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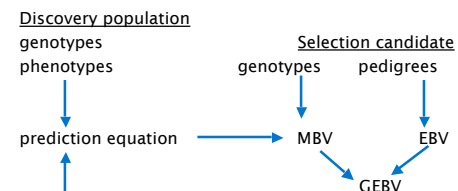
Implementation of genomic evaluation in the dairy industry

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Genomic evaluation now



Discovery population
genotypes
phenotypes

Validation population
genotypes
phenotypes


Selection candidate
genotypes
pedigrees

prediction equation

MBV

EBV

GEBV




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Dairy industry implementation

All major countries implementing genomic selection

Why?
Double rate of genetic gain
Shorter generation intervals




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Genomic selection vs progeny test

Rate of genetic gain ΔG

$$\Delta G = (i_m r_m + i_f r_f) / (L_m + L_f)$$


$$= (2 \cdot 0.8 + 0) / (6 + 2) = 0.2 \text{ progeny testing}$$

$$= (2 \cdot 0.6 + 0.8 \cdot 0.6) / (2 + 2) = 0.42 \text{ Genomic selection}$$


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Use of GEPDs and EPVs

- Selection of young bulls to progeny test ✓
- Selection of young bulls as BC ✓
- Selection of young bulls as BB
- Selection of cows as CB
- Selection of cows as CC
- Selection of heifer calves to keep
- Selection of heifers for production system
- Warning of cows susceptible to disease
- Pedigree ✓
- Sale price of animals and products
- Tracing of animals and products



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This talk

- Discovery population
- Validation population
- Accuracy
- One system of EPDs



Discovery population

Dairy industry uses AI bulls
 EPD based on progeny test
 Comparable with a trait of $h^2 = 0.8$

Number of animals needed is proportional to
 Somewhere in between $1/h^2$ and $(1-h^2)/h^2$
 Eg for trait with $h^2 = 0.3$
 need between $8/3 = 2.67$ to $(8/3)*(7/2) = 9$ times more
 for trait with $h^2 = 0.1$ need 8 to 36 times more cattle



Discovery of genes for milk protein yield

Ben Hayes, Amanda Chamberlain,
 Bolormaa Sunduimijid, Jennie Pryce, Phil Bowman



Discovery of SNPs associated with economic traits

Haplotypes give clearer picture of position of genes than single SNPs

Some genes segregate in only one breed

Some genes segregate in only one sample from a breed
 - gene has a rare allele?



Validation, accuracy and multiple breeds

Results from

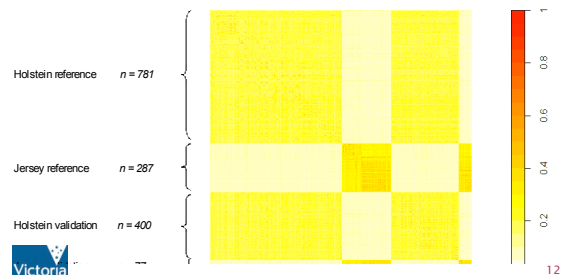
Vic DPI
 Ben Hayes

USDA
 Curt van Tassell
 Tad Sonstegard



Validation

	Holstein	Jersey
Discovery		
born	<2004	<2004
N	781	287
Validation		
born	>2004	>2004
N	400	77



Discovery, validation and accuracy

Accuracy in different breed is low

Validation Population	Discovery population	
	Holstein	Jersey
Holstein	0.53	0.03
Jersey	-0.06	0.58



13

Discovery, validation and accuracy

Use of two breed discovery population

Validation Population	Discovery population		
	Holstein	Jersey	Both
Holstein	0.53	0.03	0.53
Jersey	-0.06	0.58	0.58



14

Discovery, validation and accuracy

Statistical method for estimating prediction equation

Trait	Method	
	BLUP	Bayes
protein	0.49	0.47
fat%	0.62	0.70



15

Discovery, validation and accuracy

Theoretical vs realised accuracy

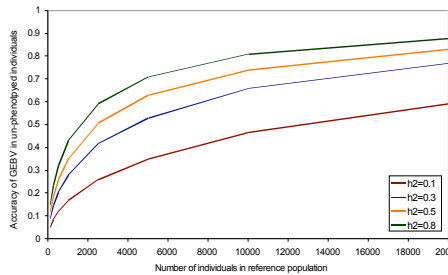
It would be useful to estimate accuracy from the discovery population. Can do this with BLUP method.

Validation Population	Realised	Theoretical
Holstein	0.54	0.55
Jersey	0.52	0.54



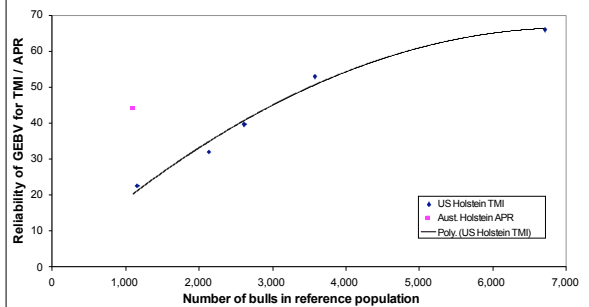
16

Effect of number of animals on accuracy of prediction equation



17

Effect of number of bulls in the reference population on the reliability of GEBV for TMI or APR



US method: $rel_{GEBV} = correlation(GEBV, ABV)^2 / rel_{ABV}$

18

Accuracy in beef cattle

Lower than in dairy

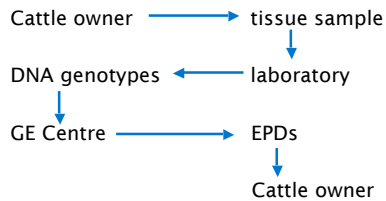
- Phenotypes instead of progeny test results
- Smaller numbers of animals
- Multiple breeds

Accuracy in beef cattle

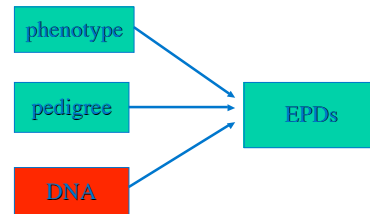
Improve by

- More cattle with phenotypes and genotypes
- Use progeny tested sire
- Multiple breed discovery, or
- Use in only one breed
- Better statistical method
- >300,000 SNPs
- Better methods to deal with rare alleles

Implementation



Adding DNA sequence data to calculate more accurate EPDs



Implementation

DNA genotypes are just another form of data to be used in calculation of EPDs

One system of EPDs is easy for cattle breeders to use

At the moment traditional EPDs are still calculated and merged with MBV

Eventually all EPD calculations will use DNA genotypes directly

Implementation

Use of the system is restricted

Only AI companies that have invested in the discovery population can get GEPDs for bulls

One EPD system has been of benefit to cattle breeders

Don't force companies to circumvent the one EPD system

Summary

All major dairy countries implementing genomic selection

- Reduce generation intervals, double genetic progress
- Biggest change since EPDs
- Needs large discovery population
- Can predict accuracy for BLUP method

Summary

Genomic selection more accurate in dairy industry than beef industry

- Fewer animals
- Not progeny tested
- Multiple breeds

Summary

System to deliver GEPDs in dairy different to beef

- Raw genotypes stored by genetic evaluation centre

Single EPD system of benefit to cattle breeders

Open system will maximise benefits to industry