more informed immediate decisions on choice of a base herd breed.

The data collected indicate that significant gains can be made in factors affecting beef production efficiency and meat quality by use of appropriate breed combinations. Differences noted in the Multibreed study of heifers and their first calves are also evident in mature cows.
It is recommended that the data be incorporated into BREEDPLAN to improve the accuracy and confidence in its use.

Contents

1 Background

1.1 Multibreed estimated breeding values

This project was established to improve beef producers ability to predict maternal performance by further development of multi-breed estimated breeding values (EBVs) based on data from cows that were generated in the MLA project "The development of Multibreed EBV's in beef cattle" project SBEF.006. Industry was widely consulted in the development of the Multibreed project, and at Beef Improvement Association Australia (BIAA) national meetings in Victoria and New South Wales it was decided that the Association pursue the development of Multibreed EBVS. BIAA members determined that non breed specific (Multi-breed) estimated breeding values should be available to producers to assist them in making more accurate decisions when choosing the type of cattle needed to help them meet market specifications.

The aim of the original Multibreed project was to produce across- breed EBVs based on data and measurement from progeny that represent a range of sires from four different breeds representative of British and European genotypes widely used in the industry. The project involved joining 6,000 Angus and Hereford cows to Angus, Hereford, Simmental and Limousin bulls. Twenty-two bulls of each breed were used. These four sire breeds provided a diversity of genotype, with two representing the most common British breed cattle type and two representing European type cattle. They were high accuracy group Breedplan sires, with a minimum accuracy of 75%, covering a range of traits for which EBVs were available. For each breed, the 22 sires were chosen to represent a similar range of EBVs for their particular breed. The EBV for 400-day liveweight was chosen as a guide, and a similar number of sires of each breed represented the top 1, 5, 10, 25, and 50 percentile bands within each breed, and so on, so that within each breed, the sires chosen represented a similar average percentile. The resultant data from the progeny generated enabled BREEDPLAN to develop across-breed EBVs for Angus, Hereford, Limousin and Simmental cattle, and an EBV correction table was produced to allow comparisons between those 4 breeds.

The Angus and Hereford dams joined to these 4 bull breeds were representative of their breeds, and were sourced from commercial properties.

1.1.1 Cattle used

At Hamilton and Struan Research centres, cows resulting from the original Multibreed project, born in 1998,1999, and 2000 were retained, and those females were used in this current maternal Multibreed project. After discussions with Dr Rob Banks MLA and Dr David Johnston AGBU, it was decided that these remaining females at Struan and Hamilton be joined to Charolais, Shorthorn and Limousin sires, the Charolais and Shorthorn as they had not been used in the original Multibreed project and would thus be used as terminal sires in order to minimise bias due to heterosis. Limousin sires were also used (they were not joined to the Limousin cross cows) so that sire linkages between the Multibreed project and the current project could be established.

The sires used were BREEDPLAN registered sires with high accuracy EBVs. These sires currently are being used in other genetic research programs, together with other high accuracy BREEDPLAN bulls. Artificial insemination was used followed by BREEDPLAN recorded backup bulls to maximise the number of suitable progeny.

2 Project Objectives

By 30 June 2007: Collect maternal trait data for genetic analysis to enhance multi-breed EBVs, from progeny of Fl multi-breed females.

The data obtained will comprise:
(i) fertility data from the dam;
(ii) ease of calving data from the dam; and
(iii) birth weight data of the progeny, and subsequent growth rate data up to and including weaning

3 Methodology

3.1 Design

3.1.1 Breeds used

Angus (Ang), Hereford (Her), Angus x Hereford (Ang x Her), Hereford x Angus (Her x Ang), Limousin x Angus (Lim x Ang), Limousin x Hereford (Lim x Her), Simmental x Angus (Sim x Ang), and Simmental x Hereford (Sim x Her) cows were joined to Charolais (Char), Shorthorn (Short) and Limousin (Lim) bulls.

3.1.2 Numbers of females used

A total of 178 Cows at Struan Research Centre, SA and 153 at DPI Hamilton that were derived from the Multibreed project were used in the project, giving a total of 331. The numbers for each breed are shown in Table 2.

Table 2. Numbers of females for each breed at the 2 locations

	Angus	Ang X Her	Hereford	Her x Ang	Lim x Ang	Lim x Her	Sim x Ang	Sim x Her
Hamilton	30	15	18	25	25	15	17	8
Struan	12	36	33	10	8	25	12	42
Total	42	51	51	35	33	40	29	50

3.1.3 Bulls used

The bulls used were Breedplan registered sires with high accuracy EBVs chosen to be representative of the breed for 200 day liveweight. A number of these sires were also being used in other genetic research programs, and provide good sire linkages, together with other high accuracy BREEDPLAN bulls. All the Shorthorn AI bulls used were bulls used in the Durham Shorthorn project. Artificial insemination was used and BREEDPLAN recorded backup bulls with genetic linkages to the bulls used in the Durham herd to maximise the number of suitable progeny. In the first year of the project an Angus bull was also used at Struan and the data from the resultant progeny were included in the analysis, as it was additional data on the females that would not have otherwise been used. The bulls used are shown in table 3.

Table 3. Bulls used in the project

Limousin	Charolais	Shorthorn [C]
AI Bulls		
Devt Polled Deon	2Up the Vegemite Kid [A]	Belmore Engineer U6
Evergreen Lardner [AB]	Airlie New Generation	Caskieben Padre [A]
Harris	Conroy Big Mac [A]	Doolibah Premier
Muscleor	Gunnadoo Red Baron	Kevlyn Downs Ripper [A]
Ramornie Polled Power Pack L51	Hillside Guy	Linsmau EL Nino F39
Riverstone Quantum	Palgrove Tribute	Mining Vale Titanic T49
White Lakes Prototype [A]	Riverglen High Performance [A]	Neearra Xceed
	Rosedale Navigator	The Grove Helmsman
	Rosedale Selector	The GroveProphet Dazzler S40
		Weebollabolla Urbenville U68
		Woolcott Millenium
Backup Bulls		
	Caithness Usewell	Dundas Park Mega Star W5
	Medburn X12E	Ingleton X120
	Temana X089	Belmore HelmsmanX71(P)

[A] CRC link – The CRC regional combinations project; [B] Multi-breed link; [C] All the Shorthorn sires have been used in the Shorthorn Durham project.

3.1.4 Joining procedure

Commencing in spring of 2003 the cows at each location were joined by synchronised AI. Cows were joined using a synchronised CIDR mating program with CIDR® insertion on day 0, injection of 2 mg oestradiol benzoate (ODB) and removal of the CIDR® and injection of 2 ml PG on day 8, injection of 1mg ODB on day 9, and insemination of every cow on day 10. A re-synchrony program was used with reinsertion of CIDR® and injection of 1mg of ODB on day 23, removal of CIDR® on day 31, injection of ODB on day 32, and AI of cows to heat detection on days 33 and 34. Experienced technicians carried out the AI.

Backup bulls were put out 2 weeks after AI, with Charolais bulls being joined to those mated by AI to Shorthorn, and Shorthorn bulls being used with those cows joined to by AI to Charolais and Limousin. The backup bulls were left with the cows for a further 3 weeks.

Weaning was carried out in Dec-January (mean weaning date – 20th Dec) for the autumn born calves (average birth date – 21st April) and in June (average date – 7th June) for the spring born calves (average birth date -21st Sept). The weaning ages were thus 252 and 260 for the autumn and spring born calves respectively.

Birth weights and cow calf identification was documented twice daily and the BREEDPLAN calving assistance score used if necessary. Post weaning progeny were scanned by an

accredited BREEDPLAN scanner and cattle at Struan were slaughtered when they reached domestic trade liveweights, and carcass data collected.

4 Results and Discussion

4.1 Statistical analysis

Data were analysed using Genstat 9 (2006), with a linear mixed model REML procedure. The initial model included the fixed effects of season, breed of dam (sire and dam of dam), breed of sire, sex, and all interactions; random effects of sire (within breed), dam, year of birth and all interactions (chiller grader was also used for appropriate parameters). The model was refined over progressive runs eliminating random terms showing negative (or aliased) variance components, and by removing non-significant fixed effects. The final model was then used to evaluate treatment effects and produce predicted means. “Dimensional” traits (P8 and rib fat depths and EMA) can be affected by the size of the carcase so we needed to account for differences in HSCW to detect effects independent of response in HSCW (growth rate response). HSCW was included as a co-variate for all other carcase traits and was significant in most cases. With scanned live animal data (P8, fat, rib fat, EMA and IMF %), live weight at scanning was used as a covariate. A total of 764 cows at the 2 locations were mated over the 2 years of joining, resulting in 667 calves.

4.2 Results

4.2.1 Cow description data

The cows were scanned by an accredited BREEDPLAN scanner so that they could be fully described in terms of their liveweight and live carcass traits. The scanning results are shown in table 4. Analysis of the scanning data included calving season, cow age, days from calving to scanning and lactation status. Analysis of scanned carcass traits included liveweight as a covariate

4.2.1.1 Liveweight and fatness

The figures at scanning indicated the breed differences in liveweight and fatness. The Angus (519kg) and Her x Ang (535kg) were lighter than the other 6 cow breeds, (P=0.008; s.e.d ±13.6), and although the Sim x Her weighed 571kg, compared to 552kg for the Lim x Her there was no significant difference between those breeds. The Simmental sired cows (567.4kg) were heavier than the Angus (537.9kg) or Hereford (545.1Kg) but not significantly heavier than those sired by Limousin (553.6kg) (P=0.03, s.e.d ±9.5). The cows from Angus dams weighed 15.0kg less than those from Hereford dams, (P=0.03, s.e.d ± 7.2kg). Condition score and fat traits indicated only small differences between breeds, but showed hybrid vigor. The Simmental sired cows were leaner than those sired by Angus and Hereford, but were not significantly different to the Limousin sired cows.

4.2.1.2 Eye muscle area

Scanned eye muscle showed that the Limousin sired cows had larger EMA's (65.2sq cm) than those sired by either the Simmental (59.0sq cm), Angus (60.8sq cm) or Hereford (59.8sq cm) (P<0.001; s.e.d ± 1.3). There was no significant effect of cow dam breed. Cows sired by Angus had a significantly higher IMF% (5.0%) than those sired by Hereford, Limousin or Simmental bulls (4.3, 4.3 and 4.0% respectively (P=0.009, s.e.d ± 3.3). There was no effect of cow dam breed on IMF%.

The cow data shows that apart from the 52.5kg difference between the Sim x Her and the Angus cows, difference in liveweight were relatively small, and apart from the Lim x Ang, and Sim x Ang cows that were leaner, there was only small differences in fatness. There appeared to be differences in distribution of fat with Angus tending to result in greater intramuscular fat (IMF %) and Hereford relatively more subcutaneous fat. The Lim sire breed clearly affected EMA.

Table 4 Effect of breed on cow liveweight and carcass scan traits.

	Weight (kg)	**Condition Score**	**EMA (sq cm)**	**P8 fat (mm)**	**Rib fat (mm)**	**IMF%**
Cow breed	P = 0.008	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
s.e.d ±	13.55	0.14	1.8	1.2	0.9	0.46
Angus	519^{b}	2.8^{abc}	61.1b^{cd}	6.0^{abc}	5.2^{ab}	5.3^{a}
Ang x Her	557^{a}	3.0^{a}	60.6^{bcde}	7.3^{a}	5.8^{a}	5.2^{a}
Hereford	555^{a}	3.0^{a}	57.9^{be}	7.4^{a}	4.7^{abc}	3.9b
Her x Ang	535^{b}	3.0^{a}	61.7^{bc}	6.7^{ab}	5.1^{ac}	5.0^{a}
Lim x Ang	556^{a}	2.7^{bc}	63.9^{ab}	4.5^{bcd}	3.4^{cd}	4.1b
Lim x Her	552^{a}	2.9^{ab}	66.4^{a}	7.1^{a}	5.6^{a}	4.6 ^{b}
Sim x Ang	563^{a}	2.4^{dc}	58.5^{cde}	2.9^{d}	2.7^{d}	4.0^{b}
Sim x Her	571^{a}	2.6^{d}	59.5^{cde}	5.1^{abcd}	3.6^{bcd}	3.7^{b}
Cow sire breed	P=0.036	P<0.001	P<0.001	P=0.007	P=0.012	P=0.009
s.e.d ±	9.5	0.11	1.3	0.87	0.61	0.33
Ang	538^{bc}	2.8^{ac}	60.8^{b}	6.6^{a}	5.5^{a}	5.0^{a}
Her	545^{bc}	2.9^{a}	59.8^{b}	7.0^{a}	4.9^{a}	4.3^{b}
Lim	554^{ac}	2.8^{ac}	65.2^{a}	5.8^{a}	4.5^{a}	4.3^{b}
Sim	567^{a}	2.6^{bc}	59.0^{b}	4.1^{b}	3.2^{b}	4.0^{b}
Cow dam breed	P=0.03	P<0.001	P=0.411	P=0.009	P=0.002	P=0.768
s.e.d ±	7.1	0.08	0.96	0.65	0.45	0.25
Ang	544b	2.7a	61.3ns	5.0ns	4.1b	4.4ns
Her	559a	2.9b	61.1ns	6.7ns	4.9a	4.3ns

Means with different postscripts differ significantly

4.2.2 Birthweight

Birthweight figures are shown in table 5. There was no effect of calving season on birthweight. Mean birthweight for the data collected was 44.4kg (s.e.±0.46). Whilst cow-breed was only significant at the P=0.06 level, it is apparent that the Sim cross cows and Lim x Her produced heavier calves than the Her x Ang and Lim x Ang. The influence of dam sire and cow dam breed were significant (P=0.002 and 0.003 respectively), with the calves from cows sired by Sim bulls (45.1kg) being significantly heavier than those born to cows sired by Her (43.5kg) or Angus bulls (43.6kg). Cows from Her dams (44.7kg) had heavier calves than those from Angus dams (43.3kg). The male calves at 45.7kg were significantly heavier than the females (42.3kg). There were no significant cow breed or calf sire or sex interactions.

Table 5 Effect of cow breed calf breed and sex on calf birthweight.

	Mean		Mean
Cow breed	(P= 0.06; s.e.d ±1.04kg)	**Dam sire breed**	(P=0.002; s.e.d ±0.7kg)
Angus	43.5[ab]	Angus	43.6[b]
Ang x Her	43.9[ab]	Hereford	43.5[b]
Hereford	44.4[ab]	Limousin	43.8 [ab]
Her x Ang	42.5[b]	Simmental	45.1[a]
Lim x Ang	42.5[b]		
Lim x Her	44.9[a]	**Calf sire breed**	(P=0.003; s.e.d ±1.5kg)
Sim x Ang	44.9[a]	Angus	45.4[a]
Sim x Her	45.3[a]	Charolais	45.4[a] (-1.1) [A]
		Limousin	42.7[ac] (+0.3)
Cow dam breed	(P=0.03;s.e.d ±0.49kg)	Shorthorn	42.5[bc] (+0.7)
Angus	43.3[b]		
Hereford	44.7[a]	**Sex**	(P<0.001; s.e.d ±0.46)
		Male	45.7[a]
		Female	42.3[b]

Means with different postscripts differ significantly

[A] Figures in brackets are half the difference between the average EBV for birth weight of the sires used compared to the breed average, indicating a possible correction factor to relate to the breed average, (a negative figure indicates the average EBVs of the sires used is less than the breed average)

The influence of the European sire breeds on cow breed is apparent; particularly the Simmental sires which are generally recognised as producing heavier calves.

4.2.3 Calving difficulty

The 5 point BREEDPLAN scoring system was used to assess calving difficulty, where 1 requires no assistance and 5 is major veterinary intervention. Generally there was a low level of calving difficulty across all breeds (table 6). It must be remembered that the cows used in this project were all mature cows, the oldest born in 1998, being 6 to 8 years old at calving in this project and the youngest born in 2001, being 3 to 5 years old when calving. When calving scores were analysed (table 6) there was no effect of calving season on calving difficulty, nor was there a significant effect of calf sire with the mean predicted calving difficulty scores of 1.03, 1.08, 1.01 and 1.06 for the Ang, Char, Lim and Short sires respectively (P=0.6 s.e.d ± 0.07). Calf birthweight was a significant factor (P<0.001), with the effect being an increase of 0.0075 ± 0.0023 of a score for each kg increase in birthweight.

Cow breed significantly affected calving difficulty score (P=0.03, ±0.06), (table 7), with the Sim x Ang having the highest mean score of 1.2, and the Lim x Ang at 0.96 the lowest.

Table 6 Cow breed and percentage of cows having each calving difficulty score

Calving difficulty Score	1	2	3	4	5	Overall %
Cow breed						
Ang	98.8 (84)	0.0	1.2 (1)	0.0	0.0	1.2
Ang x Her	99.0 (104)	1.0 (1)	0.0	0.0	0.0	1.0
Her x Ang	95.2 (60)	3.2 (2)	1.6 (1)	0.0	0.0	4.8
Her	95.9 (93)	1.0 (1)	2.1 (2)	1.0 (1)	0.0	4.1
Lim x Ang	100.0 (72)	0.0	0.0	0.0	0.0	0.0
Lin x Her	98.8 (79)	0.0	0.0	0.0	1.3 (1)	1.3
Sim x Ang	91.1 (51)	1.8 (1)	3.6 (2)	1.8 (1)	1.8 (1)	8.9
Sim x Her	98.1 (106)	0.0	0.9	0.0	0.9 (1)	1.9

Numbers in brackets are numbers of cows

Table 7 Effect of cow breed, calf sire breed and sex on mean calving difficulty score.

	Mean		Mean
Cow breed	(P= 0.032; s.e.d ±0.06)	**Dam sire breed**	(P=0.1; s.e.d ±0.04)
Angus	1.00^{bc}	Angus	1.02^{b}
Ang x Her	1.01^{bc}	Hereford	1.07^{a}
Hereford	1.08^{b}	Limousin	1.01^{b}
Her x Ang	1.05^{bc}	Simmental	1.1^{a}
Lim x Ang	1.00^{bc}		
Lim x Her	1.03^{bc}	**Calf sire breed**	(P=0.6; s.e.d ±0.07)
Sim x Ang	1.20^{a}	Angus	1.02ns
Sim x Her	1.02^{bc}	Charolais	1.08ns
		Limousin	1.01ns
Cow dam breed	(P=0.71;s.e.d ±0.03)	Shorthorn	1.06ns
Angus	1.06ns		
Hereford	1.05ns	**Sex**	(P=0.006; s.e.d ±0.03)
		Male	1.08^{a}
		Female	1.01^{b}

Means with different postscripts differ significantly

When breed of the cow's dam and sire were examined, there was no significant affect.
Cows having male calves had significantly higher calving difficulty scores than those having females, at 1.08 and 1.01 respectively (P=0.006; s.e.d ±0.03).

4.2.4 Weaning weight

Weaning weight (adjusted for age at weaning) was significantly affected by cow breed, calf sire breed, sex, and calving season (table 8). The calves from the Sim x Ang cows were heavier than those from the other breeds with a mean predicted weaning weight of 288.6kg (P<0.001, s.e.d ±4.85), the weaners from the Hereford cows were the lightest at 251.4 kg. In terms of dam sire breed, the progeny of cows sired by the Simmental bulls were the heaviest at 281.5kg (P<0.001; s.e.d ±3.38), followed by cows sired the Angus (271.3kg), Limousin (266.7kg) and Hereford (256.4kg) in that order. The cows from Angus dams produced heavier calves than those from Herford dams (272.5 and 265.5kg respectively; P<0.006; s.e.d ±2.56).

Table 8 Effect of cow breed, calf sire breed, season and sex on calf weaning weight (kg) (adjusted for age).

	Mean		Mean
Cow breed	(P<0.001; s.e.d ±4.85)	**Cow dam breed**	(P<0.006; s.e.d ±2.56)
Angus	271.2[bc]	Angus	272.5[a]
Ang x Her	271.6[bc]	Hereford	265.5[b]
Hereford	251.4[d]		
Her x Ang	262.1[c]	**Calf sire breed**	(P<0.001; s.e.d ±6.71)
Lim x Ang	271.0[bc]	Angus	251.1[b]
Lim x Her	262.3[c]	Charolais	283.9[a]
Sim x Ang	288.6[a]	Limousin	271.4[a]
Sim x Her	276.5[b]	Shorthorn	271.0[a]
Dam sire breed	(P<0.001; s.e.d ±3.38)	**Season**	(P<0.001; s.e.d ±10.26)
Angus	271.3[b]	Spring	231.2[b]
Hereford	256.4[c]	Autumn	307.5[a]
Limousin	266.7[b]		
Simmental	281.5[a]	**Sex**	(P<0.001; s.e.d ±2.56)
		Male	278.7[a]
		Female	260.0[b]

Means with different postscripts differ significantly

Both sex and calving season had a significant influence, the males (278.7kg) were heavier than the females (260.0kg) and those born in autumn (307.5kg) were heavier than those born in spring (231.2kg). However there was a sex by season interaction (P<0.001; s.e.d ±8.01) (figure 1) with the autumn born male calves being heavier (321.4kg) than autumn born females (293.6kg), but those born in spring (235.9kg) were no heavier than their female siblings (226.5kg). Calves born in autumn were always heavier than those born in spring regardless of sex, which is consistent with the Mediterranean seasonal pattern of pasture growth during winter and spring.

There were no significant differences in weaning weight between the Charolais (283.9kg), Limousin (271.4kg) or Shorthorn (271.0kg) sired calves, however those sired by the Angus bull were significantly lighter at 251.1kg (P<0.001; s.e.d ±6.71). The figures regarding the calf sire breed should be treated with some caution, as mean EBVs of these sires were NOT breed average, and it will not be until these figures are processed by BREEDPLAN using full genetic adjustments that accurate calf sire comparisons can be made.

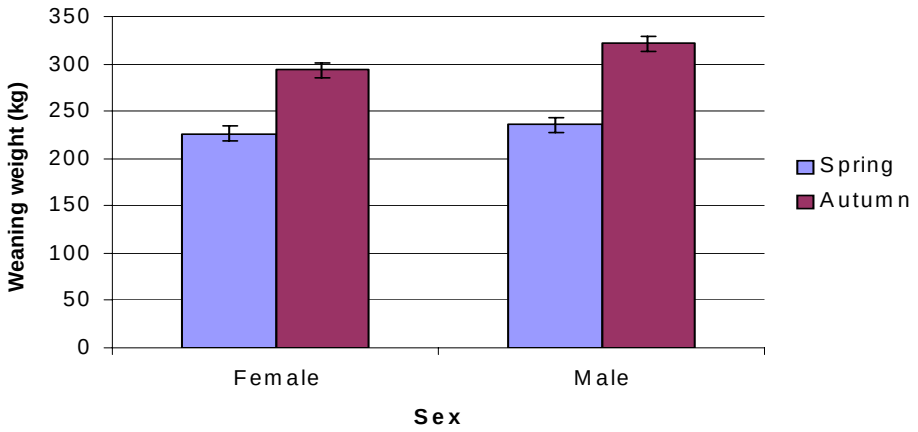

Figure 1 **Effect of calf sex and season on weaning liveweight (P<0.001; s.e.d ±8.01)**

4.2.5 200 day adjusted weaning weight

Whereas the weaning weight discussed above was corrected for actual age at weaning, the 200 day weaning weight has been derived by adjusting the raw weaning weight data to a 200 day weaning weight and then statistically analysed. This was done as a 200 day weaning weight is one of the BREEDPLAN traits used by industry.

Table 9 Effect of cow breed, calf sire breed, season and sex on 200 day weaning weight (kg).

	Mean		**Mean**
Cow breed	(P<0.001; s.e.d ±4.57)	**Cow dam breed**	(P<0.025;s.e.d ±2.41)
Angus	223.5^{bcd}	Angus	224.9^{a}
Ang x Her	225.3^{bc}	Hereford	219.5^{b}
Hereford	207.3^{e}		
Her x Ang	218.4^{cd}	**Calf sire breed**	(P<0.001; s.e.d ±4.335)
Lim x Ang	222.9b^{cd}	Angus	220.8 ^{b}
Lim x Her	215.1d^{e}	Charolais	231.3^{a} (-5.8) ^{A}
Sim x Ang	236.6^{a}	Limousin	220.9^{b} (+2.2)
Sim x Her	230.6^{ab}	Shorthorn	216.8 ^{b} (+4.8)
Dam sire breed	(P<0.001; s.e.d ±3.18)	**Season**	(P<0.001; s.e.d ±15.17)
Angus	224.5^{b}	Spring	194.5^{b}
Hereford	212.0^{e}	Autumn	250.4^{b}
Limousin	219.1^{b}		
Simmental	233.^{2a}	**Sex**	(P<0.001; s.e.d ±2.02)
		Male	230.6^{a}
		Female	214.3^{b}

Means with different postscripts differ significantly

[A] Figures in brackets are half the difference between the average EBV for 200b day weaning weight of the sires used compared to the breed average, indicating a possible correction factor to relate to the breed average, (a negative figure indicates the average EBVs of the sires used is less than the breed average)

The analysis of the 200 day weaning weight (table 9) indicated similar differences to the previous weaning weight analysis. As with the previous analysis the Sim x Angus cross cows weaned significantly heavier calves (236.6kg) than the other sire breed crosses, and the straight-bred Hereford the lightest (207.3kg). In terms of dam sire breed, the progeny of cows sired by the Simmental bulls were the heaviest at 233.5kg (P<0.001; s.e.d ±3.18), followed by cows sired by the Angus (224.5kg), Limousin (219.1kg) and Hereford (212.0kg) in that order. There was no evidence of any cow breed or calf sire breed interaction.

The cows from Angus dams produced heavier calves than those from Herford dams (224.9 and 219.5kg respectively; P<0.025; s.e.d ±2.41). The Charolais sired calves at 213.3kg were significantly heavier than the other calf sire breeds (P<0.001), however there was no difference between the other breeds. The autumn born calves were heavier than those born in spring, and, as with the previous weaning weight, the autumn born male calves (261.1kg) were heavier than their female counterparts (239.3kg) (P<0.001) but the difference between the spring born males (199.6kg) and females (188.8kg) (s.e.d ±11.02) (figure 2) was not statistically significant (figure 2).

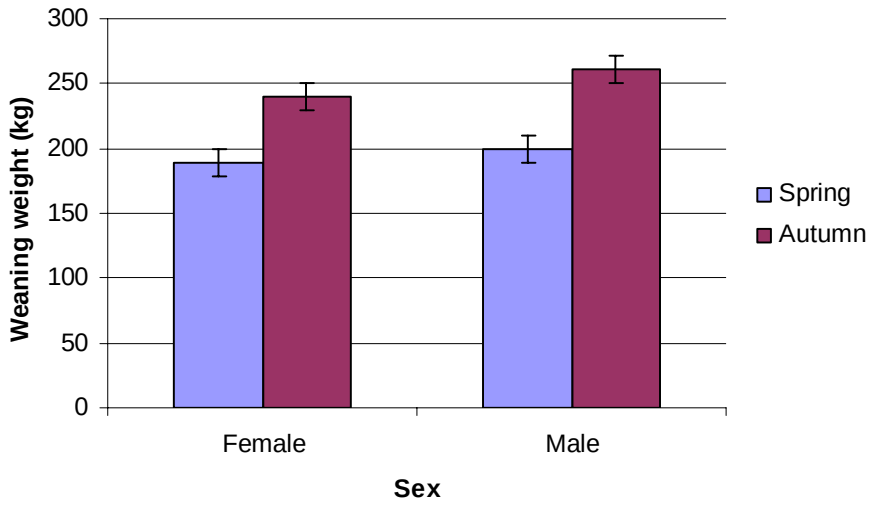

Figure 2 Effect of calf sex and season on 200 day weaning liveweight (P<0.001; s.e.d ±11.02)

These weaning figures indicate that gains can be made through appropriate use of different breeds. The Simmental sired females produce heavier calves than either of the straight bred Angus or Hereford cows, showing the advantage of using this sire breed in terms of weaning weight. Using Angus, Limousin or Simmental sires over the Hereford cow produced heavier weaners when compared to the straight bred Hereford cow. However the advantage of using these 3 breeds over an Angus cow was not always consistent, as only the Simmental sire produced heavier weaners than the straight bred Angus when joined to Angus cows. There was no significant difference in weaning weight of the progeny of the straight bred Angus cows when compared to progeny of cows derived from either Limousin of Herford bulls. Appropriate breed

use in crossbreeding program needs to be designed depending upon the starting breed used. In this case, the smaller Angus cows produced heavier weaners than Hereford cows.

There were differences in weaning weights due to calf sire breed, but these differences could reflect individual sire performance as Angus, Charolais, Limousin and Shorthorn bulls used to sire the weaners were not all breed average bulls for the traits measured, unlike the 22 bulls of each breed used to produce the cows. The mean 200 day weight EBVs for the sires used compared to the breed average varied between breeds. The 200 day breed average EBV for the Charolais, Limousin and shorthorn was 18.0, 13.0 and 18.0kg respectively, whereas the mean EBVs of the bulls used were 6.5, 17.4 and 27.5kg respectively. There were therefore differences of -11.5, +4.4 and +9.6 kg between the breed average and the bulls used average for the Charolais, Limousin and Shorthorn respectively. Halving these differences will give likely progeny weight differences, and give an indication of adjustment to the 200 day weaning weight needed to compare calf sire breeds on a breed average basis. Therefore adjusting the 200 day weaning weight by +5.8, -2.2 and – 4.8kg for the Charolais, Limousin and Shorthorn respectively may provide a better indication of calf sire breed differences.

4.2.6 Growth rate birth to weaning.

As would be expected, growth rate from birth to weaning was affected by the same factors affecting weaning weights. The overall mean growth rate was 0.92kg/day ± 0.02 (s.e.). Sex, season of calving, cow breed and calf sire breed all had a significant influence on growth rate. In relation to cow sire the cows sired by Simmental bulls had faster growing calves (0.96kg/d) than those sired by either the Hereford or Limousin (both 0.89kg/d) ($P<0.001$; s.e.d ±0.02).

The Lim x Ang and Sim x Ang cows had faster growing calves (both at 0.97kg/d) than the Angus (0.9kg/d), Hereford (0.89 kg/d), Her x Ang (0.89kg/d) and the Lim x Her (0.86kg/d) ($P<0.001$; s.e.d ±0.03). The cows from Angus dams produced calves that grew at 0.92kg/d compared to cows from Hereford dams that grew calves at 0.88kg/d, ($P<0.001$; s.e.d ±0.01).

Autumn born calves grew faster than spring born calves (1.11 compared to 0.73kg/d; $P<0.001$, s.e.d = 0.045). The autumn born males grew significantly faster than the autumn born females (1.16 and (1.05kg/d respectively), whereas the spring born males and females grew at similar rates (0.75 and 0.72 kg/d respectively) (fig 3). The Angus sire calves had the highest growth rates. However there was little difference between the other calf sire breeds.

Table 10 Effect of cow breed, calf sire breed, season and sex on growth rate from birth to weaning.

	Mean		Mean
Cow breed	(P<0.001; s.e.d ±0.03)	**Cow dam breed**	(P<0.001;s.e.d ±0.01)
Angus	0.90^{bc}	Angus	0.92^{a}
Ang x Her	0.94^{ab}	Hereford	0.88^{b}
Hereford	0.89^{bc}		
Her x Ang	0.89^{bc}	**Calf sire breed**	(P<0.001; s.e.d ±0.03)
Lim x Ang	0.97^{a}	Angus	0.98^{a}
Lim x Her	0.86^{c}	Charolais	0.92^{b}
Sim x Ang	0.97^{a}	Limousin	0.89^{b}
Sim x Her	0.95^{ab}	Shorthorn	0.89^{b}
Dam sire breed	(P<0.001; s.e.d ±0.02)	**Season**	(P<0.001; s.e.d ±0.045)
Angus	0.93^{a}	Spring	0.73^{b}
Hereford	0.89^{b}	Autumn	1.11^{a}
Limousin	0.89^{b}		
Simmental	0.96^{a}	**Sex**	(P<0.001; s.e.d ±0.009)
		Male	0.95^{a}
		Female	0.89^{b}

Means with different postscripts differ significantly

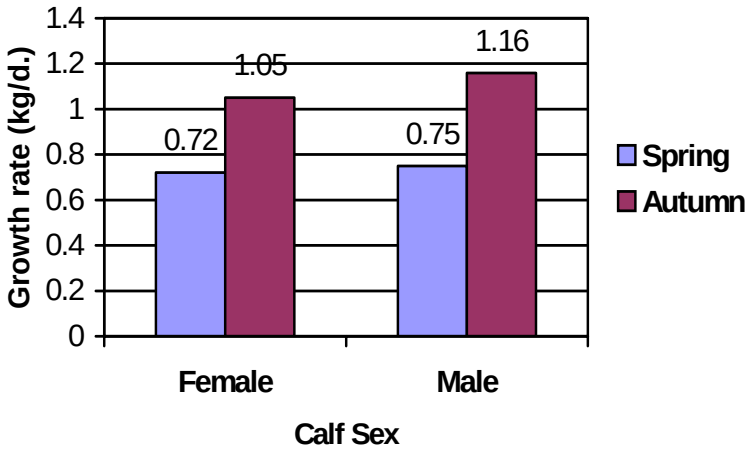

Figure 3 Effect of calf sex and season on growth to weaning (P<0.001; s.e.d ±0.03)

The breed differences in calf growth are a reflection of the differences previously discussed regarding weaning weights, and again indicate the advantages that can be gained through appropriate selection of breeds. The Simmental cross cows consistently had higher weaning weights and higher growth rates. However, this must be tempered against their heavier cow liveweights (from 13 to 30 kg heavier) which would require higher feed maintenance inputs. In contrast, the Angus cows tended to combine lighter cow weights with heavier progeny weights.

This comparison can be seen in table 11 where the calf weaning weight has been divided by cow liveweight to give Kgs of calf per kg of cow, an indication of efficiency. The Angus cows produced significantly more kgs of calf per kg of cow liveweight compared to the Hereford and Lim x Her cows, and even though the Simmental cross cows produced heavier calves their heavier liveweight countered this. In these terms cows from Angus dams were more efficient, and cows sired by Angus bulls were more efficient than those sired by Hereford bulls.

Table 11 Effect of cow breed, on kgs of calf at weaning per kg of cow liveweight

	Kg/kg		**Kg/Kg**
Cow Breed	P= 0.004; s.e.d± 0.018	**Cow Dam Breed**	P= 0.004; s.e.d ± 0.009
Angus	0.51^{a}	Ang	0.50^{a}
Ang x Her	0.47^{bc}	Her	0.47^{b}
Hereford	0.44^{c}		
Her x Ang	0.48^{ab}	**Cow Sire Breed**	P= 0.008; s.e.d ± 0.013
Lim x Ang	0.48^{ab}	Ang	0.50^{a}
Lim x Her	0.475^{bc}	Her	0.46^{bc}
Sim x Ang	0.50^{ab}	Lim	0.48^{ab}
Sim x Her	0.48^{ab}	Sim	0.50^{a}

4.2.7 Scan data of weaners

As additional information for the project, in March 2006 and 2007 weaners at both sites (both spring and autumn born) were scanned live for carcass traits by an accredited BREEDPLAN scanner. The average age of weaners at scanning was 418 days, the spring born being 517 days and autumn born 320 days. Liveweight was corrected for age at scanning, and as is usual practice when comparing carcass traits, weight at scanning was used as a covariate in the analysis of the fatness and EMA traits. Results are shown in table 12. There was no effect of calving season on any carcass parameter. However sex, cow breed and calf sire breed had a significant influence on most traits.

4.2.7.1 Liveweight at scanning

Liveweight at scanning followed the trend at weaning with the progeny from the Sim x Ang, Sim x Her, Ang x Her cross cows being the heaviest at 435, 434, and 425kg respectively (P<0.001; s.e.d ±7.2) . Progeny from Hereford cows (404kg) were significantly lighter than all apart from the Angus (417kg) and Lim x Her cross cows (410kg). There was no significant effect of cow dam breed. As was the case at weaning, the male calves were heavier 9% heavier than the females, 437 and 402kg respectively (P<0.001; s.e.d ±3.2). The Charolais sired calves (423kg) were heavier than those sired by Limousin, (408kg), there was no significant difference between those sired by Limousin and the Shorthorn (412kg) (P<0.001; s.e.d ±7.1).

4.2.7.2 Live scanned Eye Muscle area

The progeny from the Her x Ang cows had significantly larger scanned EMA (68.0 cm^2) compared to those from the Ang x Her cows (64.2 cm^2) (P<0.001; s.e.d ±1.69), there were no significant differences between the progeny from the other cow breeds. There were no significant differences between cow sire breeds or cow dam breeds. Female calves had larger EMA's compared to males (67.3 and 65.6 cm^2 respectively; (P=0.002; s.e.d ±0.52). The Limousin sired calves had larger EMA's (69.8 cm^2) compared to those of the Angus, Charolais or Shorthorn calf sire breeds, 64.9, 66.4 and 64.8 cm^2 respectively; (P<0.001, s.e.d ± 1.3).

Table 12 Effect of Cow breed, calf sire breed and sex on liveweight and scanned carcass traits of progeny.

	Scan Wt [A] (kg)	EMA [B] (sq cm)	P8 fat [B] (mm)	Rib fat [B] (mm)	IMF% [B]
Cow breed	P <0.001	P<0.001	P<0.001	P<0.014	P<0.001
s.e.d ±	7.2	1.69	0.38	0.2	0.25
Angus	417^{bce}	66.4^{ab}	4.7^{b}	4.88^{a}	4.9^{a}
Ang x Her	425^{ab}	64.2^{b}	5.0^{b}	4.57^{abc}	4.4^{bc}
Hereford	404^{e}	66.1^{ab}	4.6^{b}	4.33^{c}	3.7^{de}
Her x Ang	419^{bc}	68^{a}	6.1^{a}	4.8^{ab}	4.8^{ab}
Lim x Ang	413^{bc}	65.8^{ab}	4.7^{b}	4.41^{bc}	4.0^{cd}
Lim x Her	410^{bce}	66.1^{ab}	4.4^{b}	4.44^{bc}	3.8^{de}
Sim x Ang	435^{a}	66.8^{ab}	4.5^{b}	4.27^{c}	3.9^{de}
Sim x Her	434^{a}	67.2^{ab}	4.8^{b}	4.33^{c}	3.5^{e}
Cow sire breed	P<0.001	P=0.317	P<0.001	P=0.039	P<0.001
s.e.d ±	5.08	0.74	0.177	0.14	0.18
Ang	421^{b}	66.5ns	5.04^{a}	4.71^{a}	4.7^{a}
Her	411^{b}	65.7ns	4.99^{ac}	4.55^{b}	4.1^{b}
Lim	412^{b}	66.9ns	4.67^{bc}	4.43^{c}	3.9^{b}
Sim	435^{a}	66.8ns	4.59^{b}	4.31^{d}	3.7^{b}
Cow dam breed	P=0.425	P=0.10^{b}	P=717	P=0.09	P<0.001
s.e.d ±	3.75	0.54	0.2	0.11	0.13
Ang	421ns	66.8ns	5.0 ns	4.59ns	4.3^{a}
Her	418ns	66.1ns	4.7 ns	4.41ns	3.9^{b}
Sex	P<0.001	P=0.002	P=0.001	P<0.001	P,0.001
s.e.d ±	3.2	0.52	0.11	0.01	0.12
Male	437^{a}	65.6^{b}	4.3^{b}	4.07^{b}	3.6^{b}
Female	402^{b}	67.3^{a}	5.3^{a}	5.00^{a}	4.6^{a}
Calf Sire Breed	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
s.e.d ±	7.1	1.3	0.22	0.2	0.28
Angus	436^{a}	64.9^{b}	4.7^{b}	4.52^{ac}	5.0^{a}
Charolais	423^{ac} (-5.9)^{A}	66.4^{b}	4.5^{b}	4.17^{bc}	3.7^{c}
Limousin	408^{b} (+4.6)	69.8^{a}	4.9a	4.53^{ac}	3.3^{c}
Shorthorn	412^{bc} (+7.1)	64.8^{b}	5.2a	4.79^{a}	4.4^{b}

[A] Corrected for age at scanning, [B] corrected for liveweight at scanning
Means with different superscripts differ significantly

4.2.7.3 Live scanned P8 fat

The progeny of the Her x Ang (6.1mm) were fatter at the P8 site compared to all the other cow breeds, with no significant differences between progeny of the other cow breeds. With regards to cow sire breed, progeny of cows sired by Angus bulls were fatter (5.04mm) compared to progeny from cows sired by either Limousin or Simmental, (4.67 and 4.59mm respectively, P<0.001; s.e.d ± 0.177). Progeny from cows sired by Hereford bulls (4.99mm) were not significantly different from the other cow sire breeds. There was no difference due to cow dam breed. Females were fatter at the P8 site than males (5.3 and 4.3mm respectively; P=0.001, s.e.d ± 0.11mm). Limousin and Shorthorn sired calves (4.9 and 5.2mm) were fatter than the Charolais (4.5mm) sired calves.

4.2.7.4 Live scanned Rib fat

The scanned rib fat measurements followed those of the P8 measurements, the cows sired by Angus (4.7mm) and Hereford (5.6mm) bulls having fatter progeny than the cows sired by both Limousin (4.4mm) and Simmental sires (4.3mm) respectively (P=0.039, s.e.d ± 0.14mm). The Sim x Ang and Sim x Her (both 4.3mm) were significantly leaner than the Angus and Her x Ang (4.9 and 4.8 mm respectively). The Charolais sired calves were significantly leaner than those sired by the Shorthorn (4.2 and 4.8 mm respectively).

4.2.7.5 Live scanned IMF%

Scanned intramuscular fat measurements indicated that the Angus (4.9%) and Her x Ang (4.8%) cows had progeny with significantly higher percentages of IMF than the Limousin and Simmental cross breeds (P<0.001; s.e.d ±0.25mm). There was a significant effect of cow sire breed, with the progeny of cows sired by the Angus bulls having higher percentages of IMF (4.7%, compared to those cows sired by Hereford, Limousin or Simmental, (4.2, 3.9 and 3.7% respectively: P<0.001, s.e.d ± 0.18%. Breed of dam of cow was also significant with those cows from Angus dams having progeny with higher percentages of IMF (4.3 vs. 3.9%; P<0.001; s.e.d ± 0.13%).

Females (4.6%), had higher levels of IMF% compared to the males (3.6%) (P<0.001; s.e.d ± 0.12%).

Of the calf sire breeds, the Angus had the highest IMF% at 5.0%, followed by the Shorthorn (4.4%), there was no difference between the Charolais (3.75%) and, Limousin (3.3%) that were both significantly lower than the other 2 breeds (P<0.001; s.e.d ±0.28mm)

4.2.8 Slaughter Data

In addition to the live animal scan data, we were able to collect some slaughter data (table 13) from 271 progeny from Struan. These cattle were grown out on irrigated pasture followed by grain based rations in a farm based feedlot until they had acquired the appropriate weight (estimated HSCW 180kg) and P8 fat and (>6mm) to be slaughtered at the local Naracoorte export meatworks. The calves were selected in groups meeting these minimum criteria. Meat Standards Australia (MSA) graders graded the carcasses for fatness, marbling and EMA. Liveweight at slaughter was 468.6 ± 12.4 kg (mean ± s.e) at 475± 72.1 days of age (mean ± s.e).

4.2.8.1 Slaughter liveweight

The calves had to meet combined weight and fat minimum standards for marketing purposes which resulted in small differences in age at slaughter and would have reduced expression of genotype differences. Liveweight at slaughter was corrected for age at slaughter. The Sim x Ang (488kg) were significantly heavier than the Hereford (446kg), Lim x Her (452) and Her x Ang (465kg) ($P<0.001$; s.e.d ± 11.2kg). There was no difference between the Angus, Ang x Her, Lim x Ang, Sim x Ang or the Sim x Her cow breeds. In terms of cow sire breed, the progeny of cows sired by Hereford bulls were significantly lighter at slaughter (456kg) than progeny of cows sired by either Simmental and Angus bulls (480 and 474kg respectively) ($P<0.001$; s.e.d ± 8.0kg). Cows from Angus dams produced heavier progeny at slaughter than cows from Hereford dams (476, vs. 461 kg; $P<0.001$; s.e.d ± 5.6kg). Males were 21kg heavier than females (479 vs. 458kg; $P<0.001$; s.e.d ± 4.9kg). There was no difference ($P>0.05$) in liveweight between calves sired by Charolais, Limousin or Shorthorn sires, nor were there any cow breed or calf sire breed interaction. The autumn born cattle at Struan had heavier slaughter liveweights (482.3 vs. 454kg) compared to those born in spring ($P<0.006$; s.e.d ± 10.2kg.). There was also significant difference in slaughter age between the spring and autumn born cattle. When corrected for liveweight the autumn born cattle were slaughtered at 384.3 days of age, whilst it took the spring born cattle an extra 150 days to reach slaughter weight (534.7 days) ($P<0.001$; ± 7.4 days). There was no cow breed effect on slaughter age ($P=0.582$).

Table 13 Effect of Cow breed, calf sire breed and sex on slaughter weight and carcass traits.

	Slaughter Wt [A] (kg)	HSCW [B] (kg)	EMA [B] (sq cm)	P8 fat [C] (mm)	Rib fat [C] (mm)	MSA Marble [C]
Cow breed	P <0.001	P<0.001	P<0.001	P<0.095	P<0.002	P<0.013
s.e.d ±	11.2	6.3	0.74	1.05	0.6	15.8
Angus	473^{abc}	250^{bc}	55.7^{bc}	12.8^{a}	7.0^{bc}	232^{bc}
Ang x Her	476^{ab}	249^{bc}	55.5^{c}	12.4^{ab}	8.3^{a}	255^{ab}
Hereford	446^{d}	235^{d}	55.5^{c}	11.1^{abc}	7.0^{bc}	240^{bc}
Her x Ang	465^{bcd}	249^{bc}	54.5^{c}	12.9^{a}	7.5^{ab}	272^{a}
Lim x Ang	476^{ab}	260^{ab}	57.0^{ab}	10.5^{bc}	6.7^{bc}	243^{abc}
Lim x Her	452c^{d}	243^{cd}	57.4^{a}	10.3^{c}	6.8^{bc}	217^{c}
Sim x Ang	488^{a}	264^{a}	55.8^{bc}	11.5^{abc}	6.0^{a}	213^{c}
Sim x Her	472^{abc}	250^{bc}	54.9^{c}	11.9^{abc}	7.5^{ab}	232^{bc}
Cow sire breed	P<0.001	P<0.001	P<0.001	P<0.017	P=0.019	P<0.021
s.e.d ±	8.0	4.6	0.53	0.76	0.43	11.4
Ang	474^{ab}	249^{ab}	55.6^{b}	12.6^{a}	7.7^{a}	243^{ab}
Her	456^{c}	242^{b}	55.0^{b}	12.0^{ab}	7.2^{ab}	256^{a}
Lim	464^{bc}	251^{a}	57.2^{a}	10.4^{c}	6.8^{b}	230^{b}
Sim	480^{a}	257^{a}	55.3^{b}	11.9^{bc}	6.8^{b}	221^{b}
Cow dam breed	P=<0.001	P<0.001	P=0.94	P=0389	P=0.167	P=656
s.e.d ±	5.6	3.2	0.38	0.52	0.31	8.1
Ang	476^{a}	257^{a}	55.7ns	12.1ns	6.9ns	240ns
Her	461^{b}	244^{b}	55.8ns	11.4ns	7.4ns	236ns
Sex	P<0.001	P<0.001	P=0.009	P=0.001	P<0.018	P=0.800
s.e.d ±	4.9	2.8	0.37	0.45	0.29	7.8
Male	479^{a}	261^{a}	55.3^{b}	11.0^{b}	6.8^{b}	237ns
Female	458^{b}	239^{b}	56.3^{a}	12.3^{a}	7.5^{a}	239ns
Calf Sire Breed	P=0.062	P=0.038	P<0.001	P=0.09	P<0.308	P<0.004
s.e.d ±	11.4	7.5	0.75	1.27	0.58	14.2
Angus	491 ns	262^{a}	54.1^{b}	13.2^{a}	6.8ns	259^{a}
Charolais	467 ns	248 ^{ab}	55.6^{bc}	10.7^{ab}	6.8ns	231^{ac}
Limousin	453 ns	245^{b}	57.4^{a}	10.5^{b}	7.2ns	213^{bc}
Shorthorn	463 ns	245^{b}	56.0^{ac}	12.3^{ab}	7.6ns	249^{a}

[A] Adjusted for age; [B] Adjusted for liveweight (liveweight used as a covariate); [C] Adjusted for HSCW. Means with different superscripts differ significantly

4.2.8.2 Hot Standard Carcass weight (HSCW)

The breed differences in slaughter weight were generally reflected in HSCW with the progeny of Sim x Ang and Lim x Ang cows having heavier carcasses those from the Hereford (235kg) and Lim x Her (243kg) cow breeds (P<0.001; s.e.d ± 6.3kg). The progeny from Simmental and Limousin sired cows had heavier carcasses (257 and 251kg) than progeny from cows sired by Hereford bulls (242kg), but there was no difference in HSCW of progeny from cows sired by Angus (249kg) or Hereford bulls (P<0.001; s.e.d ± 4.6kg). As with slaughter liveweight, cows from Angus dams produced progeny with heavier carcasses (257kg) than progeny of cows from Hereford dams (244kg), (P<0.001; s.e.d ± 3.2kg). Carcasses of males were 22kg heavier than those of females (261 vs. 239 kg); (P<0.001; s.e.d ± 2.8kg). There was no difference in HSCW between calves sired by either Charolais, Limousin or Shorthorn sires (248, 245 and 245kg respectively (P=0.36; s.e.d ± 7.5kg). However, those sired by Angus (262kg) had heavier carcasses than the other sire breeds (P<0.001; s.e.d ± 7.5kg) There were no cow breed or calf sire breed interactions. Even though the HSCW showed no significant difference due to season,

when corrected for age, there was a significant age difference, with Spring born cattle being 534.7 days of age, and those born in autumn 384.3 days of age (P<0.001; s.e.d. ± 7.4)

4.2.8.3 Carcass Eye Muscle Area

The Limousin cross (both dam and sire) increased the EMA and decreased the fatness of carcasses (both subcutaneous and intramuscular). The Lim x Ang and Lim x Her cows produced progeny with larger eye muscle areas (57.4 and 57.0cm^2) than those from Hereford (55.5cm^2), Her x Ang (54.5cm^2) or Sim x Her (54.9cm^2). There was no difference in EMA of progeny from Angus (55.7cm^2), Lim x Ang (57.0cm^2) or Sim x Ang (55.8cm^2) cows. In terms of cow sire breed, Progeny from Limousin sired cows (57.2cm^2) had significantly larger EMA than those from Angus, Hereford or Simmental sire cows (55.3, 55.0 and 55.3cm^2 respectively), (P<0.001; s.e.d ± 0.53 cm^2). There was no difference due to cow dam breed. The Limousin sired calves had a larger EMA (57.4cm^2) compared to the Angus (54.1cm^2) and Charolais sired calves 55.6cm^2), P<0.001 s.e.d ± 0.75cm$^{2.}$. There was no difference between the Shorthorn and Limousin calves, or between the Limousin or Angus calves.

4.2.8.4 Carcass P8 and Rib fat

Cow breed did not have a significant effect (P>0.05) on P8 rib fat. However when compared on sire of cow breed basis, cows sired by Angus (12.6mm) and Hereford (12.0mm) bulls produced fatter progeny than cows sired by Limousin (10.4mm), (P<0.017; s.e.d ± 0.76mm).There was no difference in progeny from cows sired by either Simmental, Angus or Hereford. Angus sired cows produced calves with more rib fat compared to cows from Simmental and Limousin bulls. Breed of the cow's dam did not have an effect on fatness, which may be expected, as both being British bred would not be considered to be so different in fatness, compared to the Euro breeds.

4.2.8.5 MSA Marble score

The Her x Ang cows produced progeny with the highest marble score (272) when compared to the Angus (232), Hereford (240), Lim x Her (217), Sim x Ang (213) and Sim x Her (232) (P<.013; s.e.d ± 15.8). In Terms of cow sire breed, the Angus (243), and Her (256) sired cows produced progeny with higher scores than those of the Lim (230) and Sim (221) sired cows (P<0.021; s.e.d ± 11.4). There was no difference due to cow dam breed. Angus (259) and Shorthorn (249) sired calves had higher marble scores than those sired by Limousin (213), (P<0.004; s.e.d ± 14.2), the There was no difference between the Charolais calves (231) and the other 3 sire breeds.

4.2.9 Cow fertility data

4.2.9.1 Calving to calving Interval

The number of days from calving to calving as an indicator of possible differences due to breed was analysed, results shown in table 4 There were no apparent differences due to either individual cow breed, cow dam breed or cow sire breed. The mean predicted calving to calving interval was 367 ±2.2 days (mean ± s.e.)

Table 14 Effect of cow breed, on calving to calving interval

	Mean		Mean
Cow breed	(P=0.477 s.e.d ±6.7)	**Cow dam breed**	(P=0.87;s.e.d ±3.6)
Angus	364ns	Angus	366ns
Ang x Her	369ns	Hereford	369ns
Hereford	369ns		
Her x Ang	361ns	**Dam sire breed**	(P=.658; s.e.d ±4.7)
Lim x Ang	363ns	Angus	367ns
Lim x Her	373ns	Hereford	365ns
Sim x Ang	369ns	Limousin	368ns
Sim x Her	371ns	Simmental	370ns

4.2.9.2 Birth day of year

Birth day of year (table 15) was used as an indicator of fertility. As cows were synchronised for AI, natural mating data could not be expressed. However it would be expected that if fertility was affected cows may take longer to conceive, and thus would calve later in the calving season, i.e. day of the year. The mean calving day of the year for autumn and spring born calves was day 115 and 242 respectively.

There were no significant differences between breeds, thus no indication that the breed of cow had any influence on calving day of year. If there was a breed effect on post-partum anoestrus interval, or effect on failure to conceive at the first AI in the synchronise program, this would be reflected in calving date. There was no evidence of this occurring.

Table 15 Effect of cow breed, on birth day of year.

	Mean			Mean	
	Autumn	**Spring**		**Autumn**	**Spring**
Cow breed	(P=0.405 s.e.d ±9.9)		**Cow dam breed**	(P=0.982;s.e.d ±9.2)	
Angus	114ns	242ns	Angus	113ns	241ns
Ang x Her	114ns	243ns	Hereford	116ns	243ns
Hereford	116ns	244ns			
Her x Ang	118ns	237ns	**Dam sire breed**	(P=0.676; s.e.d ±9.5)	
Lim x Ang	109ns	243ns	Angus	114ns	242ns
Lim x Her	118ns	244ns	Hereford	116ns	241ns
Sim x Ang	107ns	240ns	Limousin	115ns	243ns
Sim x Her	117ns	242ms	Simmental	113ns	241ns

4.2.9.3 Percentage cows remaining in the herd

The number of heifers that were available for breeding at the completion of the original Multi-breed project was compared to the number of females that remained at the end of this present project (table 16). Cows not remaining either died or had been culled. These females were used in the CRC 2 'Regional Combinations and growth paths" project prior to being used in this current project. From their first joining until the present project, these females were culled from the herds if they failed to conceive in 1 year or if they were structurally unsound for some reason. If they failed to conceive in the autumn or joining they were then given a chance in the spring mating and vice versa, and then culled if not pregnant.

Table 16 Effect of cow breed, on percentage of cows remaining in the herd

	Started	Remain	%		Started	Remain	%
Cow Breed		P= 0.28; s.e.d± 8.3		**Cow Dam Breed**			P= 0.61; s.e.d ± 4.2
Ang	70	43	58.8	**Ang**	243	142	57.9ns
Ang x Her	85	54	61.2	**Her**	352	199	57.7ns
Her	92	54	60.6				
Her x Ang	55	33	63.7	**Cow Sire Breed**			P= 0.266; s.e.d ± 5.9
Lim x Ang	62	36	59.0	**Ang**	155	97	60.0ns
Lim x Her	98	42	46.5	**Her**	147	87	62.2ns
Sim x Ang	56	30	50.0	**Lim**	160	78	52.8ns
Sim x Her	77	49	62.3	**Sim**	133	79	56.1ns

* Year of birth was used as a covariate.

The percentages indicate that there were fewer Lim x Her remaining in the herd at the completion of the project compared to the Her x Ang, however this wasn't significant (P=0.28). There were no clear differences between the other breed types. Differences between the straight-bred and first cross Angus – Hereford combinations indicates approximately 4.6% hybrid vigour which is similar to that noted in the Multibreed project, but about half that noted in the US studies at Clay Centre. There were no significant difference due to either dam sire bred of cow dam breed.

4.2.9.4 Calving and weaning percentage

The percentages of calves born and weaned to cows joined are shown in table 17. Whilst only significant at P<0.072, the Lim x Ang had the highest percentage of calves born (97.8%), with the Lim X Her and straight Hereford having the lowest percentage (82.3%), there was no significant difference between the other breeds. The Lim x Ang weaned significantly more calves (95.7%), (P=0.012; s.e.d ± 6.2) than the other breed-types apart from the straight bred Angus, with no difference between the other breeds. There was no effect of either dam sire breed and cow dam breed on either calving or weaning percentage.

Table 17 Effect of cow breed on percentage of calves born and weaned to cows joined,

	% Calves born[A]	% Calves weaned		% Calves born	% Calves weaned
	P=0.072;	P=0.012;	**Cow dam**	P=0.072;	P=0.098;
Cowbreed	s.e.d ± 5.0	s.e.d ± 6.2	**breed**	s.e.d ± 2.4	s.e.d ± 3.0
Ang	90.2 (92)	84.1 [b] (88)	Ang	89.8 ns	85.1ns
Ang x Her	88.2 (119)	78.9 [b] (104)	Her	85.1 ns	82.3ns
Her	82.3 [b] (113)	73.5 [b] (102)			
			Cow sire	P= 0.074;	P=0.172;
Her x Ang	87.5 (72)	78.3 [b] (69)	**breed**	s.e.d ± 3.5	s.e.d ± 4.3
Lim x Ang	97.8[a] (74)	95.7 [a] (70)	Ang	89.2ns	86.5ns
Lim x Her	82.3 [b] (96)	76.2 [b] (84)	Her	84.9ns	81.3ns
Sim x Ang	85.2 (67)	73.3 [b] (60)	Lim	89.8ns	85.3ns
Sim x Her	83.6 (122)	83.2 [b] (101)	Sim	85.8ns	80.1ns
Average	87.4 (755)	80.4 (678)			

Numbers in brackets are numbers of cows.
[A] This data set includes calves born at Struan in 2006, not contained in the weaning data.

Tables 18 and 19 show rankings of the predicted means (from smallest to largest) for the various traits for each cow breed, cow sire breed and cow dam breed, regardless of tests of significance.

Table 18 Summary of ranking (smallest to largest) of the predicted means for the various traits for each cow breed

		Ang x Ang	Ang x Her	Her x Her	Her x Ang	Lim x Ang	Lim x Her	Sim x Ang	Sim x Her
Cow									
	Wt	1	5	4	2	6	3	7	8
	CS	4	6	6	6	3	5	1	2
	EMA	5	4	1	6	7	8	2	3
	P8 fat	4	7	8	5	2	6	1	3
	Rib fat	6	8	4	5	2	7	1	3
	IMF%	8	7	2	6	4	5	3	1
	Calving %	6	5	1	4	7	1	3	2
	Calv diff	1	2	6	5	1	4	7	3
	Wean%	7	5	2	4	8	3	1	6
	Cows Remain	3	6	8	5	4	1	2	7
	Kg Calf /kg Cow	6	2	1	4	4	3	5	4
	Kg Calf weaned/Kg Cow	6	3	1	4	7	2	3	5
Calf									
	Birth weight	2	3	4	1	1	5	5	6
	Weaning wt	5	6	1	2	4	3	8	7
	200day wean wt	5	6	1	3	4	2	7	8
	Growth birth to wean	3	4	2	2	6	1	6	5
400 day scan									
	Weight	4	6	1	5	3	2	8	7
	EMA	4	1	3	7	2	3	5	6
	P8 fat	4	6	3	7	4	1	2	5
	Rib fat	7	5	2	6	3	4	1	2
	IMF%	8	6	2	7	5	3	4	1
Slaughter									
	Weight	5	6	1	3	6	2	7	4
	HSCW	4	3	1	3	5	2	6	5
	EMA	4	3	3	1	6	7	5	2
	P8	8	6	3	7	2	1	4	5
	Rib fat	4	6	4	5	2	3	1	5
	MSA Marble	3	6	4	7	5	2	1	3

This table represents the ranking of the predicted means of the traits for each cow breed regardless of any statistical tests of significance.

Table 19 Summary of ranking (smallest to largest) of the predicted means for the various traits for each cow breed

		Cow sire breed				Cow dam breed	
		Ang	**Her**	**Lim**	**Sim**	**Ang**	**Her**
Cow							
	Wt	1	2	3	4	1	2
	CS	2	3	2	1	1	2
	EMA	3	2	4	1	2	1
	P8 fat	3	4	2	1	1	2
	Rib fat	4	3	2	1	1	2
	IMF%	3	2	2	1	2	1
	Calving %	3	1	4	2	2	1
	Calv diff	2	3	1	4	2	1
	Wean%	4	2	3	1	2	1
	Cows Remain	3	4	1	2	2	1
	Kg Calf /kg Cow	3	1	2	3	2	1
	Kg Calf weaned/Kg Cow	4	1	3	2	2	1
Calf							
	Birth weight	2	1	3	4	1	2
	Weaning wt	3	1	2	4	2	1
	200day wean wt	3	1	2	4	2	1
	Growth birth to wean	2	1	1	3	2	1
400 day scan							
	Weight	3	1	2	4	2	1
	EMA	2	1	4	3	2	1
	P8 fat	4	3	2	1	2	1
	Rib fat	4	3	2	1	2	1
	IMF%	4	3	2	1	2	1
Slaughter							
	Weight	3	1	2	4	2	1
	HSCW	2	1	3	4	2	1
	EMA	3	1	4	2	1	2
	P8	4	3	1	2	2	1
	Rib fat	3	2	1	1	1	2
	MSA Marble	3	4	2	1	2	1

This table represents the ranking of the predicted means of the traits for each cow breed regardless of any statistical tests of significance.

4.2.10 Summary of breed effects

4.2.11 *Co*w dam breed effects

In the majority of instances the analysis indicated that breed of the cows dam influenced most traits measured. Even though the two cow dam breeds used were both British bred, and would be considered to have similar attributes, differences were evident.

The cows from Hereford dams were heavier and fatter than cows reared by Angus, but were no different in terms of eye muscle area.

Cows reared by Angus dams had significantly lighter calves at birth compared to those reared by Herford dams. However there was no difference in calving difficulty. Whilst having lighter calves

at birth, the cows reared by Angus dams weaned significantly heavier calves, 272.5 and 265.5kg respectively on an age corrected basis, and 224.9 and 219.5 kg respectively when corrected to the industry standard of 200 days of age. As a consequence of lower birthweight and higher weaning weight, the calves from cows reared by Angus dams grew faster to weaning compared to calves from cows reared by Hereford dams.

The cows with Angus dams were lighter (544kg) than those reared by Hereford dams, (559kg), and when comparing these cow dam breeds in terms of kg of calf weaned to kgs of cow, which is an indicator of efficiency, the cows reared by Angus dams were more efficient, producing 0.50 kg of calf per kg of cow liveweight, compared to 0.47. Thus we have faster growing and heavier calves produced more efficiently by cows reared by Angus dams in comparison to those reared by Herford.

Breed of the cow's dam had very little influence on carcass traits. The progeny of cows reared by Angus dams had a higher scanned IMF%, than cows reared by Hereford dams. However the Hereford reared cows tended to have fatter progeny at slaughter.

There was no effect of cow dam breed on any level of fertility measured, or percentage remaining in the herd. Nor was there any significant difference in percentage of calves born or weaned. This study does not support the commonly held belief that European breed crosses will fail because of infertility.

Because there was no calf sire breed or cow breed interaction it would be unlikely that the differences observed between these 2 cow dam breeds would be any different with the use of different calf sires.

4.2.12 Cow sire breed effects

Simmental sired cows were heavier than both the Angus and Hereford sired cows, but not different to those sired by Limousin. Simmental sired cows had less subcutaneous fat than those from the other 3 breeds. However, the Angus sired cows had higher intramuscular fat levels than the other breeds. The Limousin sired cows had higher eye muscle areas than those sired by the other breeds.

Whilst cow dam breed made little difference to post weaning carcass traits, the breed of the cow's sire affected most traits. Cows sired by Angus produced progeny that were fatter at post weaning scanning and had higher levels of IMF%, than cows sired by Limousin or Simmental bulls. However, there was no difference due to cow's sire breed in scanned eye muscle area. At slaughter the progeny of Euro sired cows (both Limousin and Simmental) had higher EMA's and were leaner.

Simmental sired cows produced heavier calves at weaning followed by Angus and Limousin. However, because the cows sired by Simmental bulls were the heaviest at 567kgs when comparing the weight of weaned calf produced per kilogram of cow liveweight there was no difference between the Simmental and Angus sired cows. Hereford sired cows produced the lightest weaners. Cow sire breed influenced growth to weaning, with both the Angus and Simmental sired cows having faster growing weaners, compared to the Limousin and Herford.

Cow sire breed influenced calf birth weight, the Simmental sired cows having the heaviest calves and the Angus the lightest. Whilst calving difficulty was generally low. Both the Hereford and Simmental sired cows had higher calving difficulty than the other 2 breeds.

There was no effect of the cows sire breed on any of the fertility parameters, and no interaction between cow sire breed and calf sire breed for any trait.

4.2.13 Cowbreed effects

As could be expected, individual cowbreed influenced all traits. The Angus and Her x Ang were lighter than the other 6 cow breeds, and whilst Sim x Her cows weighed the heaviest at 571kg, the differences were not significant. There were differences in fatness, the Sim x Ang being the leanest, and the Lim X Her had the largest eye muscle area. The Angus, Her x Ang and Ang x Her had the highest intramuscular fat levels.

The breed of cow had only small effect on calf birth weight, the Her x Ang and Lim x Ang having lighter calves that the Lim x Her, Sim x Ang and Sim x Her cows. The Sim x Ang cows had a higher calving difficulty score than the other 7 cow breeds.

The Sim x Ang cows produced the heaviest weaners at 288.6kg. When converting this to kgs of calf per cow liveweight, at 0.51kg/kg they were similar to the straight Angus at 0.52 kg/kg cow liveweight. The Hereford cows produced the lightest calves, and the lowest calf liveweight per kg of cow liveweight at 0.45 kg/kg. In terms of calf liveweight gain from birth to weaning, the calves from the Lim x Ang and Sim x Ang cows grew faster than the Lim x Her.

There was little difference in scanned eye muscle area of the weaners due cow breed. The Her x Ang had the highest P8 fat measure, and the progeny of the Angus had more rib fat that those of the Sim x Ang, Sim x Her and Hereford cows. The Angus, Ang x Her and Her x Ang had progeny with a higher IMF% than the Euro cross cows.

Slaughter data indicated that the Sim x Ang cows produced progeny with heavier carcasses, and Limousin cross cows produced progeny with a larger eye muscle area that were leaner at the P8 rib site.

There was no effect of cow breed on calving to calving interval, or day of birth. However the Lim x Angus had a higher percentage of calves born compared to the Hereford or Lim x Her cows. The Lim x Ang cows also weaned a higher percentage of calves than the other breeds.

Cow breed didn't affect the number of cows remaining in the herd from birth to weaning in 2006. The oldest cow was 8 and the youngest 6 years old.

4.2.14 Calf Sire breed

Caution should be used when comparing the effects of calf sire breed, as a limited number of sires were used, and they were not all breed average sires for their respective breeds. Nevertheless the Charolais sired calves were heavier at weaning. It will not be until BREEDPLAN has analysed the data in respect of the sires and cows own EBVs that valid comparisons will be able to be made. There was no evidence of any calf sire breed by cow breed interaction with any trait measured.

4.2.15 Hybrid Vigour

The effect of hybrid vigour with the Hereford, Angus and their respective reciprocal crosses in the cow breeds was examined for the traits measured and is presented in table 20. There was evidence of positive hybrid vigour in most traits measured apart for eye muscle area and weaning

percentage, and the traits of birthweight (-1.7%) and calving difficulty (-1.0%), which for those calving traits is favourable. The weaning and liveweight traits showed a 2- 3% increase due to hybrid vigour and HSCW showed a 2.7% increase. Hybrid vigour in the fatness traits indicated increases from +1.7% (scanned rib fat) through to +19.4% for scanned P8 fat depth and increases in intramuscular fat (+11.7% for marble score and 7.0 % for scanned IMF%. These increases indicate the gains that can be achieved through strategic use of crossbreeding to provide more productive females.

Table 20 The effect of hybrid Vigour on the various traits measured

	Breed	Ang x Ang	Ang x Her	Her x Her	Her x Ang	Mean Her & Ang	Mean XB	Hybrid Vigour %
	Trait							
Cow Scan	Weight	519	557	555	535	537.0	546.0	1.7
	CS	2.8	3	3	3	2.9	3.0	3.4
	EMA	61	60.6	57.9	61.7	59.5	61.2	2.8
	P8 fat	6	7.3	7.4	6.7	6.7	7.0	4.5
	Rib fat	5.2	5.8	4.7	5.1	5.0	5.5	10.1
	IMF%	5.3	5.2	3.9	5	4.6	5.1	10.9
	Birth Wt	44	43.9	44.4	42.5	44.0	43.2	-1.7
	Calv Diff	1	1.01	1.08	1.05	1.0	1.0	-1.0
	Wean	271	272	251.4	262.1	261.3	266.9	2.1
	200 d wean wt	224	225	207.3	218.4	215.4	221.9	3.0
	Growth	0.9	0.94	0.89	0.89	0.9	0.9	2.2
	Kg calf/Kg cow	0.5	0.47	0.44	0.48	0.5	0.5	0.0
Weaner Scan	Wt	417	425	404	419	410.5	422.0	2.8
	EMA	66	64.2	66.1	68	66.3	66.1	-0.2
	P8 fat	4.7	5	4.6	6.1	4.7	5.6	19.4
	Rib fat	4.9	4.57	4.33	4.8	4.6	4.7	1.7
	IMF%	4.9	4.4	3.7	4.8	4.3	4.6	7.0
Slaughter	Wt	473	476	446	465	459.5	470.5	2.4
	HSCW	250	249	235	249	242.5	249.0	2.7
	EMA	56	55.5	55.5	54.5	55.6	55.0	-1.1
	P8 fat	13	12.4	11.1	12.9	12.0	12.7	5.9
	Rib fat	7	8.3	7	7.5	7.0	7.9	12.9
	Marble	232	255	240	272	236.0	263.5	11.7
	Calv To Calv	364	369	369	361	366.5	365.0	-0.4
	Remain	59	61.2	60.6	63.7	59.7	62.5	4.6
	%Born	90	88.2	82.3	87.5	86.3	87.9	1.9
	%Wean	84	78.9	73.5	78.3	78.8	78.6	-0.3

4.2.16 Calving season

Calving season was only retained in the analysis if it was a significant factor, thus there was no effect on calf birthweight or calving difficulty. However autumn weaned calves were heavier at weaning for both the age adjusted and 200 day weaning weights. There was no significant difference at scanning, but the autumn born cattle at Struan had heavier slaughter liveweights (482.3 vs. 454kg) compared to those born in spring, and the spring born cattle required an additional 150 days to reach slaughter weight compared to those born in autumn.

5 Success in Achieving Objectives

5.1 Data provided

5.1.1 Fertility data

5.1.2 Ease of calving data

5.1.3 Birthweight data and growth data of progeny to weaning.

5.1.4 Additional post weaning progeny scan and slaughter data.

The project has achieved its objectives which were to:
Provide BREEDPLAN with data from the F1 Multibreed females on:-

a. Fertility of dams
b. Ease of calving
c. Birthweight data and growth data of progeny to weaning

In addition, post weaning ultrasound scanning of weaners and carcass data on 270 Struan progeny has been obtained.

6 Impact on Meat and Livestock Industry – now & in five years time

6.1 Impact on Meat and Livestock Industry – now

6.1.1 Production differences

The data has yet to be fully analysed in BREEDPLAN and the implications will depend on particular producer circumstances. However, an example of comparisons which we have noted include a comparison of performance of cows derived from the Angus and Hereford base herds, and comparisons of cows sired by Angus, Hereford, Limousin and Simmental sires.

The use of different base herd breeds rather than Angus and Hereford, may have provided more varied results, as those dam breeds are both British bred genotypes. However, genetic differences between these to breeds are divergent enough to provide a comparison of the effects of hybrid vigour which indicated that most traits benefited from heterosis.

The immediate impact of these results on the beef industry would be an awareness of differences in maternal traits of cows derived from different dam and sire breeds, and as such would allow producer to make more informed immediate decisions on choice of a base herd breed. However it

will not be until the progeny of cow breeds selected are weaned that differences will become evident.

6.1.1.1 Production differences due to cow dam breed

Production differences due to breed of the base cow herd should be considered when considering cross breeding system, as most production traits in this study were influenced by breed of the cows dam i.e. Angus vs. Hereford: -

(a) Weight of mature cows: cows from Angus dams were lighter than Hereford (544 vs. 559kg) thus requiring lower maintenance.
(b) Birthweight lower in Angus (43.3 vs. 44.7kg)
(c) Angus weaned heavier calves (272 vs. 266kg)
(d) Angus had faster growing calves (0.92 vs. 0.88kg/d)
(e) Angus produced calves with higher IMF% (4.3 vs. 3.9)
(f) Angus heavier progeny at slaughter (476 vs. 461kg)
(g) Angus had higher HSCW (257 vs. 244kg)
(h) Angus produced more calf per kg cow liveweight (0.50 vs. 0.47kg/kg)

6.1.1.2 Production differences due to cow sire breed

Differences due to dam sire breed can also affect traits likely to influence production outcomes, i.e.

(a) Simmental sired cows had bigger calves, than those sired by Hereford and Angus, and Simmental sired cows had a higher calving difficulty score.
(b) Simmental sired cows weaned bigger calves at 281.5 kg
(c) Simmental and Angus sired cows had calves with a higher growth rate compared to Hereford and Limousin
(d) Simmental sired cows had heavier calves at scanning at 400 days. (435kg)
(e) Simmental and Angus sired calves were heavier at slaughter.
(f) Simmental and Angus sired cows produced more calf per KG of cow liveweight compared to the Hereford.
(g) Angus and Hereford sired cows produced fatter progeny with higher intramuscular fat
(h) Limousin sired cows produced progeny with a larger EMA at slaughter.
(i) There were no differences due to cow sire breed on the fertility traits.

6.1.1.3 Production differences due to individual cow breed

Individual cow breed results were variable, and generally followed the main effects of cow dam breed and cow sire breed. There was not one breed that consistently out performed all the others in all traits. If the main emphasis was to be on weaning weight as the most important maternal trait, Sim x Ang, was the best. However, if we were to look at kgs of calf produced per kg of cow, there were only small differences between the 8 breeds. The Lim x Ang weaned the highest percentage of calves, with no real differences between the other breeds. If we multiply the percentage of calves weaned by the kg of calf produced per cow, the Lim x Ang produced 0.46kg of calf weaned per kg of cow, followed by the Angus cows at 0.43 and the Sim X Her cows at 0.4kg/kg. The Hereford cows produced 0.32 kg/kg. In the absence of feed intake figures, this is one indication of potential increases in maternal efficiency.

The Sim X Angus having the highest calving difficulty score, and needing most calving assistance would indicate that a higher degree of management at calving would be required.

Calving percentages affect productivity; however there was little difference between most breeds apart from the Hereford, Lim x Her and Lim x Ang. Lack of individual cow breed differences in the other fertility criteria indicated that there would be little advantage in choosing a particular cow breed type to change calving to calving interval for earlier calving.

The gains made in most traits through hybrid vigour indicate the potential for the use of Crossbred dams.

6.1.1.4 Differences due to time of calving

This project was not set up to examine time of calving per se, and any differences shown should be noted with the view that there was never any attempt to measure stocking rate or intake differences between the autumn or spring calving herds. At both Struan and Hamilton the herds were run on a commercial basis and feed on offer was not measured. Autumn calving produced heavier weaners, when corrected for age at weaning. However, even though the HSCW of cattle slaughtered from Struan show no significant difference due to season, there was a significant age difference, with Spring born cattle being 534.7 days of age, and those born in autumn 384.3 days of age ($P<0.001$; s.e.d.7.4)

6.1.1.5 Short term - factors affecting returns

The real price received for beef has decreased over time and the Australian beef herd has become relatively stable, with a trend to reduced area devoted to beef production as alternative crops and trees occupy areas traditionally used for beef cattle in southern Australia. To maintain the value of the beef industry, improvement in production efficiency and market compliance have become the main areas of importance. Using a genetic approach offers a means by which this can be done without inherent cost increases. This study indicates areas where efficiency can be improved by breeding from cows with appropriate genotype. Mature cows bred from Angus base cows were lighter that those bred from Hereford cows and had greater calf production, and whilst cows bred from Simmental sires produced bigger calves, those bred from Angus sires were more efficient in terms of calf weight compared to cow weight. This should lead to lower cow maintenance costs with improved meat production from pastures. Carcass quality was also improved by using sire breeds with the desirable carcass characteristics. There was also evidence of hybrid vigour, which would lead to higher production efficiency.
As the data from this study is incorporated in BREEDPLAN it will increase accuracy of prediction of performance and hence progress in efficiency improvement in the beef industry

6.2 Impact on Meat and Livestock Industry in 5 years time

The longer term impact will be through the use of BREEDPLAN when this data, and other data that has linkages to sires used in this project, will be incorporated into additional across breed EBV's which will assist producers in choosing the most appropriate choice of animals for breeding purposes.

6.2.1 Targeted breeding programs.

It would be expected that as more data on breed comparisons is released to the industry, through both extension programs and through the use of BREEDPLAN producers would be in a much better position to make breed management decisions, and be able to more accurately target their market requirements. Continuous provision of crossbreeding data for use in Breedplan through

projects such as this one and others that have linkages to sire used in this program will allow a continuous improvement in the provision of Breedplan across breed EBVs.

The adoption and use of across breed or Multibreed EBVs will only increase if more across breed comparative data is supplied to BREEDPLAN, so that accuracies can increase and more breeds are included in the analysis. The cow breeds included in this study for maternal comparisons only represent four different breeds, and whilst Shorthorn and Charolais sires were used, it will not be until a much larger number of animals are used in studies such as this that accurate comparisons of the maternal traits of different breeds can be used.

7 Conclusions and Recommendations

7.1 Data for use in Breedplan

The data supplied from this project has been derived from only a relatively small subset of cows (331) that originated from the original Multi breed project, with approximately 650 progeny being evaluated. In comparison to the data that is currently being used in Breedplan to produce EBVs, particularly across breed EBVs, it forms only a very small component of what is needed to provide industry with a comprehensive across breed EBV evaluation.

The data provided in this report provides an indication of the likely performance of cows derived from different breeds, however the base breeds are limited to just 4, and whilst these breeds form a major component of the southern beef industry, a number of popular breeds are not represented. Whilst we did have a reasonable representation of cow sire breeds, with a mix of British bred and European types, (Angus, Hereford, Limousin and Simmental) we only had British breeds (Angus and Hereford) representing cow dam breeds. Having more diverse cow dam breeds would have provided more diversity in terms of Cow breed mix, which in the long term will be needed to fully analyse and provide across breed EBVs.

As there was no evidence of any cow breed by calf sire breed interactions for any trait, we can be confident that selection for a particular trait by using a different breed instead of a different sire within a breed, should simplify selection criteria.

7.1.1 Conclusion

The data collected indicate that significant gains can be made in factors affecting beef production efficiency and meat quality by use of appropriate breed combinations. Differences noted in the Multibreed study of heifers and their first calves are also evident in mature cows.
It is recommended that the data be incorporated into BREEDPLAN to improve the accuracy and confidence in its use.