Dairy Cattle Genetics and Sire Selection

AVS 472

2020

Amin Ahmadzadeh, Univ. of Idaho

John Swain, WSU

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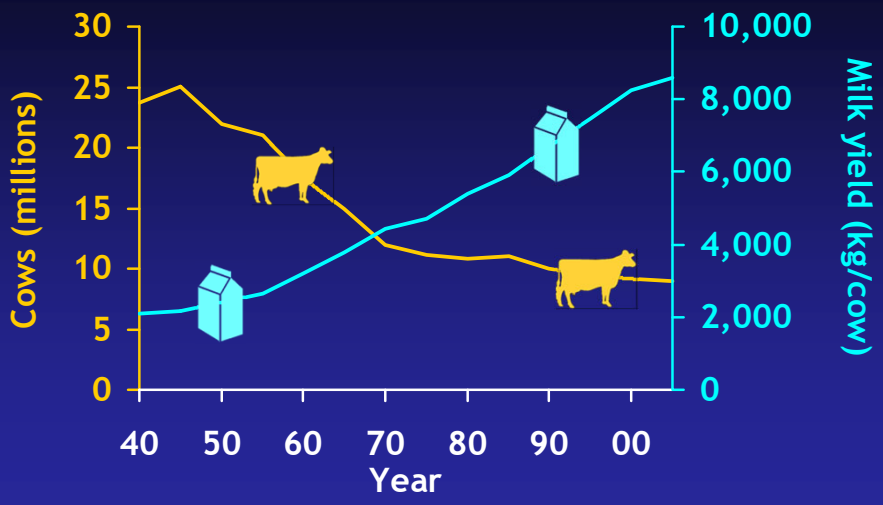
U.S. dairy population & yield



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What traits does a dairymen want to improve in his/her herd?

- ???????

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What traits does a dairymen want to improve in his/her herd?

- Production (protein, milk, fat)
- Reproduction (fertility)
- Health (SCC, metabolic disorders….)
- Feed efficiency
- Body confirmation
- Longevity, profitability…….

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How much trait improvement is:

- Management
- Genetics
- Phenotype= Genetics + ……

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Is there a single gene for:

- …… (protein, milk, fat)
- Reproduction (fertility)
- Health (SCC, metabolic disorders….)
- …….
- Body confirmation
- Longevity, profitability…….

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How do we make genetic improvement?

- Identify the animals that are genetically superior and allow them to reproduce. Don't allow the others to reproduce.
  - Must be able to evaluate traits.
  - Trait must be heritable.
  - Must know the genetic correlations.

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What controls genetic progress?

- Three factors that control genetic gain in a trait are:
  - …….- the likelihood of a trait to be passed and the ability to accurately measure that trait.
  - Selection differential-superiority of parents over the mean of the population.
  - Generation interval- the time interval between generations (age of parents at the birth of their progeny).

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Heritability (h^2)

- The portion of the variation in a phenotypic trait in a population that is due to genetic.
- Each trait's heritability remains fairly constant and, therefore, sets a limit on the rate of genetic progress.

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http://www.slideshare.net/Pammy98/download-it-4839915

Table 8-1

Heritabilities of various production and type traits

Trait	h2		h2
Milk Yield	0.3	Fat Yield	0.25
Fat Percentage	0.5	Protein Percentage	0.5
Reproduction	0.07	Milking Rate	0.3
Stature	0.42	Feet & Legs Score	0.17
Strength	0.31	Fore Attachment	0.29
Body Depth	0.37	Rear Udder Height	0.28
Dairy Form	0.29	Rear Udder Width	0.23
Rump Angle	0.33	Udder Cleft	0.24
Thurl Width	0.26	Udder Depth	0.28
Rear Legs-Side View	0.21	Front Teat Placement	0.26
Rear Legs-Rear View	0.11	Teat Length	0.26
Foot Angle	0.15	Final Score	0.29

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Selection Differential

- The superiority of the animals selected to be parents.
- **the difference in the average genetic value of the animals selected for breeding and the average genetic value of all animals in the population from which they were selected**.
- Selected parents should be better than the present generation average for improvement to take place.
- Genetic differences provide the only opportunity for selection. If all cows were genetically the same, selection would not produce change.

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- $Genetic\ Change =$

$$\frac{Accuracy\ of\ selection\ x\ Selection\ intensity\ x\ Genetic\ variation}{Generation\ Interval}$$

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Accuracy of Selection

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

- Accuracy is the strength of the relationship between a true breeding value and its predicted value being used for selection.
- Can be affected:
  - Heritability and ……of the traits
  - Records (accuracy and # of records)
  - Genomic testing

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SELECTION INTENSITY

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

- Number of traits under selection
  - When ……traits are under selection there will be ……. faster progress for any particular trait.
- Identifying the top performing 20% of the population and breeding them exclusively would represent high selection intensity
- Breeding every animal in the population is low selection intensity (slow genetic progress)

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Variation

$$Genetic\ Change = \frac{Accuracy\ of\ selection\ x\ Selection\ intensity\ x\ Genetic\ var}{Generation\ Interval}$$

- The differences that exist among the best animals for a given trait and the worst animals for that same trait.
  - e.g. More Variation: herd that has used a mix of herd bulls across whole herd
  - e.g. low variation: herd that has intensively worked with their top end genomic females over the past several generations or intense genomic testing herds.

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Generation Interval

$$Genetic\ Change = \frac{Accuracy\ of\ selection\ x\ Selection\ intensity\ x\ Genetic\ vari}{Generation\ Interval}$$

- Represents the average age of parents at the birth of their progeny.
  - Dairy cows ~ …….years!
- Can only be changed significantly through embryo transfer and other new technologies.
- ……..testing and selection significantly decreases the generation interval.

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Genetic Goals

- **Producer objectives & revenue**
  - **Elite Breeder- Sale of genetics**
  - **Producer Breeder-Sale of milk and genetics**
  - **Commercial Breeder-Sale of milk, components, cheese yield…**

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Genetic Goals

- Establish genetic goals that have economic importance.
  - Production- Milk, Fat, Protein.
  - Longevity- Functional type traits.
    - **Key to setting goals is- How is income generated in a specific herd?**

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Current System Used **Animal Model**

- Animal Model is a statistical method that gives us the best possible predictor of genetic merit considering -
  - 1. The animals own performance
  - 2. The animal ancestors
  - 3. The animal progeny
- Expressed as ……(PTAs estimate genetic merit)

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Indexes

- A tool for sire selection that incorporates numerous PTA, STA, Net Merit measures that address specific genetic and production goals.

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PTAs (Predicted Transmitting Ability)

- Are expressed as deviations in ……..from the average production traits cows born in 2018 (?).
- Base change every 5 years- last change was 2015.
- Published by bull studs and breed associations.
- **e.g. A bull with PTA for milk of plus-100 will have offspring cows that on average produce 100 more pounds of milk than an average bull.**
- **A bull with PTA for milk of plus-500 will have offspring cows that on average produce 400 more pounds of milk than a bull with PTA value of plus-100**

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Standard Transmitting Ability

- STAs the expected deviation of the average daughter of the bull from the average score for the ……trait.
- Expressed in standard deviation units.
- Range score of -3 to +3.

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Net Merit (NM) Index

- **index that simplifies the process** of selecting service sires
  - Genetic evaluations for dairy cattle are calculated for a number of economically important traits (12 PTA values).
  - Genetic merit is based on combination of economically important traits (fluid, components reproduction, longevity…)
- NM$ helps to predict the expected……

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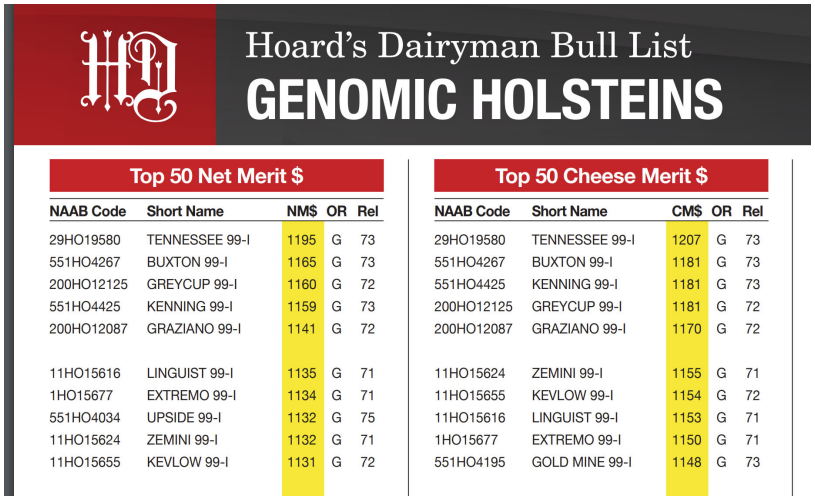
- 

Hoard's Dairyman Bull List

GENOMIC HOLSTEINS

Top 50 Net Merit $

NAAB Code	Short Name	NM$	OR	Rel
29HO19580	TENNESSEE 99-I	1195	G	73
551HO4267	BUXTON 99-I	1165	G	73
200HO12125	GREYCUP 99-I	1160	G	72
551HO4425	KENNING 99-I	1159	G	73
200HO12087	GRAZIANO 99-I	1141	G	72
11HO15616	LINGUIST 99-I	1135	G	71
1HO15677	EXTREMO 99-I	1134	G	71
551HO4034	UPSIDE 99-I	1132	G	75
11HO15624	ZEMINI 99-I	1132	G	71
11HO15655	KEVLOW 99-I	1131	G	72

Top 50 Cheese Merit $

NAAB Code	Short Name	CM$	OR	Rel
29HO19580	TENNESSEE 99-I	1207	G	73
551HO4267	BUXTON 99-I	1181	G	73
551HO4425	KENNING 99-I	1181	G	73
200HO12125	GREYCUP 99-I	1181	G	72
200HO12087	GRAZIANO 99-I	1170	G	72
11HO15624	ZEMINI 99-I	1155	G	71
11HO15655	KEVLOW 99-I	1154	G	72
11HO15616	LINGUIST 99-I	1153	G	71
1HO15677	EXTREMO 99-I	1150	G	71
551HO4195	GOLD MINE 99-I	1148	G	73

On average the daughters of Tennessee bull brings $1195 more than the breed average during the productive lifetime

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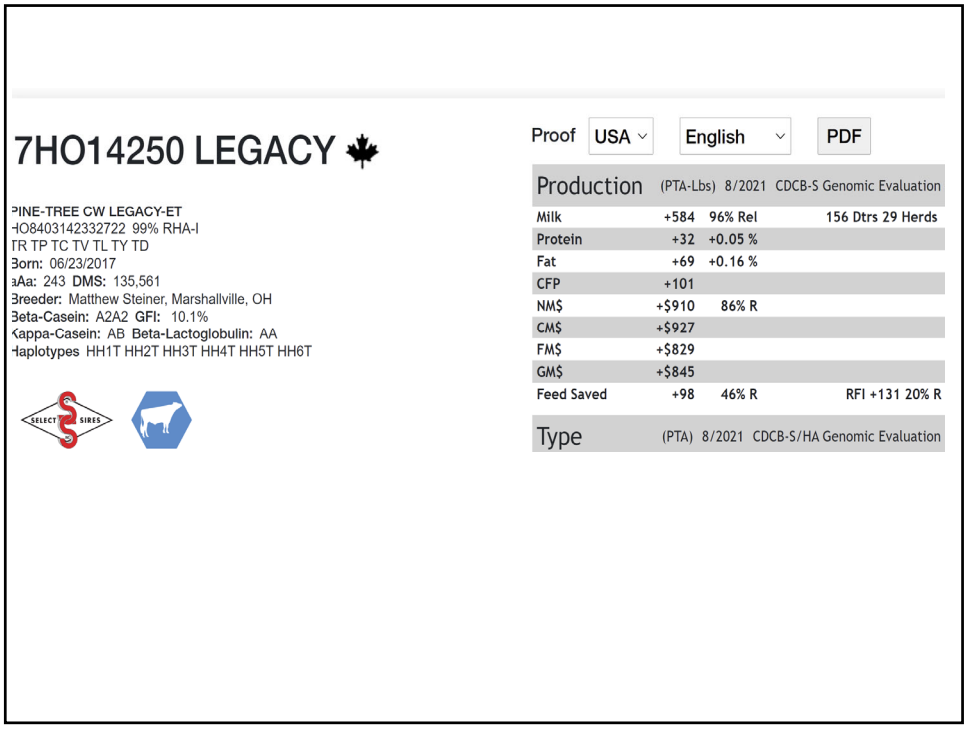

7HO14250 LEGACY

PINE-TREE CW LEGACY-ET
HO840314233272 2 99% RHA-I
TR TP TC TV TL TY TD
Born: 06/23/2017
AAa: 243 DMS: 135,561
Breeder: Matthew Steiner, Marshallville, OH
Beta-Casein: A2A2 GFI: 10.1%
Kappa-Casein: AB Beta-Lactoglobulin: AA
Haplotypes HH1T HH2T HH3T HH4T HH5T HH6T

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Production	(PTA-Lbs)	8/2021	CDCB-S Genomic Evaluation
Milk	+584	96% Rel	156 Dtrs 29 Herds
Protein	+32	+0.05 %	
Fat	+69	+0.16 %	
CFP	+101		
NM$	+$910	86% R	
CM$	+$927		
FM$	+$829		
GM$	+$845		
Feed Saved	+98	46% R	RFI +131 20% R

Type	(PTA)	8/2021	CDCB-S/HA Genomic Evaluation

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STA for Legacy

LINEAR	-2	-1	0	+1	+2		
Stature						1.12	Short
Dairy Form						0.16	Tight
Strength						1.48	Frail
Body Depth						1.81	Shallow
Rump Width						0.65	Narrow
Rump Angle						0.21	Sloped
Rear Legs Side View						0.74	Posty
Rear Legs Rear View						0.44	Hocked In
Foot Angle						0.27	Low
Feet and Legs Score						0.17	Low
Fore Udder Attachment						1.36	Strong
Rear Udder Height						1.56	High
Rear Udder Width						1.16	Wide
Udder Cleft						0.09	Strong
Udder Depth						1.07	Shallow
Front Teat Placement						0.53	Close
Rear Teat Placement						0.66	Close
Teat Length						1.38	Short

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Review

- P=G+E
- G can be influenced by management and environment: clones do not always look alike
- Genetic progress is a function Of: (heritability, accuracy) variance and generation interval
- Understand what influences each variable (reliability, inbred, genomics, DHIA,)
- PTA is used in the dairy industry and is a measure of genetic merit that can be transferred to progeny
- Largely evaluated by progeny testing (need for good records- DHIA) and genomic analysis
- Negative correlation of traits-(E.g.: milk and scc, fertility & BCSs)

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