TECHNICAL SPECIFICATIONS
- October 2024 -

SUMMARY

- Angus SteerSELECT is a genomic selection tool to help identify the genetic merit of Angus steers (87.5% Angus content or greater).

- Angus SteerSELECT provides genetic predictions for nine (9) growth, feedlot, carcase and resilience traits.

- Angus SteerSELECT also provides an overall selection Index, the Angus Steer Value (ASV).

- An addition to this product is Angus BreedCHECK, which is a genomic (DNA) based system that estimates breed composition (from 11 breeds), with a particular focus on Angus content

- The reference population (Angus animals with genotypes and phenotypes) that underpins the Angus SteerSELECT genetic prediction is based on the comprehensive data from the Angus Australia database, including hard-to-measure traits (carcase, feed intake, immune competence) from Angus Australia's reference population program, known as the Angus Sire Benchmarking program (ASBP).

- An important feature of Angus SteerSELECT is the comprehensive validation that has been undertaken to ensure it is an effective selection tool.

CONTENTS

1. BACKGROUND

Angus SteerSELECT is a genomic selection tool, developed and validated in the commercial environment, to identify the genetic merit of Angus steers (87.5% Angus content or greater). It provides the ability to predict genetic differences in key production traits, enabling greater precision in sorting and/or marketing of steers into lines suitable for the different paths in the beef supply chain (e.g. grassfed, short-fed or long-fed programs). This tool offers the opportunity to capture value throughout the beef supply chain by improving the quality and consistency of beef products.

Angus SteerSELECT provides:

- Genetic predictions for nine (9) growth, feedlot, carcase and resilience traits.
- An overall selection index, the Angus Steer Value (ASV), with simplified star rating.
- Angus BreedCHECK − genomic breed composition prediction.
- Sire verification − verification of potential sires who are registered with Angus Australia and have genomic profiles available.

Angus SteerSELECT complements other sources of information that may be used in sorting and marketing of Angus steers, such as age, weight and background information like past feedlot and carcase grading performance. Angus SteerSELECT provides valuable insight into the genetic potential of steers, particularly for traits that are difficult to assess visually (i.e. marbling potential).

Angus SteerSELECT is suitable for both Angus steers and heifers entering the beef supply chain. For breeding heifers, the companion product Angus HeiferSELECT is more suitable.

Angus SteerSELECT was developed in collaboration between Angus Australia and CSIRO (Australia's National Science Agency). Angus SteerSELECT is available direct from Angus Australia or via two collaborators Neogen and Zoetis.

2. FEATURES

2.1. Genetic Predictions

2.1.1. Traits

Angus SteerSELECT provides genetic predictions for nine (9) growth, feedlot, carcase and resilience traits. The genetic predictions are reported using an intuitive 0 − 100 scoring system, with a score of 50 representing the average genetic merit of commercial Angus steers tested with the Angus SteerSELECT product.

Higher values identify steers carrying genetics that will produce "more" of a trait, which may or may not be preferred, subject to the production system. For example, a steer with an Average Daily Gain (ADG) prediction of 80 would be expected to have a higher daily gain (kg/day) than a steer, particularly from the same cohort, with an ADG genetic prediction of 30, all other things being equal. Similarly, higher MSA Marbling genetic predictions indicate the animal is expected to produce a carcase that is more likely to have a higher marbling score.

A description of each of the traits by group is listed in Table 1.

2.1.2. Model and Reference Population

The model used for calculating the Angus SteerSELECT genetic predictions (i.e. genomic breeding values) is based on applying SNP effects to 61,105 SNPs in a standard imputed genomic profile for each of the 9 traits, for each steer. The SNP effects resulting from univariate analyses of each trait.

The reference population (Angus animals with genotypes and phenotypes) that underpins the Angus SteerSELECT genetic predictions is based on the comprehensive data from the Angus Australia database, including hard-to-measure traits (carcase, feed intake, immune competence) from Angus Australia's reference population program, the Angus Sire Benchmarking program (ASBP) (Table 2). All animals in the refence population are straight-bred Angus from Australian production systems.

Table 1. Angus SteerSELECT Genetic Predictions and Selection Index Descriptions.

	TRAIT	DESCRIPTION
GROWTH	Yearling Weight	Higher yearling weight (YW) genetic predictions indicate the animal is expected to be heavier at 400 days of age.
FEEDLOT TRAITS	Average Daily Gain	Higher average daily gain (ADG) genetic predictions indicate an animal is expected to have higher rates of weight gain during feedlot finishing, due to superior growth potential.
FEEDLOT TRAITS	Daily Feed Intake	Higher daily feed intake (DFI) genetic predictions indicate an animal is expected to eat more during feedlot finishing and may be considered less efficient.
CARCASE TRAITS	Carcase Weight	Higher Carcase Weight (CW) genetic predictions indicate the animal is expected to have a heavier carcase weight.
CARCASE TRAITS	Eye Muscle Area	Higher Eye Muscle Area (EMA) genetic predictions indicate the animal is expected to have more muscle and larger eye muscle area.
CARCASE TRAITS	Rib Fat	Higher Rib Fat (RIB) genetic predictions indicate the animal is expected to have a carcase with greater fat depth.
CARCASE TRAITS	MSA Marbling	Higher MSA Marbling (MBL) genetic predictions indicate the animal is expected to have a carcase with higher marbling scores and more intramuscular fat.
CARCASE TRAITS	Ossification	Higher Ossification (OSS) genetic predictions indicate the animal is expected to have higher levels of ossification, or physiological maturity, in the carcase which is antagonistic to eating quality.
RESILIENCE	ImmuneDEX	Higher ImmuneDEX (IMM) genetic predictions indicate the animal is expected have higher levels of general disease resilience, as measured by cell-mediated and antibody mediated immune response.
SELECTION	Angus Steer Value	Higher Angus Steer Value (ASV) genetic predictions identify animals that have a balance of genetic traits that are important to the majority of commercial, grain finishing beef production systems.
SELECTION	Angus SteerSELECT Stars	Presents the Angus Steer Value as an easy to understand 0 − 5 star rating, with more stars representing animals with a higher Angus Steer Value.

Table 2. Summary of the Angus Australia Reference population that underpins Angus SteerSELECT.

TRAIT*	N	MEAN	SD	h2
Yearling Weight (kg)	70,203	402.43	73.93	0.30
Average Daily Gain (kg/d)	5,267	1.62	0.35	0.21
Daily Feed Intake (kg/d)	5,267	14.50	2.27	0.32
Carcase Weight (kg)	6.979	428.40	55.05	0.40
Eye Muscle Area (cm^2)	4,742	90.06	10.71	0.44
Rib Fat (mm)	4,388	17.02	6.06	0.31
MSA Marbling Score	4,818	502.36	127.92	
Aus-Meat Marbling Score	2,124	3.64	1.33	0.35
Ossification Score	4,787	147.31	18.3	0.32
ImmuneDEX (Index)	5,319	-0.003	1.139	0.30

*Most feedlot, carcase and resilience data listed have been obtained from Angus Sire Benchmarking Program reference population. However, Angus Australia wishes to acknowledge the contribution of 2,124 carcase weights and AUS-MEAT marbling score records that were obtained from several feedlots and beef brand owners during the Angus SteerSELECT validation process.

2.2. Angus Steer Values

Angus SteerSELECT provides an overall selection Index being Angus Steer Value (ASV). It balances 6 traits that have an impact on efficiency, production, and profitability in most beef supply chains, particularly those that include lot feeding.

The ASV assists in making "balanced" selection decisions to identify animals that have the genetic potential to suit specific beef supply chains. Higher ASVs identify steers have a balanced genetic profile with focus on beef quantity and quality. Figure 1 shows the traits that are considered in the ASV, and how much they contribute to the overall balance of the value.

The larger the segment, the greater the impact on the selection index. In the ASV, there is a focus on increasing the beef quantity (carcase weight, EMA) and quality (Marbling), while improving efficiency (ADG and DFI) and maintaining resilience (ImmuneDEX).

Figure 2 shows the selection advantage if steers are selected using the ASV. The selection advantage is calculated by ranking a group of Angus steers on ASV and comparing the average genetic predictions of the steers in the top 30% with the average genetic predictions of all steers available for selection.

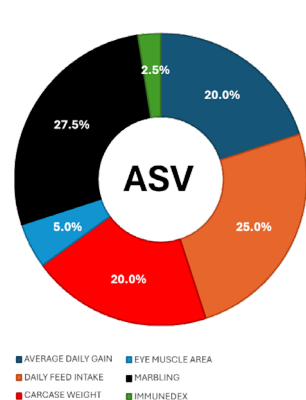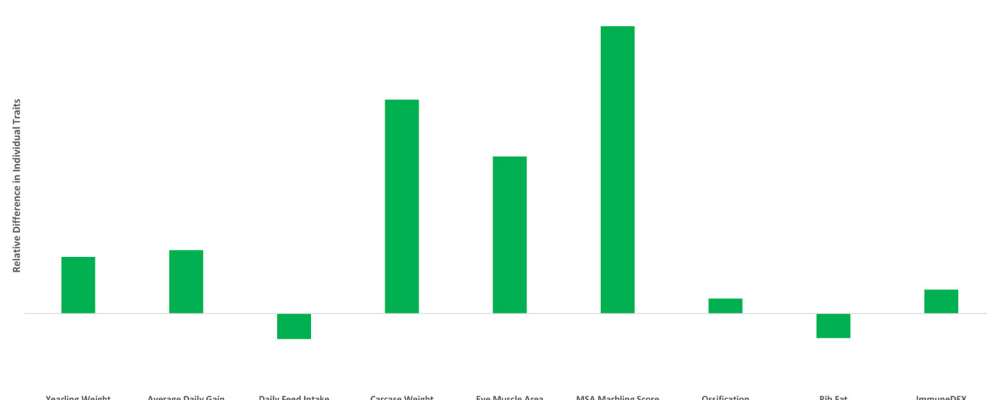Figure 1. Trait Emphasis for the Angus Steer Value (ASV)

Figure 2. Selection Advantage of the Angus Steer Value

Angus SteerSELECT - Example of Performance by Genetic Prediction

The following tables show the average performance (or phenotypes) in long-fed (>200 days on feed) and short-fed (100-120 days on feed) systems, when ranked on genetic prediction for specific traits. The long-fed and short-fed groups include 3,336 steers and 498 steer respectively. Both groups are included in the Angus SteerSELECT reference population.

As an example for interpretation, for the long-fed scenario, the

top 100 steers based on the MSA Marbling genetic prediction average 763 for MSA Marbling score, followed by 517 for the middle 100 and 395 for the bottom 100 steers.

Note - an MSA Marbling score of 700 aligns with an AUS-MEAT Marbling score of approximately 5, MSA Marbling of 500 with an AUS-MEAT score of 3 and MSA Marbling of 300 with an AUS-MEAT score of 1.

Table 3. Feedlot performance and Carcase grading differences between long-fed and short-fed based on Angus SteerSELECT genetic predictions.

Long Fed

	MSA Marbling		Carcase Weight		Average Daily Gain		Daily Feed Intake		Eye Muscle Area		Ossification		Rib Fat	
	Av GP	Av Mbl Score	Av GP	Av CWT (kg)	Av GP	Av ADG (kg/day)	Av GP	Av DFI (kg/day)	Av GP	Av EMA (cm^2)	Av GP	Av Oss. Score	Av GP	Av Rib Fat (mm)
Top 100	90	763	89	521	72	2.1	87	18.0	90	111	90	184	89	28.9
Middle 100	50	517	50	457	50	1.6	50	14.8	50	93	50	149	50	18.4
Bottom 100	12	395	11	403	28	1.2	12	11.6	12	80	12	131	12	12.3

Short Fed

	MSA Marbling		Carcase Weight		Average Daily Gain		Daily Feed Intake		Eye Muscle Area		Ossification		Rib Fat	
	Av GP	Av Mbl Score	Av GP	Av CWT (kg)	Av GP	Av ADG (kg/day)	Av GP	Av DFI (kg/day)	Av GP	Av EMA (cm^2)	Av GP	Av Oss. Score	Av GP	Av Rib Fat (mm)
Top 50	79	469	79	355	66	1.7	84	15.3	79	89	83	147	77	15.5
Middle 50	49	384	50	325	50	1.5	50	13.6	49	78	50	128	50	10.8
Bottom 50	22	344	20	295	34	1.3	17	10.5	21	70	18	112	24	8.1

Additionally, Table 4 exemplifies the percentage of animals that would meet marbling compliance specifications of greater than or equal to 500 MSA Marbling score (i.e. ~ 3 AUS-MEAT score) for long-fed animals and greater than or equal to 400 MSA Marbling score (i.e. ~ 2 AUS-MEAT score) for short-fed animals.

Table 4. Percentages of animals that meet marbling compliance specifications for Long-fed and short-fed, with example parameters.

Long Fed	MSA Marbling		
	Av GP	Av Mbl Score	Compliance
Top 100	90	763	100%
Middle 100	50	517	61%
Bottom 100	12	395	8%

Short Fed	MSA Marbling		
	Av GP	Av Mbl Score	Compliance
Top 50	79	469	84%
Middle 50	49	384	36%
Bottom 50	22	344	8%

Further, below are the performance outcomes when the same groups of steers are ranked on the Angus Steer Value (ASV). For example, this shows when ranked on ASV, in the long-fed system, the top 100 steers compared to the bottom 100 steers had on average:

- Heavier carcases by 53kg,
- More Marbling by 258 MSA marbling score points (or approx. 2.5 more AUS-MEAT marbling scores)
- More muscle with eye muscle areas 13 cm² larger.

- More efficiency with 0.6 kg/day less feed eaten
- More gain with 0.1 kg/day additional average daily gain

Table 5. Feedlot and Carcase grading differences between long-fed and short-fed based on Angus Steer Value.

Long Fed						
	Av ASV	Av CWT (kg)	Av MBI Score	Av EMA (cm²)	Av DFI (kg/day)	Av ADG (kg/day)
Top 100	80	490	689	100	14.8	1.7
Middle 100	50	457	537	92	14.9	1.6
Bottom 100	21	437	431	87	15.4	1.6

Short Fed						
	Av ASV	Av CWT (kg)	Av MBI Score	Av EMA (cm²)	Av DFI (kg/day)	Av ADG (kg/day)
Top 50	71	332	434	81	12.2	1.6
Middle 50	50	317	389	78	13.3	1.5
Bottom 50	29	315	353	77	13.7	1.4

2.3. Angus Breedcheck

Angus BreedCHECK is a genomic (DNA) based system that estimates breed composition (from 11 breeds), with a particular focus on Angus content.

Steers that are 87.5% (or 7/8th) or greater Angus content receive the Angus BreedCHECK tick.

Steers that are below 87.5% Angus content are flagged with an Angus BreedCHECK cross and provided with additional information to further understand their breed background.

This includes the percentage (%) content value estimate for:

- Angus
- Non-Angus
- British (including Angus, Hereford, Shorthorn and Murray Grey)
- Indicus (including Brahman and Santa Gertrudis)
- European (including Charolais, Simmental and Limousin)
- Dairy (including Holstein)
- Wagyu

Angus SteerSELECT genetic predictions are provided on all animals that are greater than 50% Angus content. Caution should be applied when using the Genetic Predictions for animals less than 87.5% Angus as the associated reference population is based on straight bred Angus animals.

The software underpinning Angus BreedCHECK was developed in collaboration with the CSIRO (Australia's National Science Agency). This is based on an allele frequency approach, with effects being applied to 61,105 SNPs in a standard imputed genomic profile for each of the 11 breeds, for each steer. There are 2,743 animals in the reference population (animals with known breed and genotypes) that underpins Angus BreedCHECK as listed in table 5.

Table 5. Summary of the reference population that underpins Angus BreedCHECK

BREED	REFERENCE POPULATION SIZE
Angus	641
Brahman	872
Charolais	90
Hereford	150
Holstein	72
Limousin	62
Murray Grey	62
Santa Gertrudis	219
Shorthorn	210
Simmental	29
Wagyu	339
Total	**2,743**

2.4. Sire Verification

DNA based sire verification is included as a feature of Angus SteerSELECT.

An essential prerequisite for sire verification, is that candidate sires must be registered with Angus Australia and have genomic profile available.

In many cases, a genomic (DNA) profile will have previously been recorded with Angus Australia for sires (by the breeder or a previous owner) and can be used to conduct the DNA sire identification component of the Angus SteerSELECT testing. Details of whether a DNA profile is stored for each registered sire can be viewed on the Angus Database Search facility on the Angus Australia website.

If a genomic profile has not previously been recorded, a DNA sample can be collected for the sire and request a genomic profile from Angus Australia. DNA test request forms are available from the Angus Australia website.

DNA tests can only be ordered for animals that you own, and so you will need to ensure that all registered bulls have been transferred into your ownership on the Angus Australia database prior to requesting the genomic profile.

2.5. Add-on BVDV Testing

Bovine viral diarrhoea virus (BVDV) in cattle is a complex disease that is caused by bovine pestivirus. Bovine pestivirus and its resulting diseases have several interchangeable names including bovine viral diarrhoea (BVD), pestivirus and bovine pestivirus. Mucosal disease is a fatal disease that develops in animals persistently infected with BVDV.

BVDV can reduce herd reproductive rates through infertility or abortion, as well as reduce animal's immunity to a range of other diseases such as bovine respiratory disease (BRD). BVDV is common in Australia and Meat and Livestock Australia (MLA) have identified BVDV as the second most costly disease to Australian cattle herds, after cattle tick infection, and the most important cattle disease southern cattle herds. It is estimated to have an economic impact of $114 million per year.

BVDV testing can be conducted in association with Angus SteerSELECT as an optional add-on from both Zoetis (TSU samples only) and Neogen (TSU and tail hair samples). This testing facilitates the identification of animals persistently infected with BVDV.

If BVDV testing is required, this should be nominated on the order form. Angus SteerSELECT and BVDV testing can be conducted from the same DNA sample.

3. VALIDATION

An important feature of Angus SteerSELECT is the comprehensive validation that has been undertaken to ensure it is an effective selection tool, particularly for Australian and New Zealand Angus steers and production systems.

The validation includes a combination of peer reviewed journal papers and internal validation. Three peer reviewed papers, focusing on the carcase trait genetic predictions, show Angus SteerSELECT can predict differences in phenotype and performance. The papers are:

- "Development of Angus SteerSELECT: a genomic-based tool to identify performance differences of Australian Angus steers during feedlot finishing: Phase 1 validation" with conclusion: Genomic prediction equations can predict differences in carcase weight, marbling score, ossification score and carcase value in both short-fed and long-fed Australian Angus. Reference: Hine B. C. et al (2021). Development of Angus SteerSELECT: a genomic-based tool to identify performance differences of Australian Angus steers during feedlot finishing: Phase 1 validation. Animal Production Science 61, 1884-1892. https://doi.org/10.1071/AN21051

- "Bias, dispersion, and accuracy of genomic predictions for feedlot and carcase traits in Australian Angus steers" with conclusion: Estimates of h^2 and GEBV quality metrics suggest a potential for accurate genomic selection of Australian Angus for feedlot performance and carcase traits. Reference: Alexandre, P.A. et al (2021) Dispersion, and accuracy of genomic predictions for feedlot and carcase traits in Australian Angus steers. Genet Sel Evol 53, 77. https://doi.org/10.1186/s12711-021-00673-8

- "On the value of adding commercial data into the reference population of the Angus SteerSELECT genomic tool" with conclusion "The strong genomic relationship between the Reference and the Commercial populations, coupled with the significant increases in GEBV accuracies, demonstrated the potential benefits of including the commercial population into the reference population of a future improved version of the Angus SteerSELECT genomic tool." Reference Reverter A et al (2023) On the value of adding commercial data into the reference population of the Angus SteerSELECT genomic tool. Animal Production Science 63 (11) 947-956 https://doi.org/10.1071/AN22452

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For more information on how Angus SteerSELECT can enhance
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