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Genomic Selection for High Quality Beef Production

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About my Project

- Wagyu herd located NSW/QLD
- ~ 5000 genotypes
- ~ 1000 carcass phenotypes
- Also birthweight, Growth, Fertility and Feed Intake Data
- How do we use Genomic Selection within a breeding program
 - Genomic methodology
 - Information Sources
 - Breeding Program Design
 - Balancing genetic gain and genetic diversity (mate allocation)



Wagyu... Why all the hype?

- High Marbling
 - Texture/Juiciness
 - Meat flavour
 - Palatability
- 1-2% of Australian beef herd
- 80-90% of production exported
- Feeder steers (400kg) \$6/kg vs. \$2.40/kg
- Steaks sell \$130-450/kg in Australia, \$600/kg internationally





Genomic Selection... Why all the hype?







Phenotype = Genotype + Environment









• Indicates genetic merit of a animal



Phenotype = **Genotype** + Environment

Additive

• "gene effects ADD together"



- Estimated Breeding Values (EBVs)
 - Indicates genetic merit of a animal

• Calculated based on own performance records as well as relatives information

	November analysis 1 2018 Wagyu GROUP BREEDPLAN													
			200	400	600	Mat				Eye		Retail		
	Gestation	Birth	Day	Day	Day	Cow		Scrotal	Carcase	Muscle	Rump	Beef		Marble
	Length	Wt	Wt	Wt	Wt	Wt	Milk	Size	Wt	Area	Fat	Yield	Marble	Fineness
	(days)	(kg)	(kg)	(kg)	(kg)	(kg)	(kg)	(cm)	(kg)	(sq cm)	(mm)	(%)	Score	(%)
EBV	+1.3	+0.4	-1	-4	-8	-8	-11	-2.6	-10	+6.6	+0.7	+0.5	+1.5	+0.46
Acc	97%	98%	98%	98%	98%	97%	98%	97%	98%	97%	97%	95%	97%	96%
Breed Avg. EBVs for 2016 Born Calves Click for Percentiles														
EBV	+0.3	+1.0	+10	+15	+18	+19	+0	+0.0	+13	+0.8	+0.2	-0.1	+0.5	+0.12



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Relationship Matrices



Pedigree Relationship Matrix





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- Greater push to select animals based on the genes that control traits.
- DIFFICULT !!!

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- DIFFICULT !!!
- Genomic selection :- information from a large number of markers distributed across the genome can be used to capture diversity
 - Can estimate breeding values without having a precise knowledge of where specific genes are located.



- Greater push to select animals based on the genes that control traits.
- DIFFICULT !!!
- Genomic selection :- information from a large number of markers distributed across the genome can be used to capture diversity
 - Can estimate breeding values without having a precise knowledge of where specific genes are located.
- On average across siblings, each share 50% of their genes with each other but there is variation to this rule

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Relationship Matrices



Pedigree Relationship Matrix



Genomic Relationship Matrix

	1	2	3	4	5
1	1.06				
2	0.06	0.88			
3	0.51	0.52	0.86		
4	0.50	0.49	0.41	0.96	
5	0.55	0.51	0.42	0.58	1.02

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Trait Heritability

- **Heritability** is the proportion of total variation between individuals in a given population due to genetic variation.
- This number can range from 0 (no genetic contribution) to 1 (all differences on a trait reflect genetic variation).
- Important determinant of response to selection



Trait Heritability

- **Heritability** is the proportion of total variation between individuals in a given population due to genetic variation.
- This number can range from 0 (no genetic contribution) to 1 (all differences on a trait reflect genetic variation).
- Important determinant of response to selection
- How does using Genomic Relationships impact trait heritability?



Traits of Interest

Standard Traits (AUS-Meat)

- Hot standard Carcass Weight
- P8 (rump) fat depth
- Marble Score
- With Wagyu
 - Marble score 9+



- AUS-MEAT does not consider marbling distribution/fineness
- Subjective assessment



MIJ Camera Image Traits



- Fig. 1. Photography equipment used at the slaughter house and sample images. (a) The photography equipment. A photograph is being taken of the 5th–6th cross-section of the carcass. (b) A representative image of the 5th–6th cross-section. (c) The rib-eye area cropped from image (b) and used for image analysis. (d) The binarised image of (c), and the black area shows marbling on the rib eye. (e) The coarse marbling image from (d) after thinning.
- of ADELAIDE

Maeda *et al.* 2014

- Percentage Marbling
- % Marbling Coarseness (flecks > 0.5cm)
- Marbling Fineness (flecks < 0.5cm)
- Percentage Marbling minus the largest marbling fleck
- Index Trait (combines Marbling Fineness and Percentage Marbling)
- Image Rib-Eye area

Pedigree vs. Genomic Estimates

Trait	Method	¹ N	Range of h ²	Weighted mean h ²	Genomic h ²
Carcass Weight	AUS-Meat	3	0.24-0.59	0.42	0.57
Subcutaneous fat thickness	AUS-Meat	3	0.19-0.84	0.31	0.34
Marbling Score	AUS-Meat	3	0.23-0.54	0.43	0.60
Camera rib-eye muscle area	MIJ	4	0.33-0.62	0.47	0.44
Percentage marbling area	MIJ	6(5)	0.37-0.76	0.62	0.80
Marbling coarseness index	MIJ	6(5)	0.31-0.50	0.45	0.57
Coarseness index of largest marbling particle	MIJ	5(4)	0.05-0.20	0.08	-
Marbling fineness	MIJ	4	0.38-0.55	0.42	*data available
Combined Marbling Index					0.56
Percentage Marbling minus Largest Marbling Particle					0.78



Genetic Correlations

	HSCW	P8	I_REA	% Marb	Coarseness	Combined	% Marb - LRG	MarbSCORE
						Index		
HSCW*		0.26	0.29	0.07	0.24	0.07	0.06	0.15
Р8	0.14		-0.02	0.03	0.08	-0.05	0.03	0.01
I_REA	0.33	-0.05		0.15	0.40	0.39	0.16	0.29
% Marb	-0.09	-0.04	0.23		0.53	0.69	0.98	0.77
Coarseness	-0.02	0.12	0.31	0.64		0.01	0.43	0.49
Combined Index	-0.03	-0.23	0.48	0.79	0.18		0.72	0.56
% Marb - LRG	-0.10	-0.06	0.22	1.00	0.61	0.81		0.77
MarbSCORE	-0.05	-0.06	0.33	0.97	0.65	0.83	0.97	
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Genetic Correlations

	HSCW	P8	I_Rib Eye	% Marb	Coarseness	Combined	% Marb - LRG	MarbSCORE
			Area			Index		
HSCW*		0.26	0.29	0.07	0.24	0.07	0.06	0.15
Р8	0.14		-0.02	0.03	0.08	-0.05	0.03	0.01
I_Rib Eye Area	0.33	-0.05		0.15	0.40	0.39	0.16	0.29
% Marb	-0.09	-0.04	0.23		0.53	0.69	0.98	0.77
Coarseness	-0.02	0.12	0.31	0.64		0.01	0.43	0.49
Combined Index	-0.03	-0.23	0.48	0.79	0.18		0.72	0.56
% Marb - LRG	0.10	0.06	X <u>0.22</u>	1.00	0.61	0.81		0.77
MarbSCORE	-0.05	-0.06	0.33	0.97	0.65	0.83	0.97	



Summary

- Genomic selection involves using thousands of markers located across the genome to describe relationships between animals in a population.
- Genomic relationships more accurate
 - Increases trait heritability
- High heritability for Camera Traits vs. AUS-MEAT
- Increasing marbling % increased coarseness of marbling particles
- Combined index (that accounted for marbling fineness) better option
 - Desirable relationship with other important traits







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