BULL DISCOVERY

Powered by genomics

Genomics has a wide and varied range of uses within modern Angus breeding programs, from confirming important parentage details or genetic condition status through to improving confidence when making breeding decisions.



Utilising the varied applications of genomics to better identify elite sires within their herd is just one-way breeders can benefit from the technology.

The following case study examines the use of genomic testing in the herd of a current Angus Australia member.

When Genomic Testing

Genomics enables a more informed selection decision to be made, through higher accuracy EBVs. This decision can be made earlier in an animal's life and can be hugely valuable when making breeding and purchasing decisions.

Genomic testing when incorporated into a breeding value will cause;

- No change in the average breeding value for a group of animals.
- An increase in the spread of breeding values between animals in the group, driven by movement in individual EBVs and re-ranking within the group.
- The accuracy of the breeding values to increase, with a greater increase in accuracy for hard to measure compared to easy to record traits.

Genomics does this by better describing the relationship between the tested animal and the reference population. As relationships can be developed between not only pedigree relations but also animals that share genes in common.



in www.angusaustralia.com.au

Examining the Bulls

The following case study examines the identification of an elite herd sire from a group of 138 bulls and the impact genomics has on their selection. The bulls represent a range of different genetics, including local and international sires.

The use of genomic testing confirmed important parentage information ensuring that all data used in the bulls' EBV calculation, as part of this analysis, is coming from an accurate pedigree.

Average Breeding Value

When genomic information is included into the calculation of the breeding values, we see very little or no change in the average breeding value of the 138 bulls (Table 1). When examining those breeding values which recorded a slight positive or negative movement it is important to context the movement in relation to the magnitude of the breeding value. For instance, +3 kg in 111 kg, as seen in 600 day weight represents a less than 2.5% movement.

Breeding Value Spread

The spread of breeding values for the group, has increased significantly with the inclusion of genomic information (Table 2). The increase in spread has come about from the individual movement in breeding values, which has resulted in the re-ranking of bulls within the group.

This occurs because with genomics we have better understanding of the genes the animal inherited and how they perform. This greater understanding allows the breeding value calculation to not only develop pedigree links but also links with animals that share genes in common.

This increase in breeding value spread is a valuable feature of genomic testing, because not only does it enable breeders to examine better described traits but enables separation of animals, which previously may had been very similar breeding values.

T				
anned a subrade chande	in the hulls breeding	values with the inco	rnoration of donoi	mic information
Table I Average change	in the build breeding		poration of genor	

	BWT (kg)	200 (kg)	400 (kg)	600 (kg)	MCW (kg)	SS (cm)	CWT (kg)	EMA (cm²)	RIB (mm)	P8 (mm)	RBY (%)	IMF (%)
No Genomics	+3.9	+48	+85	+111	+86	+1.7	+62	+5.8	-0.1	-0.4	+0.4	+2.1
Genomics Included	+4.1	+49	+87	+114	+88	+1.6	+64	+5.8	-0.1	-0.4	+0.4	+2.1
BV Difference	+0.2	+1	+2	+3	+2	-0.1	+2	0	0	0	0	0

Table 2 - Breeding value spread for the bulls with and without the incorporation of genomic information

No Genomics												
EBV	BWT	200	400	600	MCW	SS	СМТ	EMA	RIB	P8	RBY	IMF
Min.	+0.3	+34	+64	+79	+47	-1.2	+37	+2.8	-2.8	-4.4	-1.4	+1.0
Avg.	+3.9	+48	+85	+111	+86	+1.7	+62	+5.8	-0.1	-0.4	+0.4	+2.1
Max.	+9.1	+64	+113	+148	+151	+3.8	+87	+10	+4.3	+5.1	+3	+3.4
					Geno	mics Incl	uded					
EBV	BWT	200	400									
		200	400	600	MCW	SS	CWT	EMA	RIB	P8	RBY	IMF
Min.	-1.5	+32	400 +54	600 +69	мсw +16	SS -1.5	CWT +29	EMA 0	RIB -3.5	P8 -5.3	RBY -2.5	IMF +0.2
Min. Avg.	-1.5 +4.1	+32 +49	400 +54 +87	600 +69 +114	MCW +16 +88	SS -1.5 +1.6	CWT +29 +64	EMA 0 +5.8	RIB -3.5 -0.1	P8 -5.3 -0.4	RBY -2.5 +0.4	IMF +0.2 +2.1

Individual Movement and Ranking

The re-ranking of individuals significantly affected the bulls with the highest EBVs for each trait. Bulls shown in red fell outside the highest 15 for the trait with the inclusion of genomics. Bulls in yellow were previously in the highest 15, but changed position, while the bulls in green moved into the highest 15 with the inclusion of genomics (Table 3).

Importantly the change in ranking doesn't mean an individual's breeding value moved. For example, the bull M223 was the highest EBV bull for 200 day weight without genomics. Despite the inclusion of genomics resulting in no change to his breeding value, his ranking moved to 6th with genomics included (Table 3). This was the result of the movement of the other bulls.

On average, the inclusion of genomics caused 5 new bulls to enter the highest 15 for each of the examined traits. Of the highest 15, on average 1 bull remained in the same ranking position across the examined traits.

The correlation between the EBVs for each trait with and without genomic information (Table 4), supports what was observed in the re-ranking of the 15 highest EBV bulls, highlighting that a large amount of reranking was observed in breeding values with the inclusion of genomics.

If we look at the re-ranking of the bulls as a group we see further evidence to support this. The heat map

demonstrates the movement of bulls as a group with the inclusion of genomics for the breeding values, which are used to calculate the Angus Breeding Index (ABI). The ABI captures the bulls movement across a range of traits (Figure 1).

The heat map shows that of the 13 bulls originally in the highest 10 percent of the group (total of the far-right column), 8 remained in the highest 10 percent with the inclusion of genomics. 3 bulls dropped to be ranked in the highest 20 percent of the group, while 2 bulls dropped to be ranked in the highest 30 percent (see far-right column).

Table 3 – Ranking top 15 bulls for each trait, with and without the inclusion of genomic information (Red=dropped outside top 15 with genomic inclusion, Yellow= changed rank order but remained in the top 15, Green=moved into the top 15 with genomic inclusion)

No Genomics												
Rank	BWT	200	400	600	MCW	SS	СМТ	EMA	RIB	P8	RBY	IMF
1	M63	M223	M149	M81	M81	M174	M81	M149	M42	M249	M300	M197
2	M289	M198	M223	M223	M287	M307	M177	M242	M8	M53	M131	M167
3	M8	M81	M198	M333	M250	M109	M149	M153	M29	M238	M271	M188
4	M212	M225	M225	M198	M46	M263	M103	M131	M308	M307	M214	M90
5	M20	M148	M148	M149	M333	M298	M225	M177	M249	M42	M202	M289
6	M162	M149	M118	M225	M223	M65	M148	M163	M65	M38	M133	M82
7	M165	M102	M81	M245	M225	M223	M248	M214	M20	M308	M149	M225
8	M53	M118	M248	M46	M198	M321	M83	M111	M176	M120	M89	M102
9	M169	M186	M237	M148	M186	M315	M46	M202	M45	M29	M328	M80
10	M89	M237	M102	M83	M83	M142	M237	M300	M145	M20	M242	M117
11	M140	M248	M186	M287	M156	M328	M8	M38	M23	M145	M156	M140
12	M141	M240	M103	M102	M323	M275	M223	M248	M307	M118	M275	M240
13	M14	M257	M240	M257	M220	M333	M165	M99	M53	M117	M248	M63
14	M155	M197	M257	M156	M6	M57	M257	M81	M120	M315	M64	M198
15	M179	M188	M290	M118	M256	M259	M98	M148	M54	M198	M174	M223
Genomics Included												
					Genom		Jucu					
RANK	BWT	200	400	600	MCW	SS	CWT	EMA	RIB	P8	RBY	IMF
RANK 1	BWT M63	200 M225	400 M148	600 M245	MCW M287	SS M307	CWT M81	EMA M300	RIB M65	P8 M249	RBY M300	IMF M104
RANK 1 2	BWT M63 M8	200 M225 M81	400 M148 M225	600 M245 M81	MCW M287 M245	SS M307 M54	CWT M81 M103	EMA M300 M214	RIB M65 M29	P8 M249 M145	RBY M300 M64	IMF M104 M167
RANK 1 2 3	BWT M63 M8 M329	200 M225 M81 M102	400 M148 M225 M245	600 M245 M81 M225	MCW M287 M245 M250	SS M307 M54 M275	CWT M81 M103 M83	EMA M300 M214 M242	RIB M65 M29 M35	P8 M249 M145 M315	RBY M300 M64 M214	IMF M104 M167 M197
RANK 1 2 3 4	BWT M63 M8 M329 M289	200 M225 M81 M102 M240	400 M148 M225 M245 M102	600 M245 M81 M225 M46	MCW M287 M245 M250 M81	SS M307 M54 M275 M65	CWT M81 M103 M83 M149	EMA M300 M214 M242 M274	RIB M65 M29 M35 M308	P8 M249 M145 M315 M307	RBY M300 M64 M214 M280	IMF M104 M167 M197 M188
RANK 1 2 3 4 5	BWT M63 M8 M329 M289 M89	200 M225 M81 M102 M240 M245	400 M148 M225 M245 M102 M81	600 M245 M81 M225 M46 M287	MCW M287 M245 M250 M81 M46	SS M307 M54 M275 M65 M177	CWT M81 M103 M83 M149 M225	EMA M300 M214 M242 M274 M274	RIB M65 M29 M35 M308 M8	P8 M249 M145 M315 M307 M29	RBY M300 M64 M214 M280 M242	IMF M104 M167 M197 M188 M90
RANK 1 2 3 4 5 6	BWT M63 M8 M329 M289 M89 M212	200 M225 M81 M102 M240 M245 M223	400 M148 M225 M245 M102 M81 M103	600 M245 M81 M225 M46 M287 M333	MCW M287 M245 M250 M81 M46 M83	SS M307 M54 M275 M65 M177 M315	CWT M81 M103 M83 M149 M225 M148	EMA M300 M214 M242 M274 M153 M111	RIB M65 M29 M35 M308 M8 M8	P8 M249 M145 M315 M307 M29 M212	RBY M300 M64 M214 M280 M280 M242	IMF M104 M167 M197 M188 M90 M53
RANK 1 2 3 4 5 6 7	BWT M63 M8 M329 M289 M89 M212 M179	200 M225 M81 M102 M240 M245 M223 M103	400 M148 M225 M245 M102 M81 M103 M248	600 M245 M81 M225 M46 M287 M333 M83	MCW M287 M245 M250 M81 M46 M83 M333	 SS M307 M54 M275 M65 M177 M315 M333 	CWT M81 M103 M83 M149 M225 M148 M177	EMA M300 M214 M242 M274 M153 M115 M115	RIB M65 M29 M35 M308 M308 M8 M42 M120	 P8 M249 M145 M307 M29 M212 M53 	RBY M300 M64 M214 M280 M280 M242 M237	IMF M104 M167 M197 M188 M90 M53 M82
RANK 1 2 3 4 5 6 7 8	BWT M63 M8 M329 M289 M89 M212 M179 M155	200 M225 M81 M102 M240 M245 M223 M103 M103	400 M148 M225 M245 M102 M81 M103 M248 M46	600 M245 M81 M225 M46 M287 M333 M83 M156	MCW M287 M245 M250 M81 M81 M83 M333 M156	 SS M307 M54 M275 M65 M177 M315 M333 M32 	CWT M81 M103 M83 M149 M225 M148 M177 M46	EMA M300 M214 M242 M274 M153 M115 M156 M163	RIB M65 M29 M35 M308 M308 M42 M120 M249	 P8 M249 M145 M315 M307 M29 M212 M53 M123 	RBY M300 M64 M214 M280 M280 M242 M237 M275	IMF M104 M167 M197 M188 M90 M53 M82 M117
RANK 1 2 3 4 5 6 7 8 9	BWT M63 M8 M329 M289 M89 M212 M179 M155 M14	200 M225 M81 M102 M240 M245 M223 M103 M148 M198	400 M148 M225 M245 M102 M81 M103 M248 M46 M118	600 M245 M81 M225 M46 M287 M333 M333 M156 M148	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 	 SS M307 M54 M275 M65 M177 M315 M333 M32 M194 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245	EMA M300 M214 M242 M274 M153 M153 M151 M156 M163	RIB M65 M29 M35 M308 M42 M42 M120 M244 M120 M245 M1426	 P8 M249 M145 M307 M29 M212 M53 M123 M308 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131	 IMF M104 M167 M197 M188 M90 M53 M82 M117 M236
RANK 1 2 3 4 5 6 7 8 9 10	BWT M63 M8 M329 M289 M89 M212 M179 M155 M14 M106	200 M225 M81 M102 M240 M245 M245 M223 M103 M103 M148 M198	400 M148 M225 M245 M102 M81 M81 M103 M248 M46 M118 M223	600 M245 M81 M225 M46 M287 M333 M333 M83 M156 M148 M102	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 M6 	 SS M307 M54 M275 M65 M177 M315 M333 M32 M194 M321 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245 M156	EMA M300 M214 M242 M274 M153 M153 M156 M164 M64 M21	RIB M65 M29 M35 M308 M42 M120 M249 M145 M53	 P8 M249 M145 M307 M29 M212 M53 M123 M308 M8 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131 M89	IMF M104 M167 M197 M188 M90 M53 M82 M12 M117 M236 M156
RANK 1 2 3 4 5 6 7 8 9 10 11	BWT M63 M8 M329 M289 M89 M212 M179 M155 M14 M106 M321	200 M225 M81 M240 M245 M245 M223 M103 M148 M198 M149 M149	400 M148 M225 M245 M102 M81 M103 M248 M46 M118 M223 M149	600 M245 M81 M225 M46 M287 M333 M33 M156 M148 M102 M38	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 M6 M220 	 SS M307 M54 M275 M65 M177 M315 M333 M32 M194 M321 M321 M321 M321 M321 M321 M321 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245 M156 M248	EMA M300 M214 M242 M274 M153 M153 M156 M164 M163 M64 M21	RIB M65 M29 M35 M308 M42 M42 M120 M249 M120 M249 M120 M249 M1451 M53 M1766	 P8 M249 M145 M307 M29 M212 M53 M123 M308 M308 M38 M38 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131 M89 M285	 IMF M104 M167 M197 M188 M90 M53 M53 M82 M117 M236 M156 M323
RANK 1 2 3 4 5 6 7 8 9 10 11 12	BWT M63 M8 M329 M289 M212 M179 M155 M14 M106 M321 M141	200 M225 M81 M102 M240 M245 M245 M103 M103 M148 M198 M149 M149 M248	400 M148 M225 M245 M102 M81 M103 M248 M46 M118 M223 M149 M240	600 M245 M81 M225 M46 M287 M333 M333 M83 M156 M148 M102 M38 M103	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 M6 M220 M80 	 SS M307 M54 M275 M65 M177 M315 M333 M32 M194 M321 M142 M109 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245 M156 M248 M86	EMA M300 M214 M242 M274 M153 M153 M156 M156 M164 M21 M148 M202	RIB M65 M29 M35 M308 M42 M42 M42 M120 M249 M145 M145 M145 M145 M145 M145 M145	 P8 M249 M145 M307 M29 M212 M53 M123 M308 M38 M38 M238 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131 M89 M285 M285	IMF M104 M167 M188 M90 M53 M82 M117 M236 M156 M323 M80
RANK 1 2 3 4 5 6 7 8 9 10 11 12 13	BWT M63 M8 M329 M289 M212 M179 M155 M14 M106 M321 M141 M169	200 M225 M81 M102 M240 M245 M223 M103 M148 M198 M149 M149 M248 M333 M83	400 M148 M225 M245 M102 M81 M103 M248 M46 M18 M240 M149 M240 M198	600 M245 M81 M225 M46 M287 M333 M33 M156 M148 M102 M38 M103 M6	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 M6 M220 M80 M280 	 SS M307 M54 M275 M65 M177 M315 M333 M32 M321 M194 M321 M142 M109 M263 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245 M156 M248 M86 M287	EMA M300 M214 M242 M274 M153 M153 M156 M163 M64 M20 M148 M202 M99	RIB M65 M29 M35 M308 M42 M42 M120 M145 M53 M145 M53 M176 M45 M162	 P8 M249 M145 M307 M29 M212 M53 M123 M308 M38 M238 M238 M65 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131 M89 M285 M291 M131 M89 M285 M285 M285 M2917	 IMF M104 M167 M187 M90 M53 M82 M117 M236 M156 M323 M80 M125
RANK 1 2 3 4 5 6 7 8 9 10 11 12 13 14	BWT M63 M8 M329 M289 M212 M179 M155 M14 M106 M321 M141 M169 M99	200 M225 M81 M102 M240 M245 M245 M103 M148 M198 M149 M248 M333 M83 M83	400 M148 M225 M245 M102 M81 M103 M248 M46 M118 M223 M149 M240 M198 M83	600 M245 M81 M225 M46 M287 M333 M33 M156 M148 M102 M38 M103 M103 M6 M223	 MCW M287 M245 M250 M81 M46 M83 M333 M156 M234 M6 M220 M80 M280 M320 	 SS M307 M54 M275 M65 M177 M315 M333 M321 M321 M194 M194 M109 M263 M298 	CWT M81 M103 M83 M149 M225 M148 M177 M46 M245 M156 M248 M86 M287 M21	EMA M300 M214 M242 M274 M153 M153 M156 M156 M164 M21 M21 M148 M202 M99 M42	RIB M65 M29 M35 M308 M42 M42 M42 M120 M145 M145 M145 M145 M145 M145 M145 M145 M176 M45 M162 M176 M162 M176 M162 M176	 P8 M249 M145 M307 M29 M212 M53 M123 M308 M38 M38 M238 M65 M162 	RBY M300 M64 M214 M280 M242 M237 M275 M99 M131 M89 M285 M217 M291 M131 M29 M131 M29 M131 M29 M131 M29 M131 M29	 IMF M104 M107 M197 M188 M90 M53 M82 M117 M236 M156 M323 M80 M125 M243

Table 4 – Correlation between bulls breeding value with and without genomics												
	BWT	200	400	600	MCW	SS	CWT	EMA	RIB	P8	RBY	IMF
Correlation	0.85 ו	0.85	0.84	0.88	0.87	0.87	0.86	0.71	0.84	0.85	0.79	0.78

Bull Percentile (No Genomics)												
		91-100	81-90	71-80	61-70	51-60	41-50	31-40	21-30	11-20	1-10	
	1-10	0	0	0	0	0	0	1	0	2	8	
	11-20	0	0	0	0	0	1	1	4	7	3	
	21-30	0	0	1	2	0	1	0	7	0	2	
Bull	31-40	0	2	0	2	0	4	3	2	2	0	
Percentile	41-50	0	1	1	2	4	1	0	0	0	0	
(Genomics)	51-60	0	2	2	3	3	4	3	2	0	0	
	61-70	0	1	3	4	0	1	1	0	0	0	
	71-80	2	1	2	2	1	5	1	1	0	0	
	81-90	3	5	3	2	2	1	0	0	1	0	
	91-100	8	2	3	0	0	0	0	0	0	0	

Figure 1 - Percentile band movement of bulls for ABI with the incorporation of genomic information

Breeding value accuracy

The final area to examine is the change in the accuracy of EBVs. The accuracy for all EBVs increased, with an average increase of between 6% to 12%, depending on the trait. A greater increase in accuracy was observed in the hard to measure traits (CWT, IMF, etc.) compared to the traits that are more routinely recorded (BWT, 400, etc.) (Table 5).

The improvement in accuracy allows greater confidence when making breeding and purchasing decisions.

Table 5 - Average EBV accuracy change in the bulls breeding values with the incorporation of genomic information

	BWT	200	400	600	MCW	SS	CWT	EMA	RIB	P8	RBY	IMF
No Genomics Accuracy	64%	60%	60%	62%	58%	55%	52%	50%	52%	52%	48%	47%
Genomics Included Accuracy	71%	69%	67%	69%	64%	64%	60%	58%	62%	59%	54%	57%
Accurancy Difference	+7%	+9%	+7%	+7%	+6%	+9%	+12%	+8%	+10%	+7%	+6%	+10%

What genomics has delivered to bull selection

The genomic testing of the bulls has enabled a better understanding and ability to identify the top performing animals through an increase in the spread and accuracy of breeding values within the group.

Based on the highest 15 bulls across the examined traits, a third of the bulls identified were not present in the list prior to genomic testing (Table 3).

These bulls may not have been considered as potential sire options because of their rank within the group, if genomic testing was not performed, and therefore the breeding program could not benefit for their genetic contribution.

By implementing genomic testing, these bulls were identified and the breeder had the opportunity to select them for use within the breeding program, highlighting that genomics enables a more informed decision to be made earlier in an animal's life.

Genomic testing the bulls also has a number of additional benefits to those bulls which were not selected for use within the breeding program. Genomics added value to them as sale bulls through confirmation of pedigree, improved reliability of genetic condition status, and improved breeding value accuracy.

For more information contact Angus Australia: 02 6773 4600 | office@angusaustralia.com.au www.angusaustralia.com.au

Take Home Messages

Genomics increases the accuracy and spread of breeding values

Average breeding value doesn't change for the tested group

Genomics enables a more informed selection decision to be made earlier in an animals life



Angus Australia gratefully acknowledges the co-funding contribution from the Meat and Livestock Australia Donor Company.



For more information visit www.angusaustralia.com.au



