


# The role of reference populations in beef genetic evaluation

Matt Wolcott.  
Animal Genetics  
& Breeding Unit,  
Armidale.



February 2021 Brahman BREEDPLAN																		
	Gestation Length (days)	Birth Wt. (kg)	200 Day Wt. (kg)	400 Day Wt. (kg)	600 Day Wt. (kg)	Mat Cow Wt. (kg)	Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcass Wt (kg)	Eye Muscle Area (sq.cm)	Rib Fat (mm)	Rump Fat (mm)	Retail Beef Yield (%)	Percent IMF (%)	Percent Normal Sperm (%)	Flight Time (secs)	Shear Force (kgs)
EBV	+0.8	+4.0	+24	+34	+43	+56	+2	+1.0	+1.3	+25	+3.6	-0.8	-1.0	+1.0	-0.1	-	-0.02	+0.08
Accuracy	33%	52%	56%	56%	57%	54%	40%	43%	36%	48%	39%	39%	48%	30%	33%	-	42%	40%
Breed Avg. EBVs for 2019 Born Calves <a href="#">Click for Percentiles</a>																		
EBV	-0.3	+2.4	+19	+27	+37	+40	-2	+0.9	-2.0	+21	+2.6	-0.3	-0.4	+0.6	-0.1	+0.0	+0.01	+0.00
Traits Analysed: Genomics																		

# Outline

- What is a reference population?
- Information used in modern genetic (genomic) evaluations.
- Achieving gains in selection accuracy:
  - Relatedness, heritability and accuracy.
- Reference population projects.
  - Beef Information Nucleus projects (BINs)
  - Repronomics & Southern multi-breed.
  - Kaiuroo & Trans-Tasman MDC projects.

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- What is a reference population?
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# Reference populations & genomic selection

## Seedstock recording + pedigree



- Easy to measure.
- Lower cost recording.
- High volume of records.

# Reference populations & genomic selection

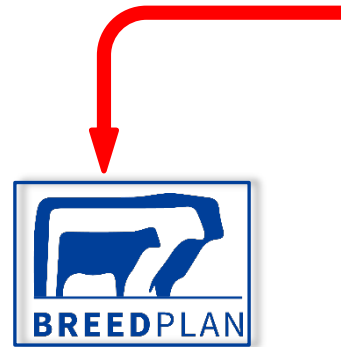
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# Reference populations & genomic selection

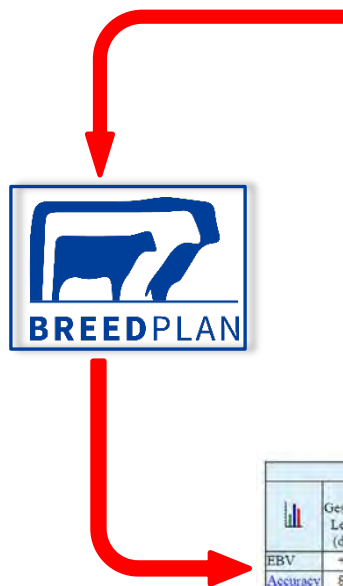
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# Reference populations & genomic selection

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	Gestation Length (days)	Birth Wt. (kg)	200 Day Wt. (kg)	400 Day Wt. (kg)	600 Day Wt. (kg)	Mat Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcass Wt (kg)	Eye Muscle Area (sq.cm)	Rib Fat (mm)	Rump Fat (mm)	Beef Yield (%)	Percent IMF	Normal Sperm (%)	Flight Time (secs)	Shear Force (kgs)		
EBV	+0.6	0.0	+21	+27	+44	+12	+1	+2.3	-7.0	+18	+2.8	+1.5	+1.5	+0.4	+0.1	+4.3	+0.05	-0.08	
Accuracy	89%	92%	96%	97%	97%	94%	81%	95%	84%	84%	75%	69%	86%	58%	63%	83%	95%	77%	

Breed Avg. EBVs for 2019 Born Calves [Click for Percentiles](#)

EBV	-0.3	+2.4	+19	+27	+37	+40	-2	+0.9	-2.0	+21	+2.6	-0.3	-0.4	+0.6	-0.1	+0.0	+0.01	+0.00	
-----	------	------	-----	-----	-----	-----	----	------	------	-----	------	------	------	------	------	------	-------	-------	--

Traits Analysed: 200WT,400WT,600WT,SS,FAT,EMA,PNS,Genomics

Statistics: Number of Herds: 5, Progeny Analysed: 309, Scan Progeny: 194, Number of Dirs: 34

SELECTION INDEX VALUES		
Market Target	Index Value	Breed Average
Jap Ox Index (\$)	+\$ 44	+\$ 30
Live Export Index (\$)	+\$ 40	+\$ 27

# Reference populations & genomic selection

## Reference population



- Intensive recording.
- Economically important traits.
- Lower volume of recording.
- Breed representative animals.

## Seedstock recording + pedigree



- Easy to measure.
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February 2021 Brahman BREEDPLAN																		
	Gestation Length (days)	Birth Wt (kg)	200 Day Wt (kg)	400 Day Wt (kg)	600 Day Wt (kg)	Mat Cow Wt (kg)	Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcass Wt (kg)	Eye Muscle Area (sq cm)	Rib Fat (mm)	Rump Fat (mm)	Beef Yield (%)	IMF (%)	Percent Normal Sperm (%)	Flight Time (secs)	Shear Force (kg)
EBV	+0.6	0.0	+21	+27	+44	+12	+1	+2.3	-7.0	+18	+2.8	+1.5	+1.5	+0.4	+0.1	+4.3	+0.05	-0.08
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Traits Analysed: 200WT,400WT,600WT,SS,FAT,EMA,PNS,Genomics  
Statistics: Number of Herds: 5, Progeny Analysed: 309, Scan Progeny: 194, Number of Dvs: 34

SELECTION INDEX VALUES		
Market Target	Index Value	Breed Average
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# Reference populations & genomic selection

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## Seedstock recording + pedigree



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Improved EBV accuracy

February 2021 Brahman BREEDPLAN																		
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Breed Avg. EBVs for 2019 Born Cattle are as follows:																		
EBV	-0.3	+2.4	+19	+27	+37	+40	-2	+0.9	-2.0	+21	+2.6	-0.3	-0.4	+0.6	-0.1	+0.0	+0.01	+0.00
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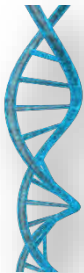
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# Reference populations & genomic selection

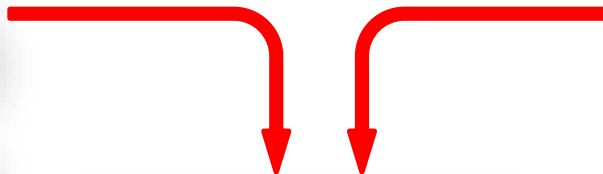
## Reference population



+



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- Economically important traits.
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## Seedstock recording + pedigree



+



- Easy to measure.
- Lower cost recording.
- High volume of records.

# Reference populations & genomic selection

## Reference population



- Intensive (\$) recording.
- Economically important traits.
- Lower volume of recording.
- In a representative x-section.

## Seedstock recording + pedigree



- Relatively easy to measure.
- Lower input / cost recording.
- High volume of records.



## Unrecorded young selection candidate





# Reference populations & genomic selection

## Reference population



- Intensive (\$) recording.
- Economically important traits.
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- In a representative x-section.

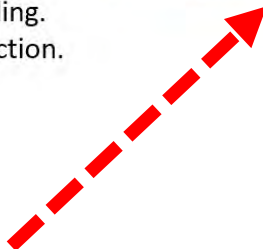
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## Unrecorded young selection candidate



# Reference populations & genomic selection

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
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## Unrecorded young selection candidate



## SOMERTON LAZARUS (IVF) (PS)

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	Gestation Length (days)	Birth Wt. (kg)	200 Day Wt. (kg)	400 Day Wt. (kg)	600 Day Wt. (kg)	Mat Cow Wt. (kg)	Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcass Wt (kg)	Eye Muscle Area (sq.cm)	Rib Fat (mm)	Rump Fat (mm)	Retail Beef Yield (%)	IMF (%)	Percent Normal Sperm (%)	Flight Time (secs)	Shear Force (kgs)
EBV	+0.8	+4.0	+24	+34	+43	+56	+2	+1.0	+1.3	+25	+3.6	-0.8	-1.0	+1.0	-0.1	-	-0.02	+0.08
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Traits Analysed: Genomics

# Reference populations & genomic selection

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
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# Reference populations & genomic selection

## Reference population



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
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Accuracy	33%	52%	56%	56%	57%	54%	40%	43%	36%	48%	39%	39%	48%	30%	33%	-	42%	40%
Based on EBVs for 2019 Brahman Cows and Bulls																		
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Traits Analysed: Genomics



# Reference populations & genomic selection

## Genomic information in the BREEDPLAN SS analysis

*Reference population = ALL animals with a genotype and a phenotype.*



# Reference populations & genomic selection

## Genomic information in the BREEDPLAN SS analysis

***Reference population = ALL animals with a genotype and a phenotype.***

- Whether part of a designed project or not.
  - Applies for all traits in the evaluation.



# Reference populations & genomic selection

## Genomic information in the BREEDPLAN SS analysis

***Reference population = ALL animals with a genotype and a phenotype.***

- Whether part of a designed project or not.
  - Applies for all traits in the evaluation.

***Maintaining quality of all reference recording is extremely important.***



# Reference populations & genomic selection

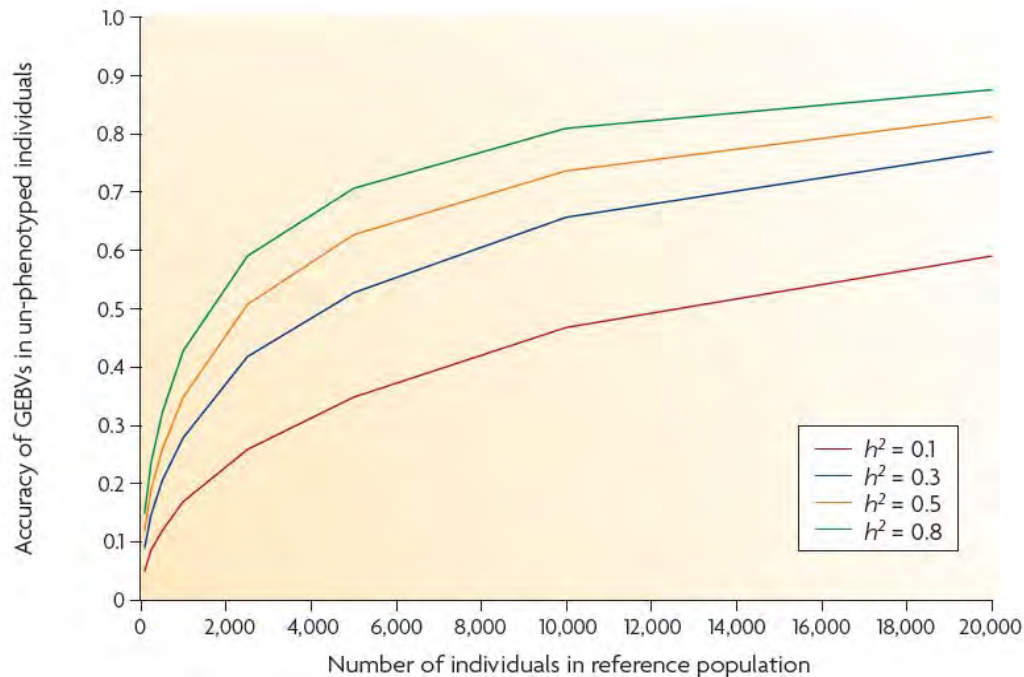
Number or records for reference traits:

- Target EBV accuracy.
- Heritability of the trait(s).

# Reference populations & genomic selection

## Number or records for reference traits:

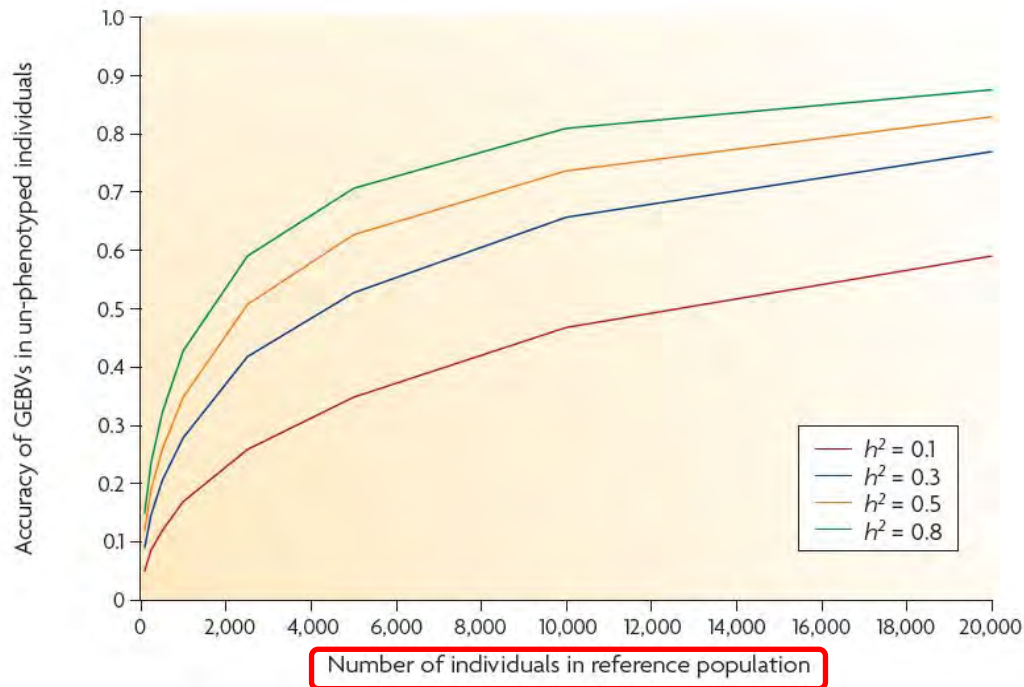
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# Reference populations & genomic selection

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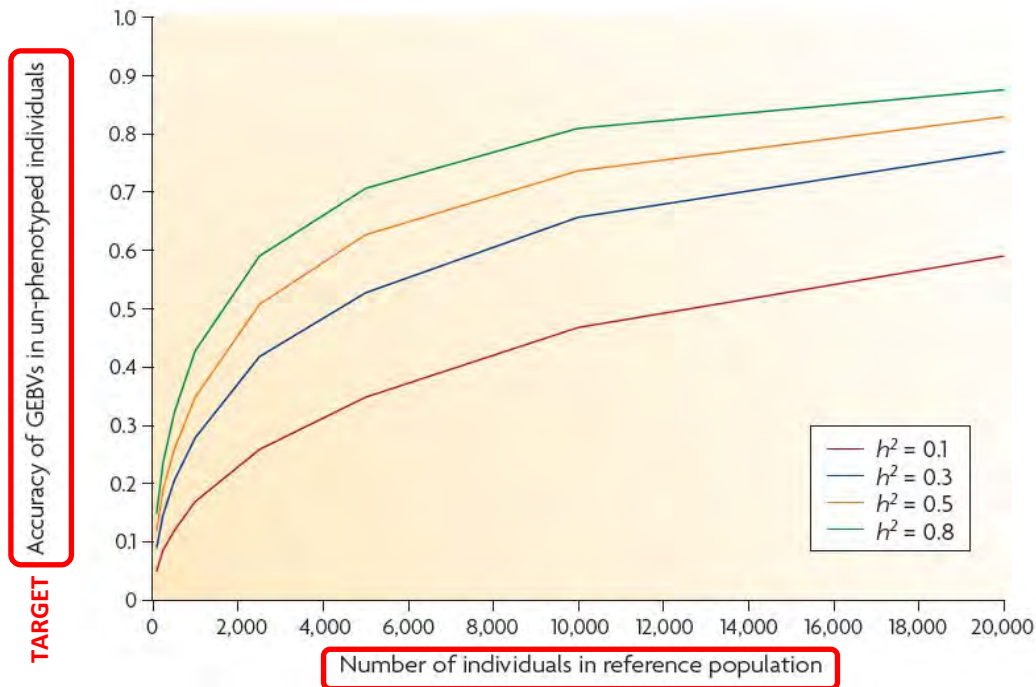
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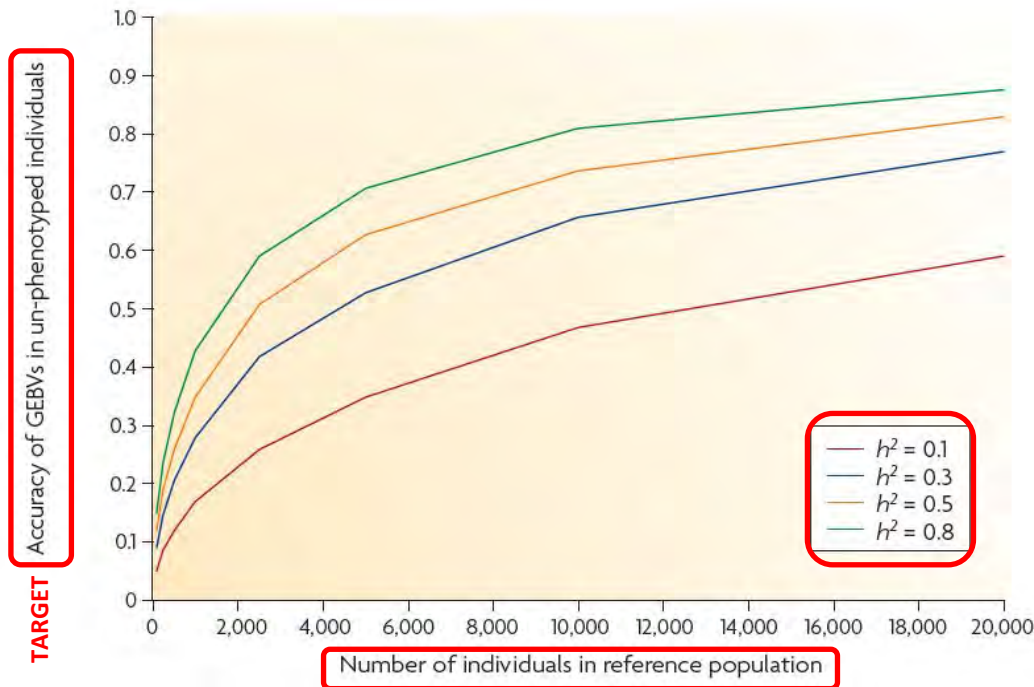
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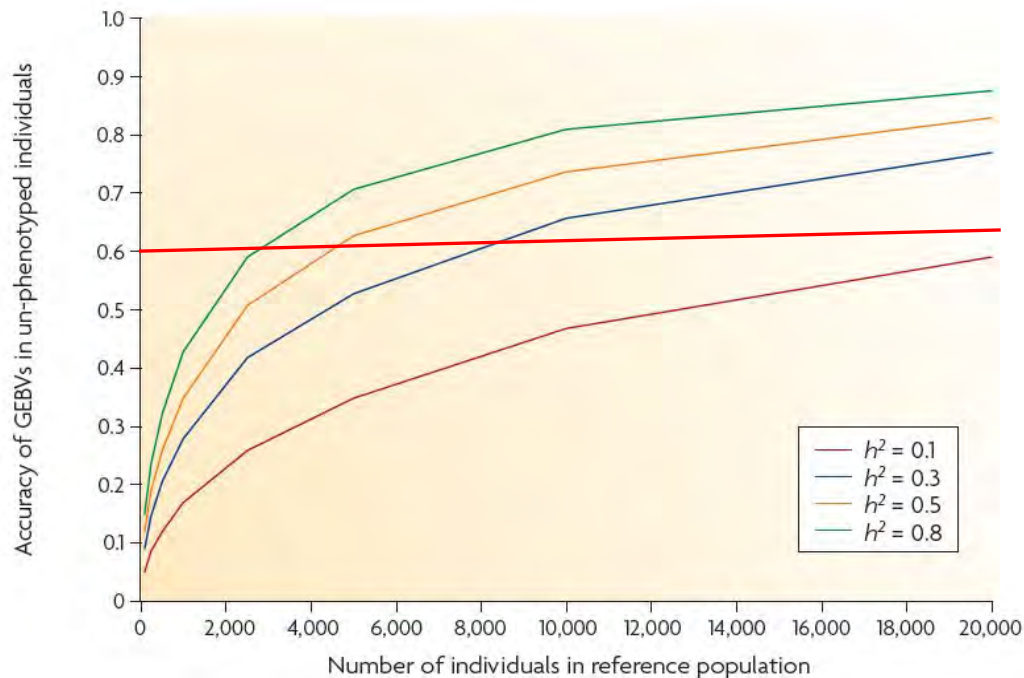




# Reference populations & genomic selection

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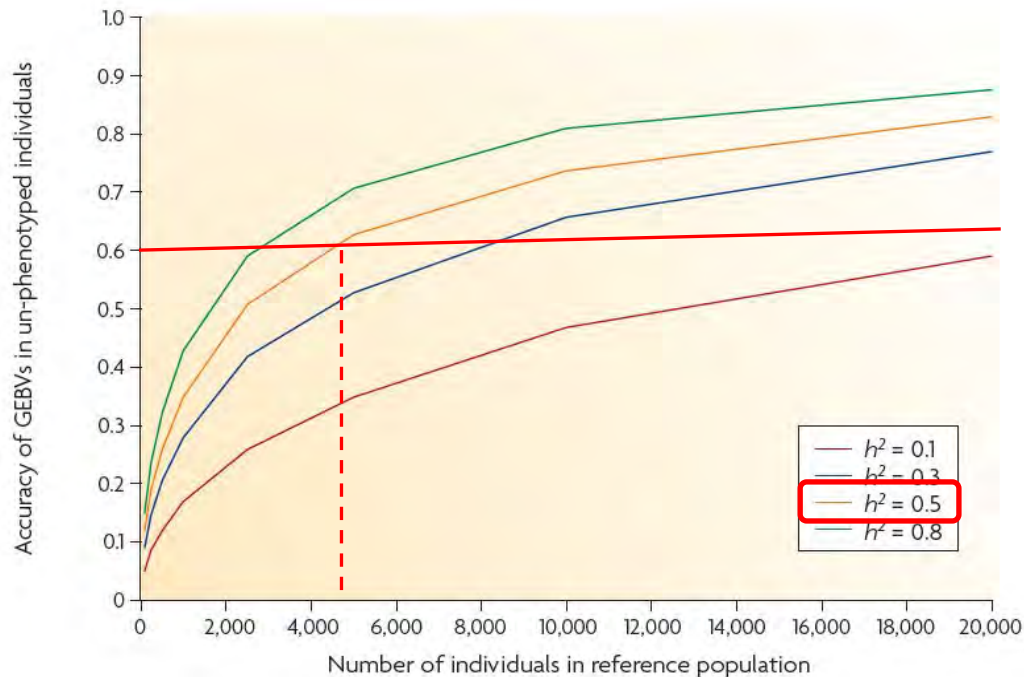
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# Reference populations & genomic selection

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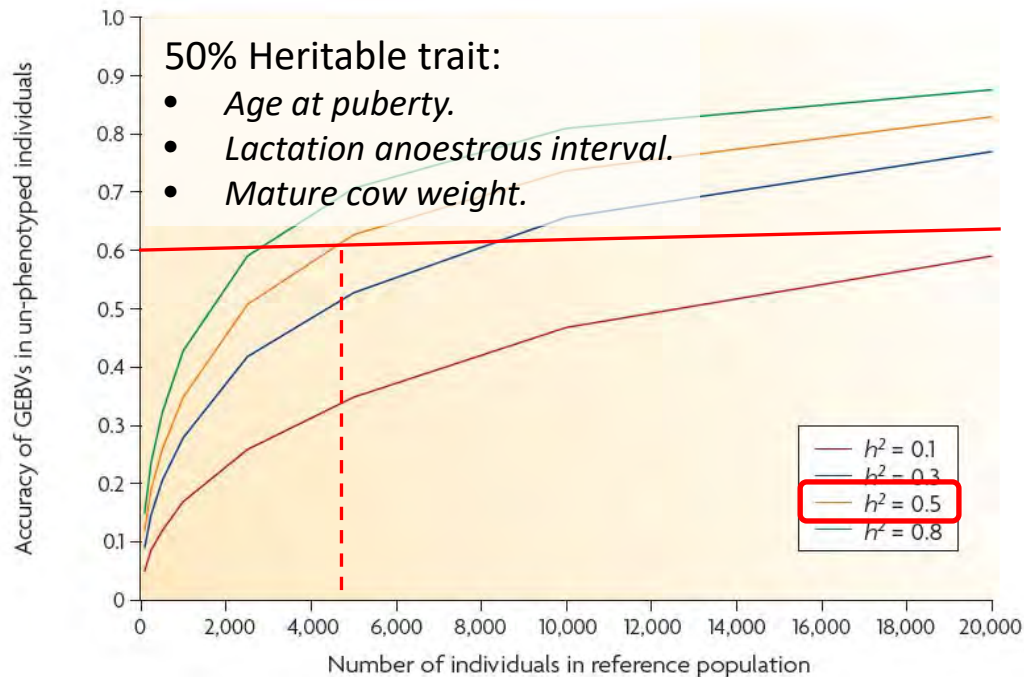
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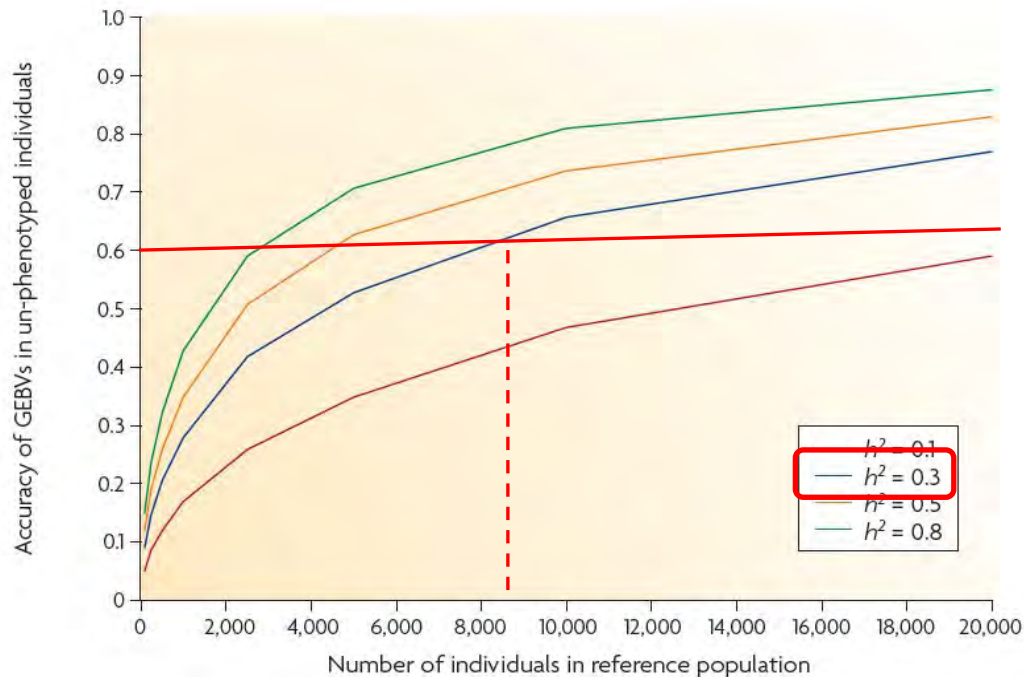
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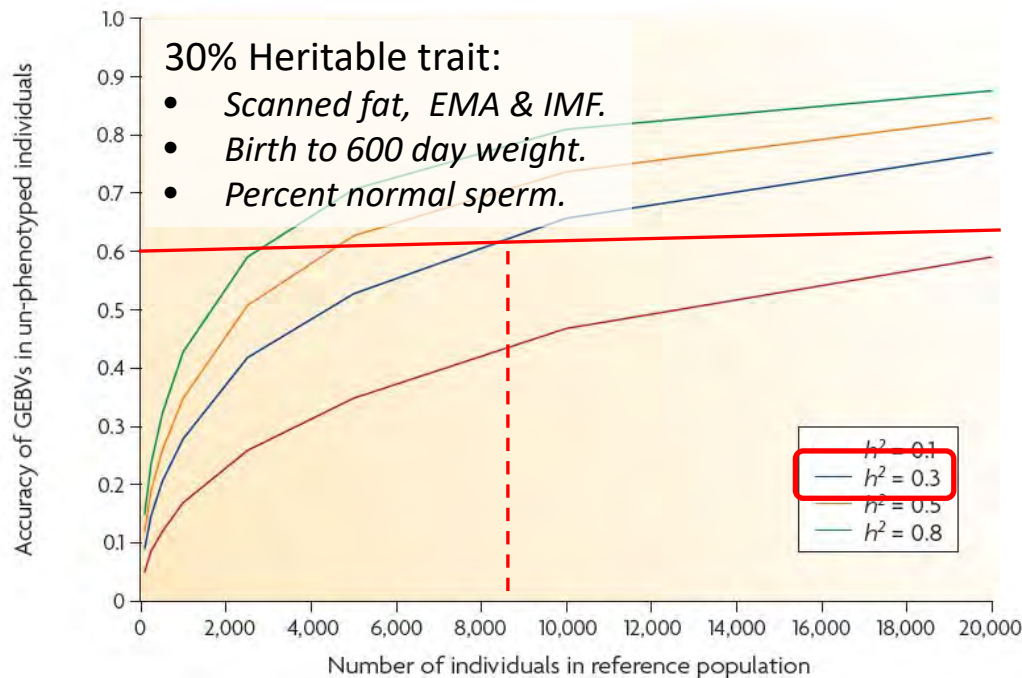
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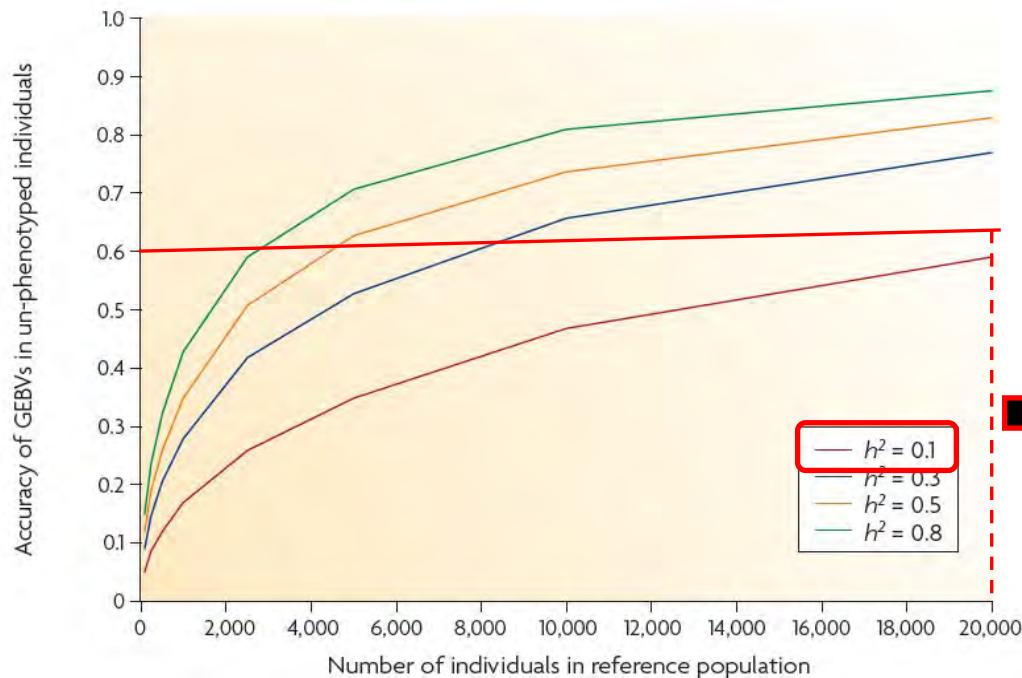
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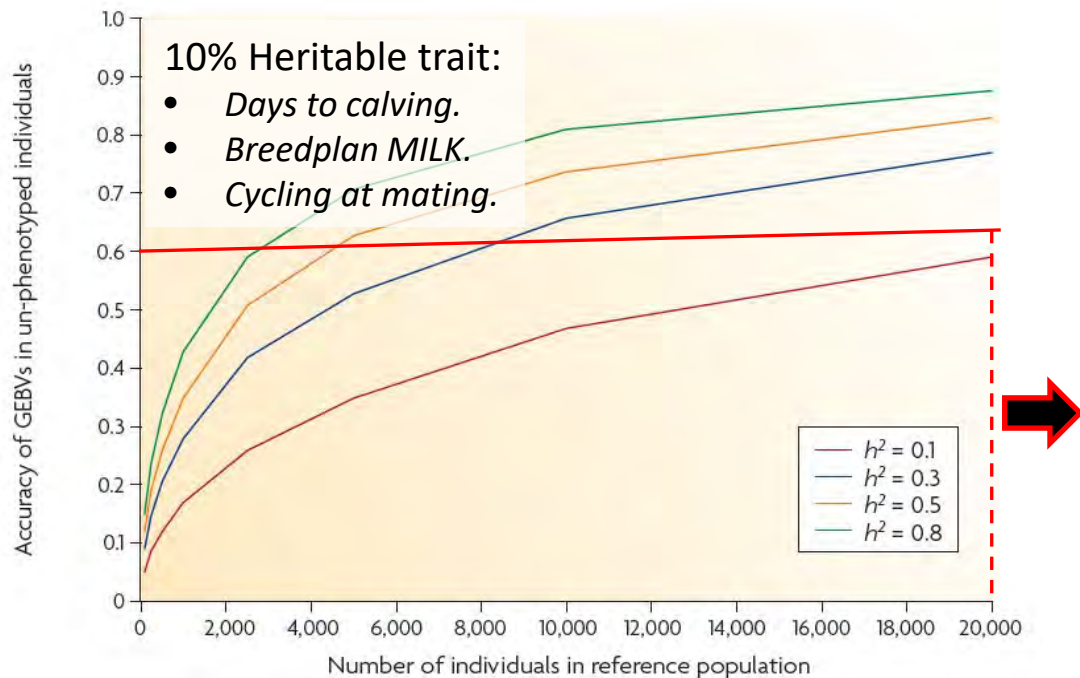
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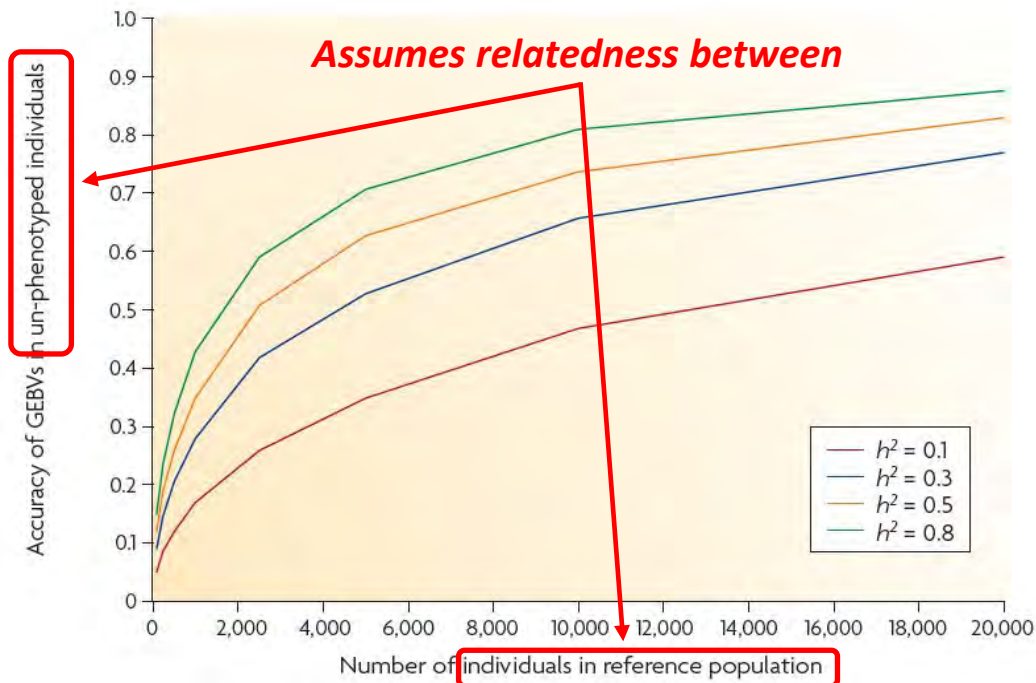




# Reference populations & genomic selection

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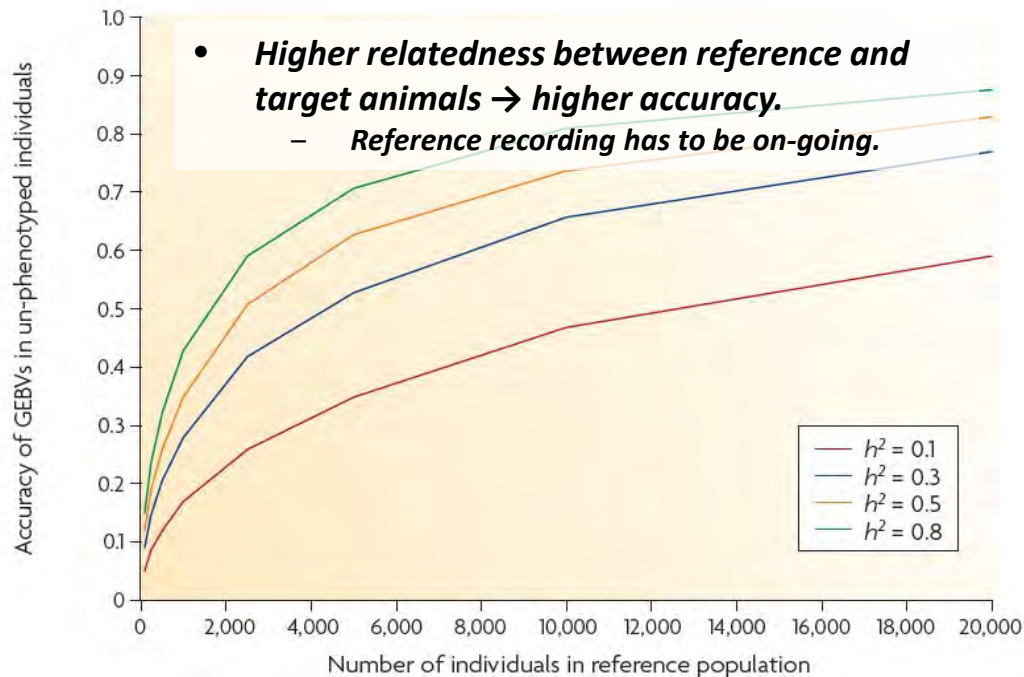




# Reference populations & genomic selection

## Number or records for reference traits:

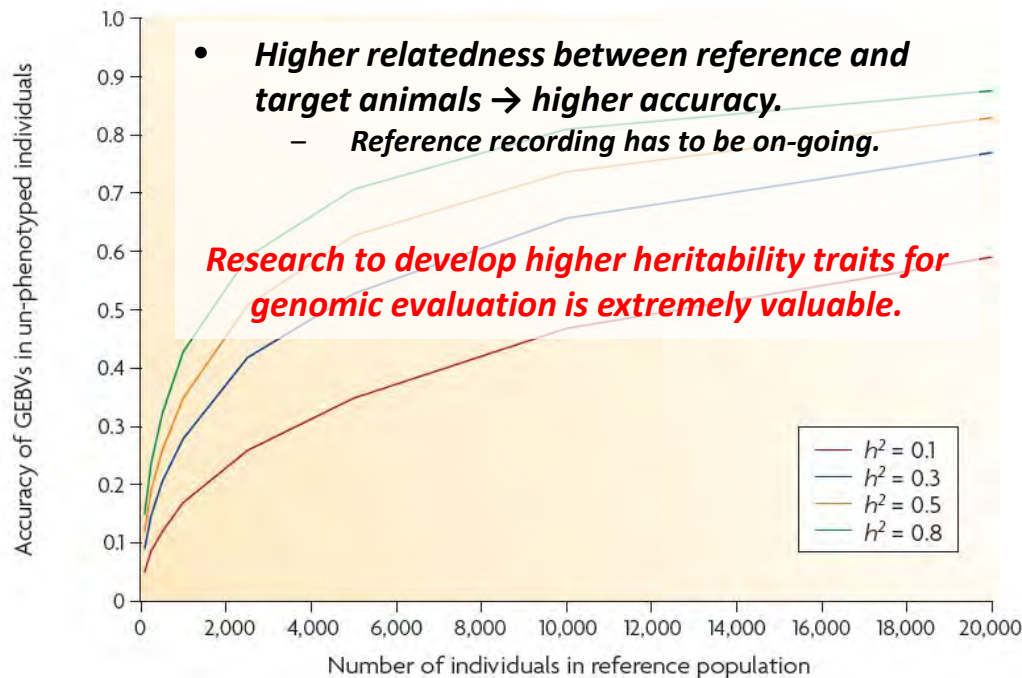
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# Reference populations & genomic selection

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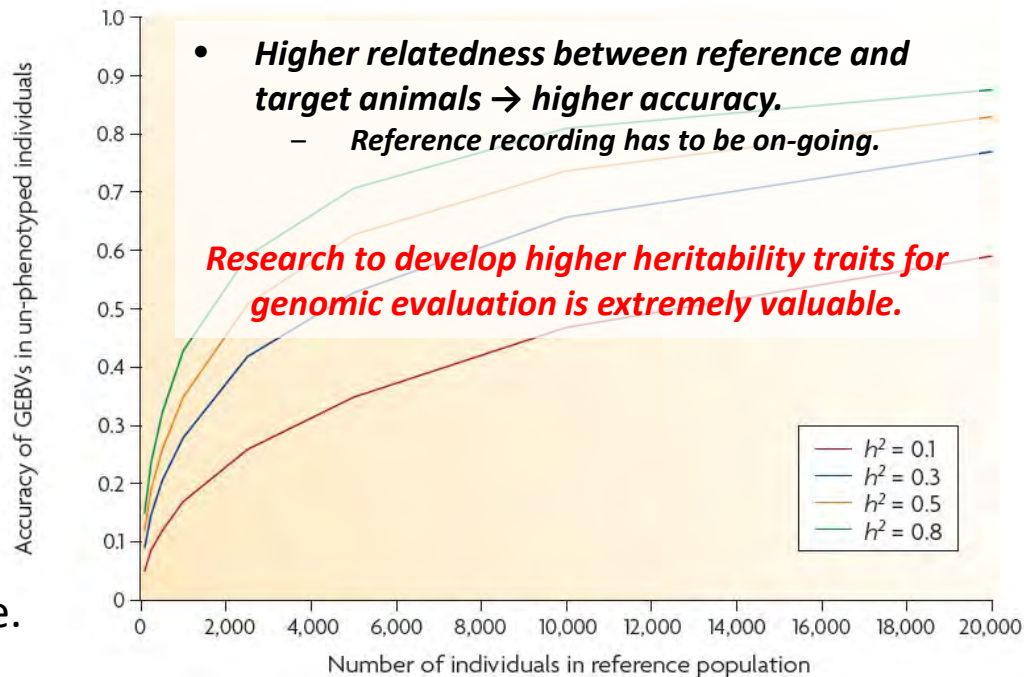
# Reference populations & genomic selection

## Number or records for reference traits:

- Target EBV accuracy.
- Heritability of the trait(s).

Reference project  $\neq$  progeny test.

- Improve accuracy for whole population.
- Not just targeted sires.
- For traits of greatest economic value.



# Reference populations & genomic selection

What to record in the reference population:

# What to record in the reference population

Key traits to include in the reference.

- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.

# What to record in the reference population

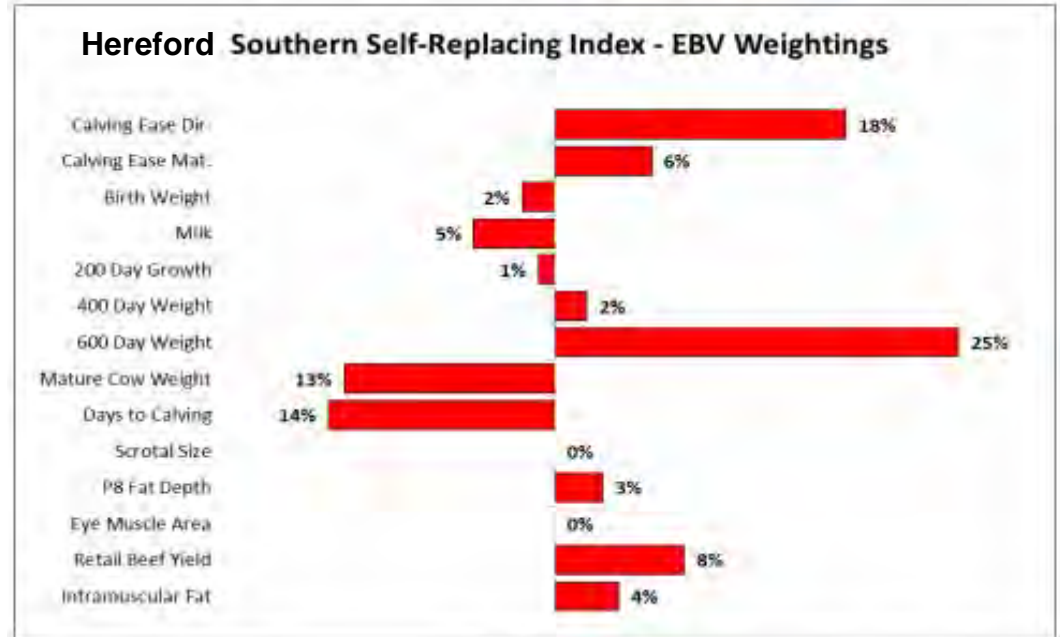
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# What to record in the reference population

Key traits to include in the reference.

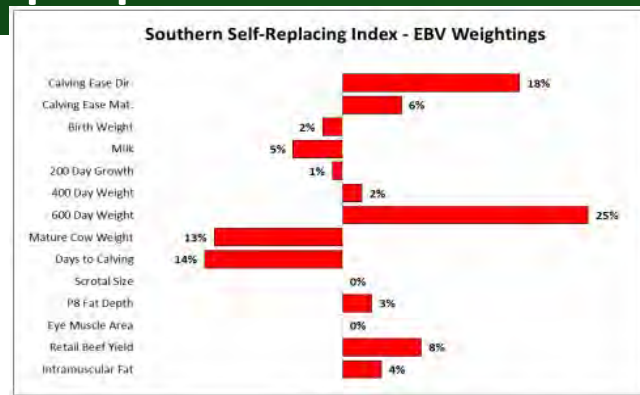
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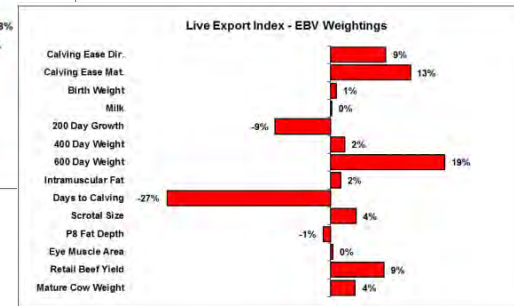
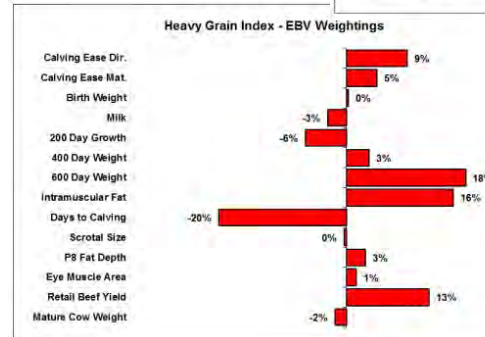
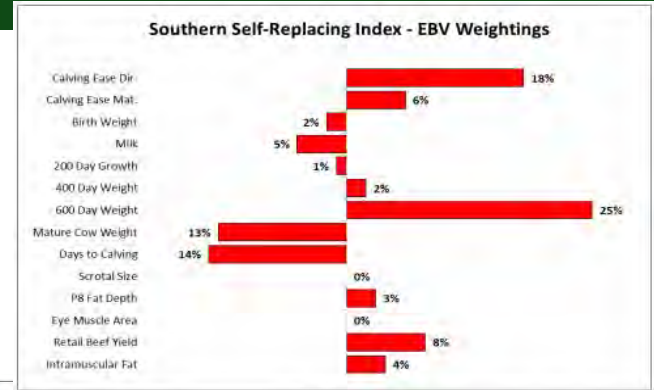




# What to record in the reference population

## Key traits to include in the reference.

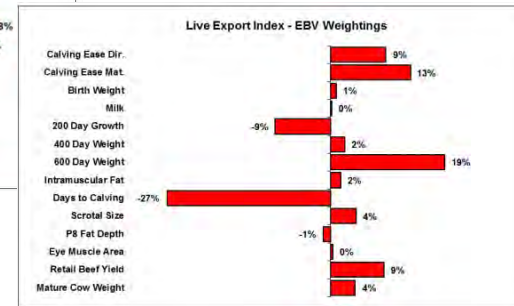
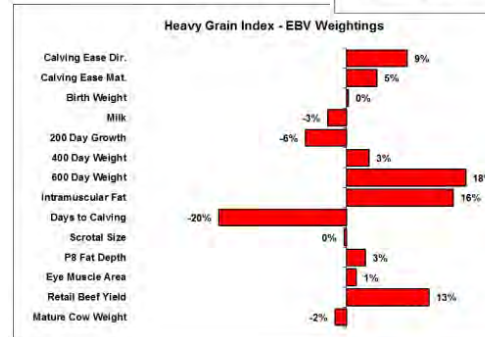
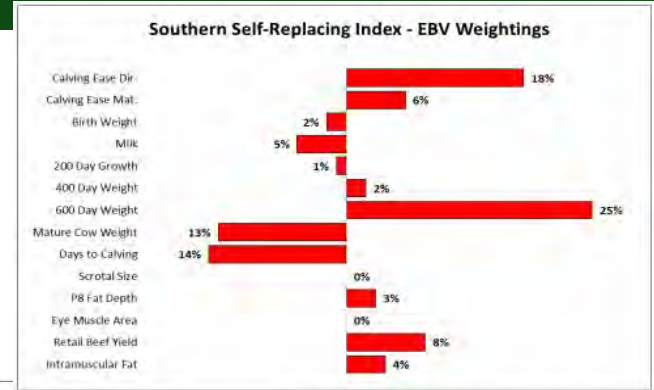
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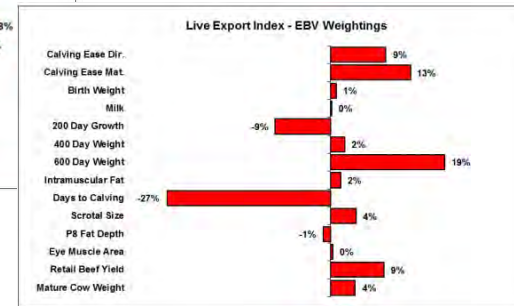
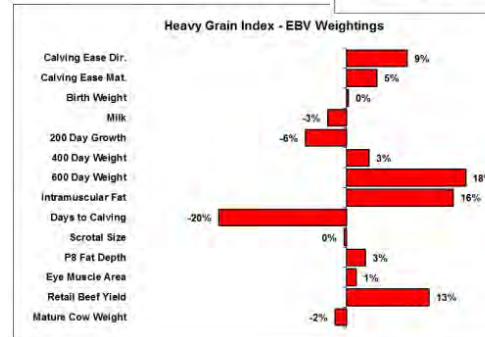
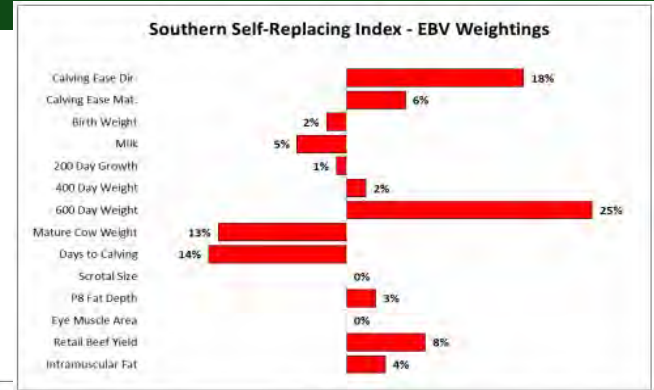
- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.
  - Growth to slaughter.
  - Calving ease.
  - Marbling.
  - Reproduction.
  - Mature cow traits.
  - Retail Beef Yield.



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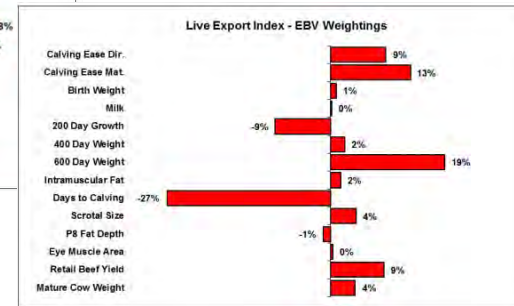
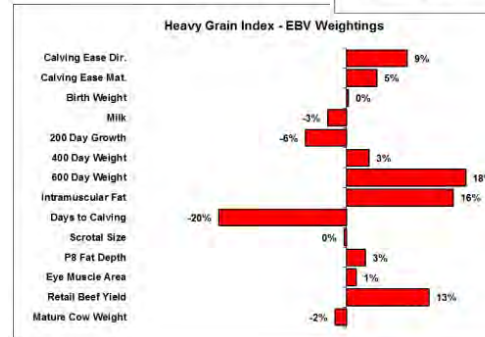
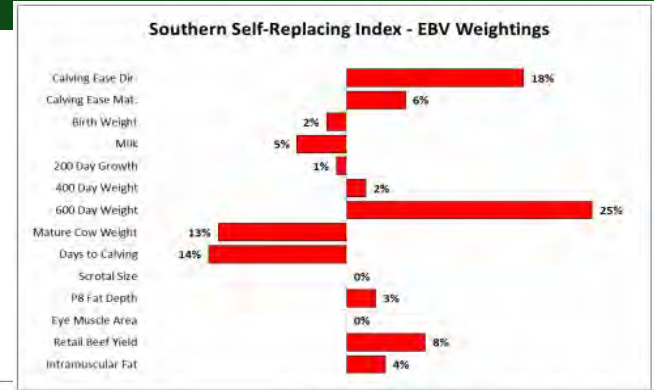
- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.
  - **Growth to slaughter. Good.**
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  - Retail Beef Yield.



# What to record in the reference population

## Key traits to include in the reference.

- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.
  - Growth to slaughter. Good.
  - Calving ease. OK for some breeds.
  - Marbling.
  - Reproduction.
  - Mature cow traits.
  - Retail Beef Yield.

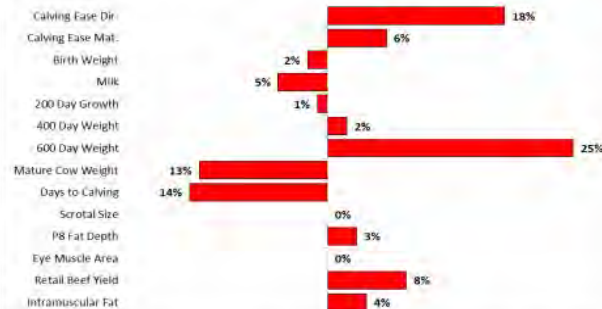


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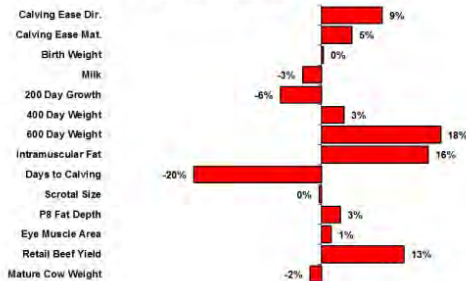
## Key traits to include in the reference.

- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.
  - **Growth to slaughter.**      **Good.**
  - **Calving ease**      **OK for some breeds.**
  - **Marbling**      **Universally**
  - **Reproduction.**      **Low.**
  - **Mature cow traits.**      **Low.**
  - **Retail Beef Yield.**

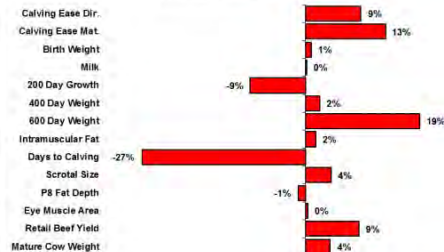
Southern Self-Replacing Index - EBV Weightings



Heavy Grain Index - EBV Weightings



Live Export Index - EBV Weightings



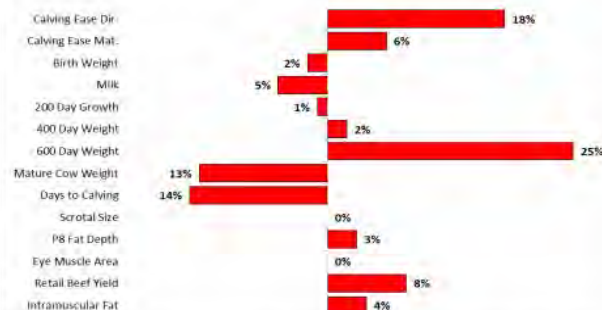
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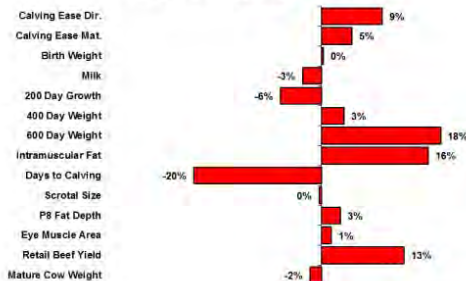
- Based on breeding objectives.
- BreedObject accurately identifies drivers of profitability.

- **Growth to slaughter.** Good.
- **Calving ease** OK for some breeds.
- **Marbling** Universally
- **Reproduction.** Universally
- **Mature cow traits.** Low.
- **Retail Beef Yield** Universally very low.

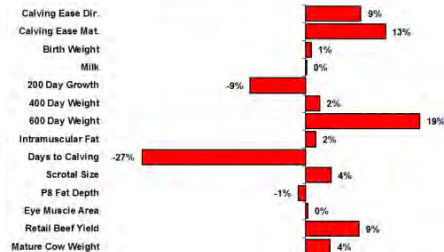
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Heavy Grain Index - EBV Weightings



Live Export Index - EBV Weightings



# What to record in the reference population

## Key traits to include in the reference.

- Reference population projects need to accurately record traits of highest economic importance.
- The most impact will be for lowly recorded traits of high economic importance.
- Those will not be the same for every breed (or sectors in a breed).
- Profit based breeding objectives highlight where recording efforts are best places.

# Industry supported reference populations

Industry funded & managed reference  
populations:

Research projects.



# Reference data from research herds

## The Repronomics Project

- Large industry (MLA) funded project
  - Led by Dr. David Johnston.
  - Building on Beef CRC results in industry.
- Intensively recording female reproduction.
  - Heifers scanned to determine age at puberty.
  - Lactating first calvers scanned to measure lactation anoestrus interval.
  - Males finished and slaughtered for carcass traits.



# Reference data from research herds

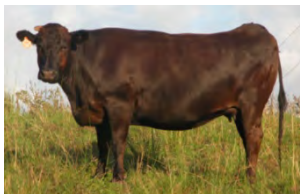
## The Repronomics Project

- Purebred Brahman, Santa Gertrudis and Droughtmaster.
- And X-breeds in *next* phase of the project.
- Sires sourced from industry & to insure linkage to other research / BIN projects.
  - Including female progeny of Beef CRC cows.
- All animals genotyped → Reference pop.



# Reference data from research herds

## Southern Multi-Breed Project



- Intensive recording of performance for
  - Female reproduction.
  - Mature cow body composition.
  - Male growth and carcass traits.
- Will form the basis for across-breed EBVs and \$Indexes for temperate breeds.
- Linked to northern Repronomics project.
- All animals genotyped → reference pop.

# Kaiuroo MDC project

Collecting reference population data in a  
commercial seedstock herd:

The Kaiuroo MDC project.

# The Kaiuroo MDC project

## AIMS

- Collect hard to measure female and MALE reproduction traits:
- In animals well linked to the current Brahman population.
- To improve description of these in a representative sample of the Brahman population.
- And allow Brahman breeders to make more accurate selection for key drivers of profitability.

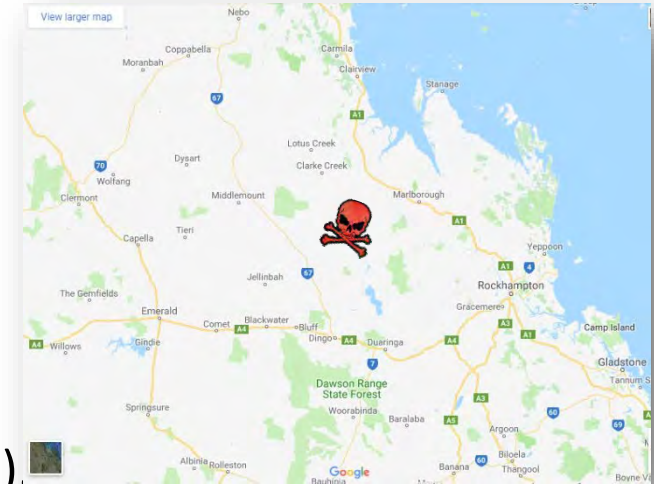
# Kaiuroo snapshot

- The 'Kaiuroo Aggregation'
  - 5 neighbouring properties.
  - In the Fitzroy River basin.
  - 34,500ha with 600ha irrigated leucaena.
  - 1,000 Brahman stud female .
  - 4,000 commercial cows (Brahman and X-bred)
- Evolution of the 'Tartrus' Brahman stud.
- Owned by The Rohatyn Group.



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- Evolution of the 'Tartrus' Brahman stud.
- Owned by The Rohatyn Group.
  - **Brahman stud dispersed in 2020.**
  - **Bulls and cows still in industry.**






# Kaiuroo snapshot

## Pedigree and performance recording

- Data in BREEDPLAN analysis since 1963.
- Dates of birth (and DTC) since 1990.
- CRC I, II & III participants.
- One of the best recorded Brahman herds in Australia.

### Brahman Animal Details TARTRUS SAMBO 3273 (H)

**Identifier:** TTS973273M(REG)  
**Sex:** Male  
**PH No.:** 973273  
**Birth Date:** 20/10/1996  
**Calving Year:** 1997  
**Status:** Active  
**Registration Status:** Registered  
**Sire:** [JDH SIR REM MANSO 95 \(IMP US\)](#)  
**Dam:** [DUMBARTON MISS V8 TEXCZAR 0/107 \(ET\) \(H\)](#)  
**Breeder:** SIR GRAHAM MCCAMLEY  
**Current Owner:** SIR GRAHAM MCCAMLEY  
**Horn:** Horned  
**Colour:** Grey  
**DNA Genotype:** Yes  
**Progeny:** [\[128 - View\]](#) [\[View by Herd\]](#)  
**Pedigree:** [\[View\]](#)  
**EBV Graph:** [\[View\]](#)

July 2018 Brahman BREEDPLAN																	
	Birth Wt. (kg)	200 Day Wt (kg)	400 Day Wt (kg)	600 Day Wt (kg)	Mat Cow Wt (kg)	Milk (kg)	Scrotal Size (cm)	Days to Calving (days)	Carcass Wt (kg)	Eye Muscle Area (sq.cm)	Rib Fat (mm)	Rump Fat (mm)	Retail Beef Yield (%)	IMF (%)	Percent Normal Sperm (%)	Flight Time (secs)	Shear Force (kgs)
EBV	+2.7	+11	+23	+36	+63	-3	-0.7	-0.9	+19	+3.2	+0.7	-1.1	+0.2	0.0	+1.4	+0.13	+0.23
Acc	94%	94%	95%	96%	94%	91%	86%	90%	91%	88%	85%	88%	65%	81%	68%	89%	86%
Breed Avg. EBVs for 2016 Born Calves <a href="#">Click for Percentiles</a>																	
EBV	+2.7	+19	+26	+36	+41	-2	+0.6	-0.3	+21	+2.4	-0.4	-0.6	+0.6	-0.1	+0.0	+0.01	+0.04

Traits Observed: 200WT,600WT,Genomics

Statistics: Number of Herds: 5, Progeny Analysed: 116, Scan Progeny: 102, Carcass Progeny: 48, Number of Dtrs: 52

SELECTION INDEX VALUES		
Market Target	Index Value	Breed Average
Jap Ox Index (\$)	+\$ 27	+\$ 25
Live Export Index (\$)	+\$ 24	+\$ 22

# Kaiuroo MDC project

- The gap
  - Beef CRC showed percent normal sperm (PNS) measured in young bulls was heritable.
  - AND had useful genetic relationships with female reproduction.
  - Since CRC, very little new PNS data coming into Brahman genetic evaluation.
- Opportunity for intensive phenotyping in industry to drive genomic evaluation for PNS & confirm relationships with AP/LAI.



# Kaiuroo MDC project

## Kaiuroo MDC experimental design

- Measure PNS in young bulls over three years (2016 – 2018).
- Intensively record female reproduction to confirm genetic relationships with PNS.
  - All heifers scanned to determine age at puberty.
  - Lactating first calvers scanned to measure lactation anoestrus interval.



# Kaiuroo MDC project

## Kaiuroo MDC experimental design

- Project design includes genetic links with Repronomics and Brahman BIN projects.
- Links with SMB generated recently.
- Very good linkage to contemporary Brahman population.



# Kaiuroo MDC project

The Kaiuroo MDC project:

Results and outcomes for industry.

# Kaiuroo MDC Results

## Percent normal sperm EBV & accuracy change

SIRE	Progeny		Herds	Pre - MDC		Post - MDC	
	Kaiuroo	Brahman		EBV	Acc (%)	EBV	Acc (%)

# Kaiuroo MDC Results

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Tartrus 055342M							
Lancefield D Larwood							
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LCM Ambassador 700/7							
NBS Kingston Town							
Elrose Fair Play							



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Tartrus 055342M	7	136	1				
Lancefield D Larwood	34	119	1				
JDH Pecos Manso	12	93	16				
LCM Ambassador 700/7	14	114	20				
NBS Kingston Town	19	70	8*				
Elrose Fair Play	9	159	19				

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JDH Pecos Manso	12	93	16		19		51
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**Average accuracy improvement for sires ~ 30%**

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Average change in Sire PNS EBVs close to zero.



# Kaiuroo MDC Results

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- 32 sires evaluated with progeny outside of Kaiuroo.
  - 2380 Ex Kaiuroo progeny.
  - In ~75 herds.
  - Including 2 Repronomics.
  - Producing ~ 30% increase in SIRE accuracy

# Kaiuroo reference population project

## Reference population in seedstock herd

- Industry level improvement in PNS accuracy.
- Benefits spread around a large number of herds.



# Kaiuroo reference population project

Creating opportunities for Brahman breeders to :

- Improve accuracy of selection for male fertility.
- See correlated improvement in female reproduction EBV accuracy.
- Purchase and market bulls with better information on genetic profitability.



# Reference populations & genomic selection

## Conclusions

# Reference populations & genomic selection

## Conclusions

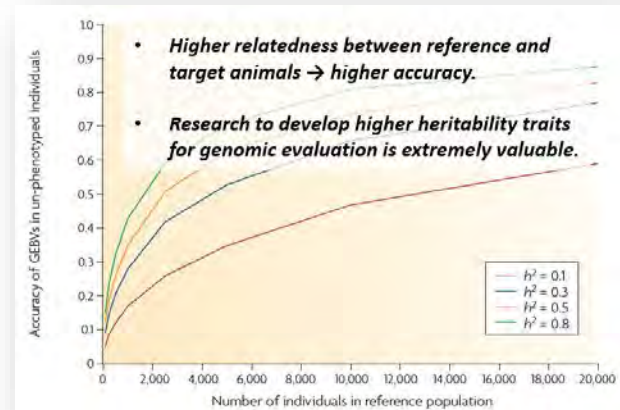
- The reference population = any animals with genotypes + phenotypes.



# Reference populations & genomic selection

## Conclusions

- The reference population = any animals with genotypes + phenotypes.
- EBV accuracy depends on:
  - The size of the reference population.
  - Trait heritability.
  - The relatedness to 'target' animals.





# Reference populations & genomic selection

## Successful beef reference populations:

- Identifying and measuring the right traits is key.
  - Economically based breeding objectives.
- Intensive recording of hard to measure phenotypes in industry funded projects.
  - Needs to be on-going.
- Good herd level recording adds to the data in the reference and the accuracy of genomic selection.

# Thank you

Many people to thank for all their work in making this data available:

- Meat and Livestock Australia.
- Repronomics™ & Southern multi-breed.
  - All participating breeds, breeders & staff.
- Kaiuroo owners, managers and staff.
- NSW Department of Primary Industries.
- QLD Department of Agriculture & Fisheries.
  - QLD Repronomics research stations.



Performance Herds Australia



Department of Primary Industries

