

Genetic Gains in Lifetime Merit Indexes during the use of three Genetic Evaluation Methods

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Introduction

- **Genetic evaluations are calculated for over 40 traits in the United States, depending on the dairy breed.**
- **These evaluations are credited with bringing continuous annual improvement for most of these traits, especially for Holsteins where the number of service bulls provide more opportunity for choices.**
- **The genetic evaluations have had a positive impact on genetic improvement for a multitude of traits in all breeds.**

Introduction & Objectives

- **Several genetic evaluation procedures were implemented by USDA following the daughter-dam comparison first used in 1915.**

The intension of this examination was to compare the genetic gains made in lifetime merit traits from the use of three evaluation methods.

This examination also compared the genetic gains made in other traits during the evaluation periods as well.

Genetic Evaluation Methods Available from USDA

US National Evaluation Method	Month and Year Initiated	Years of Impact
Daughter-Dam Comparison (DD)	1915	“1958” to 1964
Herdmate Comparison (HC)	January 1961	1964 to 1971
Improved Herdmate Comparison (IHC)	July 1968	1971 to 1977
Modified Contemporary Comparison (MCC)	November 1974	1977 to 1992
Animal Model Evaluation (AM)	July 1989	1992 to 2011
Genomic Evaluation (GE)	January 2008 (unofficial) January 2009 (official)	2011 to 2019

Basic Comparison within Sire Evaluation Methods

- **Herdmate Comparisons:** Daughters vs “other cows in herd”.
- **Modified Contemporary Comparison:** Daughter vs “other cows of same age”, adjusting for merit of contemporaries’ sires. Ancestors incorporated into sire evaluation for first time. All combining used the inverse of expected variance.
- **Animal Model Evaluation:** Same fixed and random effects as MCC. Had best linear unbiased prediction (BLUP) properties.
- **Genomic Evaluation:** Animal Model features + use of SNPs.

Methods

- **Gains from replaced method was assumed to start 3 years after evaluation method changed.**
- **Why 3 years? Nine months are expected before daughters are born (i.e., gestation length) and at least 2 more years before they initiate lactation.**
- **The difference in daughters' Estimated Breeding Value was derived between the start and end of each evaluation method for lifetime merit indexes and individual traits.**

Annual genetic gain in lifetime merit indexes from different evaluation methods

US National Evaluation Method	Years of Impact	Gain in NM\$		Gain in FM\$		Gain in CY\$		Gain in GM\$	
		HO	JE	HO	JE	HO	JE	HO	JE
Cow breed ->									
Modified Contemporary Comparison 1974	1977 to 1992	48	67	49	68	47	66	35	50
Animal Model Evaluation 1989	1992 to 2011	47	59	44	59	47	58	36	47
Genomic Evaluation 2009	2011 to 2019	126	85	115	77	128	86	120	70

Annual genetic gain in lifetime merit indexes from different evaluation methods {MCC gains exceed AM gains}

US National Evaluation Method	Years of Impact	Gain in NM\$		Gain in FM\$		Gain in CY\$		Gain in GM\$	
		HO	JE	HO	JE	HO	JE	HO	JE
Cow breed ->									
Modified Contemporary Comparison 1974	1977 to 1992	48	67	49	68	47	66	35	50
Animal Model Evaluation 1989	1992 to 2011	47	59	44	59	47	58	36	47
Genomic Evaluation 2009	2011 to 2019	126	85	115	77	128	86	120	70

Annual genetic gain in lifetime merit indexes from different evaluation methods {**GE gains exceeds twice the AM gains**}

US National Evaluation Method	Years of Impact	Gain in NM\$		Gain in FM\$		Gain in CY\$		Gain in GM\$	
		HO	JE	HO	JE	HO	JE	HO	JE
Cow breed ->									
Modified Contemporary Comparison 1974	1977 to 1992	48	67	49	68	47	66	35	50
Animal Model Evaluation 1989	1992 to 2011	47	59	44	59	47	58	36	47
Genomic Evaluation 2009	2011 to 2019	126	85	115	77	128	86	120	70

Annual genetic gain in lifetime merit indexes across 42 yrs.

US National Evaluation Method	Years of Impact	Gain in NM\$		Gain in FM\$		Gain in CY\$		Gain in GM\$	
		HO	JE	HO	JE	HO	JE	HO	JE
Cow breed ->									
Annual US dollar gain across 42 years	1977 to 2019	62	67	59	66	63	66	51	52

Annual genetic gain in milk traits from evaluation methods

US National Evaluation Method	Years of Impact	Gain in Milk Yield (kg)		Gain in Fat Yield (kg)		Gain in Protein Yield (kg)	
		HO	JE	HO	JE	HO	JE
Cow breed ->							
Daughter Dam 1915	1958 to 1964	22	18	0.8	0.8	–	–
Herdmate Comparison 1961	1964 to 1971	41	50	1.5	1.7	–	–
Improved Hermate Comparison 1968	1971 to 1977	68	82	2.1	2.7	1.0	–
Modified Contemporary Comparison 1974	1977 to 1992	89	107	3.2	3.8	2.5	3.1
Animal Model Evaluation 1989	1992 to 2011	76	88	2.5	3.1	2.5	2.7
Genomic Evaluation 2009	2011 to 2019	106	87	5.7	4.0	4.1	3.4

Annual genetic gain in milk traits from evaluation methods

US National Evaluation Method	Years of Impact	Gain in Milk Yield (kg)		Gain in Fat Yield (kg)		Gain in Protein Yield (kg)	
		HO	JE	HO	JE	HO	JE
Cow breed ->							
Modified Contemporary Comparison 1974	1977 to 1992	89	107	3.2	3.8	2.5	3.1
Animal Model Evaluation 1989	1992 to 2011	76	88	2.5	3.1	2.5	2.7
Genomic Evaluation 2009	2011 to 2019	106	87	5.7	4.0	4.1	3.4

Conclusions

- **Since 1958, changes in sire evaluations methods in the US for milk, fat and protein yield generally resulted in increases in the rate of genetic gains in the Holstein and Jersey breeds.**
- **Most method changes accelerated the rate of gain in milk yield by ≥ 20 kg. The exception was the transition from MCC to the Animal Model Evaluation.**
- **The percentage gains in lifetime merit indexes were not as large as those for milk traits as changes in methods for evaluations for health and fitness traits were less frequent.**

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Thank You