ANGUS HeiferSELECT™

TECHNICAL SPECIFICATIONS

- June 2025 -

SUMMARY

· Angus HeiferSELECT is a genomic selection tool to help inform the selection of Angus replacement females (87.5% Angus content or greater) in a commercial beef breeding operation.

· Angus HeiferSELECT provides genetic predictions for fourteen (14) maternal, fertility, growth, feed intake, carcase and resilience traits.

· Angus HeiferSELECT provides three overall selection Indexes being Cow-Calf Value (CCV), Feedlot and Carcase Value (FCV) and Total Breeding Value (TBV) which have been developed in collaboration with AbacusBio (a global leader in the development of livestock selection indexes) and are based on the latest selection index economic modelling and current day production parameters.

· 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 HeiferSELECT 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 HeiferSELECT is the comprehensive validation that has been undertaken to ensure it is an effective selection tool, particularly for Australian Angus in Australian production systems.

CONTENTS

1. BACKGROUND

Angus HeiferSELECT is a genomic selection tool to help inform the selection of Angus replacement females (87.5% Angus content or greater) in a commercial beef breeding operation.

Angus HeiferSELECT provides:

- Genetic predictions for fourteen (14) maternal, fertility, growth, feed intake, carcase and resilience traits
- Genetic prediction for cow-calf value, feedlot-carcase value and total breeding value (with star rating)
- Angus BreedCHECK – genomic breed composition prediction
- Sire verification – Possible sires must be registered with Angus Australia and have genomic profiles available

Angus HeiferSELECT complements other sources of information that may be used in commercial replacement heifer selection, such as phenotypic evaluation, age, weight and pedigree information, and provides valuable insight into the genetic potential of heifers, particularly for traits that are otherwise difficult, time consuming or expensive to measure using traditional methods.

EVOLUTION OF HEIFERSELECT

Angus HeiferSELECT was developed in collaboration between Angus Australia and CSIRO (Australia's National Science Agency).

The first generation of Angus HeiferSELECT was commercialised in 2017.

The 2nd generation of Angus HeiferSELECT was commercialised in November 2021 following 18 months of close collaboration between Angus Australia and CSIRO. Further research conducted in partnership with CSIRO culminated in the release of a fertility genetic prediction, Heifer Conception, being released in August 2023.

In June 2025, HeiferSELECT has been upgraded to a higher density genomic panel, expanded reference populations, and updated Overall Values (selection indexes) index parameters, with the inclusion of a weighting on Heifer Conception genetic predictions and refreshed economic values. BreedCHECK within HeiferSELECT was also updated to align with SteerSELECT through updated allele frequency estimates and a larger reference population.

Angus HeiferSELECT is available direct from Angus Australia or via two collaborators Neogen and Zoetis.

2. FEATURES

2.1. Genetic Predictions

2.1.1. Traits

Angus HeiferSELECT provides genetic predictions for fourteen (14) maternal, fertility, growth, feed intake, carcase and resilience traits. The genetic predictions are reporting using an intuitive 0 – 100 scoring system, with a score of 50 representing the average genetic merit of commercial Angus heifers tested with the Angus HeiferSELECT product.

Higher values identify females carrying genetics that will produce "more" of a trait, which may or may not be preferred, subject to your breeding objective. For example, a female with a Yearling Weight genetic prediction of 80 would be expected to produce progeny that are heavier at 13-14 months of age than a female with a Yearling Weight genetic prediction of 30, all other things being equal. Similarly, higher HC genetic predictions indicate the animal is expected to produce daughters that are more likely to conceive and conceive earlier as heifers (older foetal age at pregnancy diagnosis).

A description of each of the traits by group are listed in table 1.

2.1.2. Model and Reference Population

The model used for calculating the Angus HeiferSELECT 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 14 traits, for each heifer. The SNP effects resulting from univariate analyses of each trait.

The reference population (Angus animals with genotypes and phenotypes) that underpins the Angus HeiferSELECT 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, known as the Angus Sire Benchmarking program (ASBP) (Table 2). All animals in the refence population are straight-bred Angus from Australian production systems.

Table 1 - Description of 14 Angus HeiferSELECT Genetic Predictions

	TRAIT	DESCRIPTION
COW-CALF TRAITS	Calving Ease	Higher Calving Ease (CE) genetic predictions indicate the animal is expected to experience lower birth weight and fewer calving difficulties as a 2 year old heifer (i.e. greater calving ease).
	Weaning Weight	Higher Weaning Weight (WW) genetic predictions indicate the animal is expected to produce progeny with heavier live weights at 200 days of age, due to superior growth potential.
	Milk	Higher Milk genetic predictions indicate the animal is expected to produce progeny with heavier live weights at 200 days of age, due to superior maternal attributes (i.e. more milk).
	Yearling Weight	Higher Yearling Weight (YW) genetic predictions indicate the animal is expected to produce progeny with heavier live weights at 400 days of age.
	Mature Cow Weight	Higher Mature Cow Weight (MCW) genetic predictions indicate the animal is expected to have a heavier weight at 3.5 years of age, and produce female progeny that are heavier. Heavier mature weights are associated with higher feed and maintenance costs, but conversely higher returns for cull cows.
	Heifer Conception	Higher Heifer Conception (HC) genetic predictions indicate the animal is expected to produce daughters that are more likely to conceive and conceive earlier as heifers (older foetal age at pregnancy diagnosis), than those with lower values.
FEEDLOT TRAITS	Average Daily Gain	Higher Average Daily Gain (ADG) genetic predictions indicate the animal is expected to produce progeny with higher rates of weight gain during feedlot finishing, due to superior growth potential.
	Daily Feed Intake	Higher Daily Feed Intake (DFI) genetic predictions indicate the animal is expected to produce progeny that eat more during feedlot finishing, and may be considered less efficient than lower
CARCASE TRAITS	Carcase Weight	Higher Carcase Weight (CW) genetic predictions indicate the animal is expected to produce progeny with heavier carcase weights.
	Eye Muscle Area	Higher Eye Muscle Area (EMA) genetic predictions indicate the animal is expected to produce progeny with more muscle and larger eye muscle area.
	Rib Fat	Higher Rib Fat (RIB) genetic predictions indicate the animal is expected to produce progeny with greater fat depth.
	MSA Marbling	Higher MSA Marbling (MBL) genetic predictions indicate the animal is expected to produce progeny with higher marbling scores and more intramuscular fat
	Ossification	Higher Ossification (OSS) genetic predictions indicate the animal is expected to produce progeny with 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 to produce progeny with higher levels of general disease resilience, as measured by cell-mediated and antibody mediated immune response.

Table 2. Summary of Angus HeiferSELECT Reference Population

TRAIT	N	MEAN	SD	h2
Birth Weight (kg)	100,375	36.03	5.05	0.41
Weaning Weight (kg)	94,440	245.52	52.55	25
Yearling Weight (kg)	70,203	402.43	73.93	0.30
Mature Cow Weight (kg)	13,236	544.34	81.87	0.37
Heifer Conception (weeks)	6,774	12.81	7.34	0.27
Average Daily Gain (kg/day)	5,267	1.619	0.35	0.21
Daily Feed Intake (kg/day)	5,267	14.502	2.27	0.32
Carcase Weight (kg)	6,979	428.4	55.05	0.40
Eye Muscle Area (cm2)	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	18.30	0.32
ImmuneDEX (Index)	5,319	-0.003	1.14	0.30

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

2.2. Overall Values

Angus HeiferSELECT provides three overall values based on economic selection index modelling being Cow-Calf Value (CCV), Feedlot and Carcase Value (FCV) and Total Breeding Value (TBV).

2.2.1. Cow-Calf Value (CCV)

Cow-Calf Value (CCV) estimates the genetic differences between animals in net profitability in a typical commercial Angus self-replacing herd, focusing on the traits related to the cow-calf production system. The Cow-Calf Value assists in making "balanced" selection decisions, taking into account the relevant calving ease, growth and maternal attributes to identify animals that are most suitable for use within a particular commercial enterprise. Higher Cow-Calf value genetic predictions identifies animals that will improve overall profitability in the majority of commercial systems selecting Angus females.

The Cow-Calf Value is a sub-index (i.e. component) of the Total Breeding Value.

Figure 1 shows the traits that are considered in the CCV, 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 CCV, the main focus is increasing Heifer Conception, along with weaning and yearling weight, while maintaining calving ease, mature cow weight and carcase traits.

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

Figure 1. Trait Emphasis for the Cow-Calf Value (CCV)

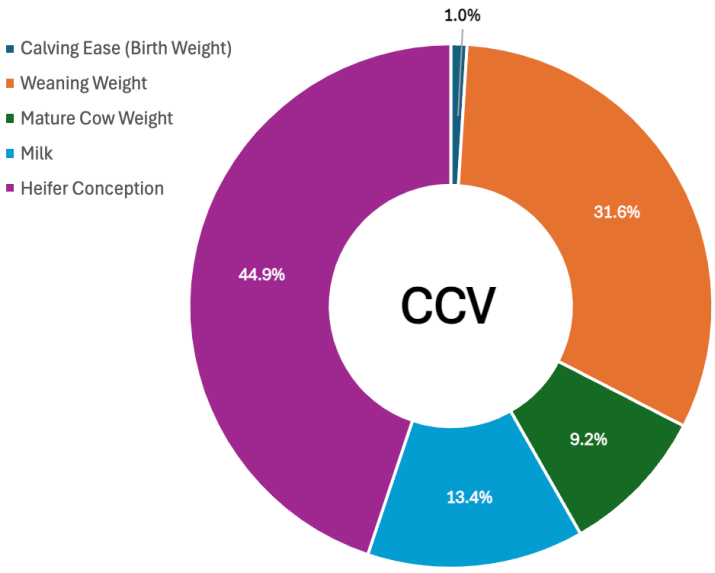
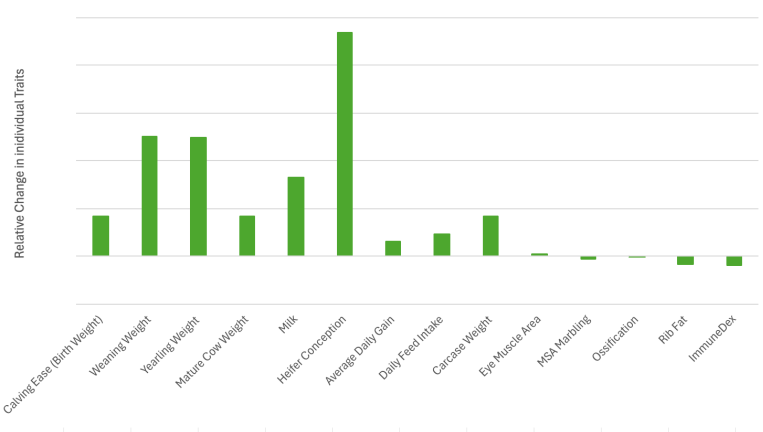


Figure 2. Selection Advantage for Cow-Calf Value



2.2.2. Feedlot and Carcase Value (FCV)

Feedlot-Carcase Value (FCV) estimates the genetic differences between animals in net profitability in a typical commercial Angus self-replacing herd, focusing on the traits related to feedlot and processor performance, along with consumer expectations. The Feedlot-Carcase Value assists in making "balanced" selection decisions, taking into account the relevant growth, feed intake and carcase attributes to identify animals that are most suitable for use within a particular commercial enterprise. Higher Feedlot-Carcase Value genetic predictions identifies animals that will improve overall profitability in the majority of commercial systems selecting Angus females with progeny entering grain finishing supply chain.

The Feedlot-Carcase Value is a sub-index (i.e. component) of the Total Breeding Value

Figure 3 shows the traits that are considered in the FCV, and how much they contribute to the overall balance of the value. In the FCV, there is a focus on increasing MSA marbling and carcass weights while maintaining maternal traits and reducing daily feed intake.

Figure 4 shows the selection advantage if heifers are selected using the FCV. The selection advantage is calculated by ranking a group of Angus heifers on FCV, and comparing the average genetic predictions of the heifers in the top 30% with the average genetic predictions of all heifers available for selection.

Figure 3. Trait Emphasis for the Feedlot-Carcase Value

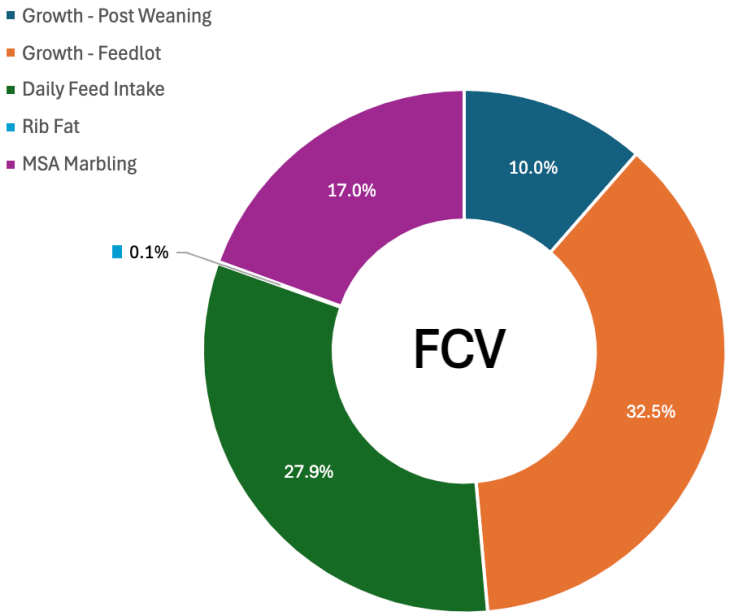
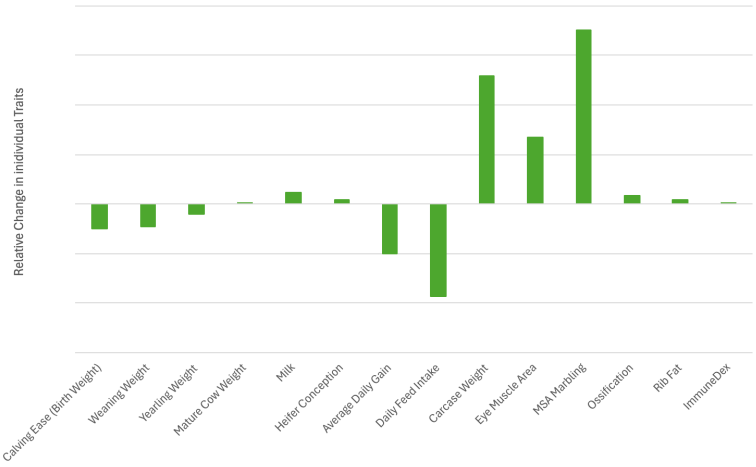


Figure 4. Selection Advantage for Feedlot-Carcase Value



2.2.3. Total Breeding Value (TBV)

Total Breeding Value (TBV) estimates the genetic differences between animals in net profitability in a typical commercial Angus self-replacing herd with progeny entering the grain finishing supply chain. The Total Breeding Value assists in making "balanced" selection decisions, taking into account the relevant calving ease, growth, feed intake and carcase attributes to identify animals that are most suitable for use within a particular commercial enterprise. Higher Total breeding value genetic predictions identifies animals that will improve overall profitability in the majority of commercial systems selecting Angus females.

The Cow-Calf Value and Feedlot-Carcase value are sub-indexes (i.e. components) of the Total Breeding Value.

Figure 5 shows the traits that are considered in the TBV, 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 TBV, there is a focus on increasing growth resulting in heavier carcase weights and more MSA marbling, while maintaining calving ease.

Figure 6 shows the selection advantage if heifers are selected using the TBV. The selection advantage is calculated by ranking a group of Angus heifers on TBV, and comparing the average genetic predictions of the heifers in the top 30% with the average genetic predictions of all heifers available for selection.

Figure 5. Trait Emphasis for the Total Breeding Value

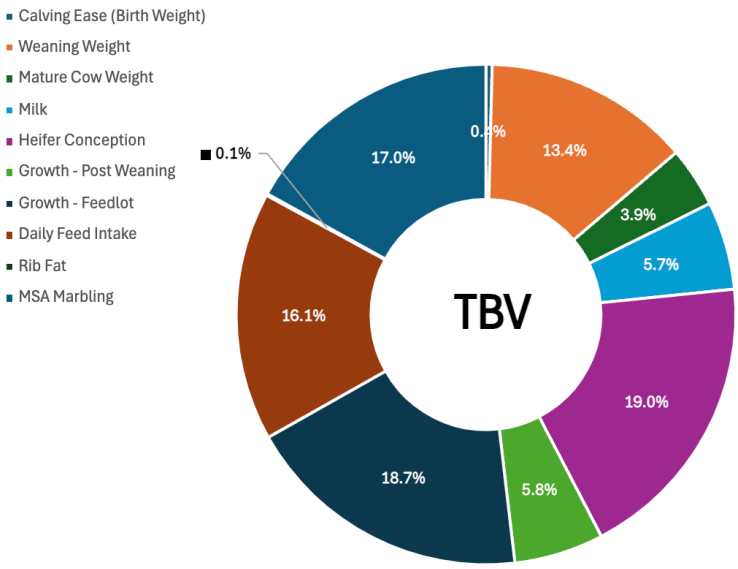
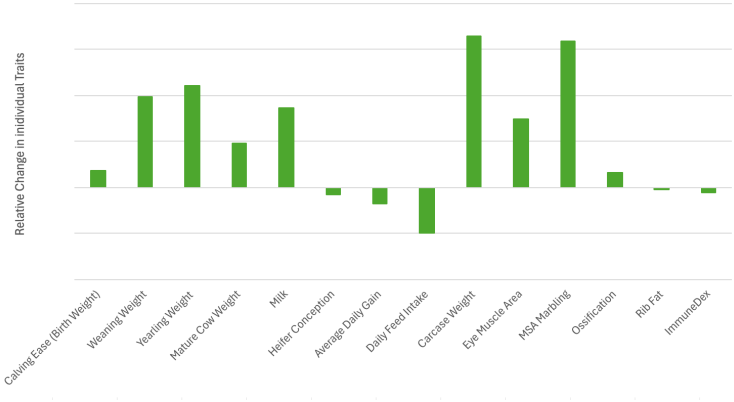


Figure 6. Selection Advantage for the Total Breeding Value



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.

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

Heifers 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.

Angus HeiferSELECT 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.

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 (Holstein)
- Wagyu

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 heifer. There are 2,743 animals in the reference population (animals with known breed and genotypes) that underpins Angus BreedCHECK as listed in table 3.

Table 3. Summary of the Reference Population that Underpins Angus BreedCHECK

BREED	REFERENCE
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 HeiferSELECT.

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 HeiferSELECT 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 the 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 HeiferSELECT 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 HeiferSELECT and BVDV testing can be conducted from the same DNA sample.

Table 4. Angus HeiferSELECT Genetic Effects Table

CE (kg)	WW (KG)	YW (KG)	MW (kg)	Milk (kg)	HC (weeks)	ADG (kg/day)	DFI (kg/day)	CW (kg)	EMA (cm2)	RIB (mm)	MBL (score)	OSS (score)	CCV ($)	FCV ($)	TBV ($)
-0.67	3.12	3.73	6.47	1.22	0.54	0.02	0.19	5.22	1.31	0.56	15.24	1.69	30.54	34.07	37.79

3. GENETICS EFFECTS TABLE

The Angus HeiferSELECT genetic effects table (Table 4.) enables you to assess genetic differences between heifers tested with Angus HeiferSELECT in real terms by providing the predicted genetic difference per ten (10) unit change in Angus HeiferSELECT value.

The genetic effects table can be used to predict the difference in progeny performance between two females. For example, a female with a Carcase Weight genetic prediction of 80 would be expected to produce progeny that are, on average, 13.05kg heavier at around 2 years of age, compared to a female with a Carcase Weight genetic prediction of 30, all other things being equal.

[*Working:* 5.22kg genetic difference per 10 unit HeiferSELECT value, 26.1kg (5.22 x 5) genetic difference per 50 unit HeiferSELECT value, 13.05kg (26.1 / 2) progeny difference (as females only contribute half of the genetics to the progeny, with the remainder coming from the sire to which they are joined)]

Also note:

- Calving Ease is presented in birth weight units of kgs, with higher CE genetic predictions resulting in lower birth weight, a major contributor to overall calving ease.
- The CCV, FCV and TBV are based of economic modelling underpinned by current day parameters therefore Australian dollar ($) units apply.

4. VALIDATION

An important feature of Angus HeiferSELECT is the comprehensive validation that has been undertaken to ensure it is an effective selection tool, particularly for Australian Angus in Australian 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 HeiferSELECT (and the related product 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 carcass weight, marbling score, ossification score and carcass 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.

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- *"Bias, dispersion, and accuracy of genomic predictions for feedlot and carcase traits in Australian Angus steers"* with conclusion: Estimates of h2 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.

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- *"Development of female fertility indicator traits for the Angus HeiferSELECT genomic tool"* with conclusion: Selection based on Heifer Conception (PREG) can result in tangible gains in female fertility in Angus females in commercial enterprises through the use of Angus HeiferSELECT.
Reference: Alexandre, P.A. et al (2023) Development of female fertility indicator traits for the Angus HeiferSELECT genomic tool. Proc. Assoc. Advmt. Anim. Breed. Genet. 25: 67 - 70.

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If you are interested to know more about the Angus HeiferSELECT Techincal Specifications please contact Angus Australia:

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