

Introduction to Genomic Selection



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WHY USE SELECTION?

Estimated cost to raise a heifer is \$2000-\$3000
Second greatest expense for dairy after feed costs

To improve performance

- Nutrition
- Hygiene
- Health program
- Genetics ← Selection

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ACHIEVEMENT OF GENETIC CHANGE IN RESPONSE TO SELECTION

$$\text{Genetic Change} = \frac{\text{Accuracy of selection} \times \text{Selection intensity} \times \text{Genetic variation}}{\text{Generation Interval}}$$

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**SELECTION
PREDICTION EQUATIONS**

The PTA measures the expected difference between the animal's offspring and the mean of all offspring for that trait.



mean of the herd's offspring = 25,000 pounds
mean of the cow's offspring = 27,000 pounds
PTA = +2000 lbs.

PTA's are estimates of an animal's genetic value for a given trait that will be passed to offspring.

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**SELECTION
PEDIGREE-BASED PTA**

Advantages

- Very effective with animals with large numbers of progeny
- Most effective with traits that are:
 - Easy to measure
 - Inexpensive to measure
 - Occur early in life
 - Moderate to high heritability

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**SELECTION
PEDIGREE-BASED PTA**

Disadvantages

- Accuracy is not as high for most females throughout their lives
- Expensive and time consuming to "prove" bulls through extensive progeny testing
- Not effective for traits that are:
 - Difficult to measure
 - Expensive to measure
 - Occur late in life

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SINGLE NUCLEOTIDE POLYMORPHISMS (SNP)

- The bovine genome has been mapped and genes that influence key production traits such as milk production, reproduction, physical traits, and milk quality have been identified.
- SNPs provide researchers a way to study the genetic root of the differences that are apparent across dairy cows and are related to important traits (this approach is genomic selection)



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SELECTION PEDIGREE-BASED GENE

- SNP-based genetic linkage analysis can be used to map particular loci, for milk production, fertility, diseases
- Genomic testing allows producers to take a virtual snapshot of a portion of the genes that are flowing in the population and that regulate economically important traits (milk, components, fertility).
- Genomic selection involves making use of the estimated association between very many SNP's and the phenotype to estimate the breeding value of animals without phenotype.

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ADVANTAGES OF GENOMIC SELECTION

- Prediction can be done at a much earlier age rather than waiting for offspring to perform (shorter generation interval)
- A greater accuracy of predicted genetic merit for young animals.
 - Selecting for traits that are difficult to measure
 - Selecting for traits that are expensive to measure
 - Animal that has 0 or few offspring

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INCREASING ACCURACY

Comparison of August 2020 genomic and traditional evaluations

2718 Holstein young available bulls

Trait	PIA			Reliability (%)		
	Genomic average	Traditional average	Difference ¹	Genomic average	Traditional average	Difference ²
Birth weight (lb)	512	500	+12	91	77	+14
Birth (pounds)	509	501	+8	845	79	+85
BWT (pounds)	50.8	49.1	+1.7	15.7	79	+63
System (pounds)	27.1	27.5	-0.4	9.5	79	+23
Scorable cell score	2.05	2.00	+0.05	0.55	77	+22
Productive life (months)	2.8	2.5	+0.3	1.1	78	+23
Lactability	2.7	2.4	+0.3	1.3	75	+35
Daughter pregnancy rate (%)	0.1	0.5	-0.4	1.1	75	+47
Cow conception rate	0.8	0.2	+0.7	1.2	75	+27
Heifer conception rate	0.4	0.1	+0.3	1.0	75	+43
Bone density index	3.5	3.0	+0.5	0.9	70	+47
Daughter calving ease	2.1	2.3	-0.2	0.8	53	+29
Final score	1.05	0.93	+0.12	0.23	77	+46

¹Genomic minus traditional

Council on Dairy Cattle Breeding, https://queries.uscdcb.com/eval/summary/comparexml_menu.cfm

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WHO AND WHEN TO GENOTYPE

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USING GENOMIC SELECTION

Who to genotype?

- Identify replacements, sell or send other heifers to feed yard
- Rank females for mating decisions



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USING GENOMIC SELECTION

When to genotype?

- First 30 days
- Post-weaning (6 months)



Inform mating decisions

- Elite females – sexed semen, better bulls, ET donors
- Poorer females – beef bulls, recipients of embryos

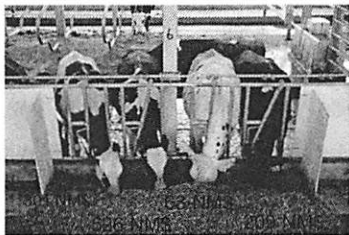


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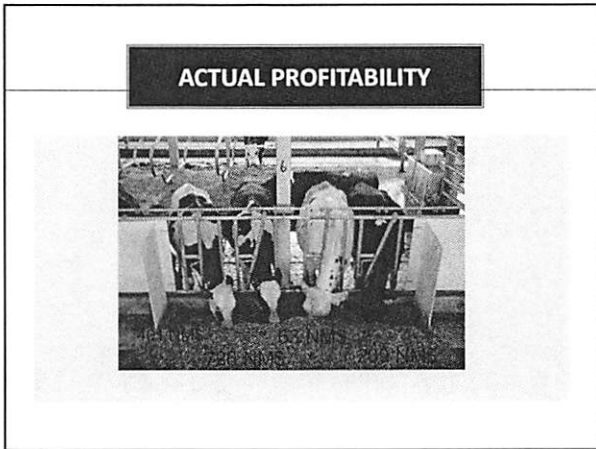
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PREDICTED PROFITABILITY

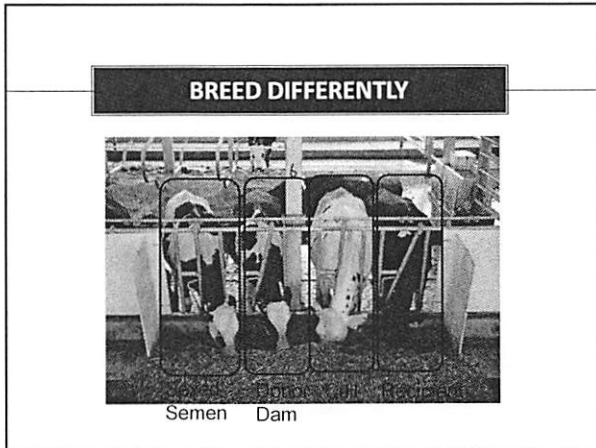


- Which will be the most profitable heifer?
- Which heifer will be the least profitable?

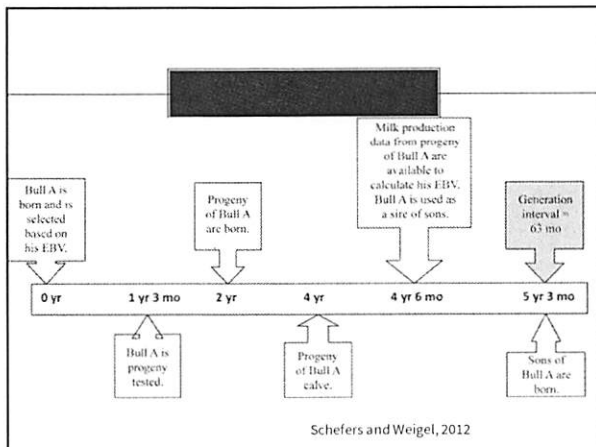
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