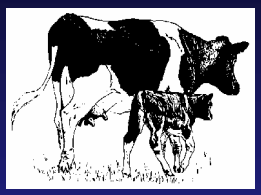
Retrofitting genetic-economic indexes to demonstrate responses to selection across 2 generations of Holsteins



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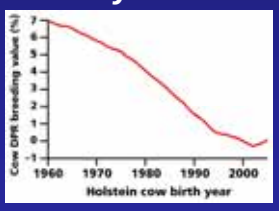
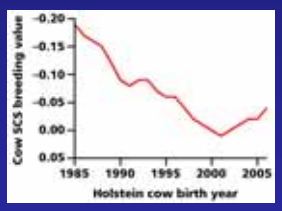
20th century trait emphasis

- Yield
  - Volume
  - Component percentages
- Genetic decline in traits negatively correlated with milk yield
  - Fertility
  - Mastitis resistance





Addition of health & fitness traits

- More comprehensive data recording
- Development of genetic evaluations
  - Calving ease, 1978
  - Type, 1978–82
  - Productive life (PL), 1994
  - Somatic cell score (SCS), 1994
  - Daughter pregnancy rate (DPR), 2003
  - Stillbirth, 2006

Genetic-economic indexes

- Allows breeders to base selection decisions on a single trait while improving several traits
- Helps produce cows with fewer functional deficiencies and greater capacity for efficient performance over a longer herdlife
- Updated periodically
  - Genetic evaluations available for new traits
  - Economic weights are no longer appropriate

Relative emphasis in USDA indexes

Trait	PD$, 1971	MFP$, 1976	Net merit (NM) 1994	2000	2003	2006
Milk	52	27	6	5	0	0
Fat	48	46	25	21	22	23
Protein	…	27	43	36	33	23
PL	…	…	20	14	11	17
SCS	…	…	–6	–9	–9	–9
Udder	…	…	…	7	7	6
Feet/legs	…	…	…	4	4	3
Body size	…	…	…	–4	–3	–4
DPR	…	…	…	…	7	9
Calving difficulty						
Service sire	…	…	…	…	–2	…
Daughter	…	…	…	…	–2	…
Calving ability	…	…	…	…	…	6

Objective

- Demonstrate progress that would have been made for currently evaluated traits if alternative indexes had been the basis for selection decisions across 2 generations

Retrofitted indexes

Trait	PD$, 1971	MFP$, 1976	Net merit (NM) 1994	2000	2003	2006
Milk	52	27	6	5	0	0
Fat	48	46	25	21	22	23
Protein	…	27	43	36	33	23
PL	…	…	20	14	11	17
SCS	…	…	–6	–9	–9	–9
Udder	…	…	…	7	7	6
Feet/legs	…	…	…	4	4	3
Body size	…	…	…	–4	–3	–4
DPR	…	…	…	…	7	9
Calving difficulty						
Service sire	…	…	…	…	–2	…
Daughter	…	…	…	…	–2	…
Calving ability	…	…	…	…	…	6

Data

- 25 cow groups based on sire and maternal grandsire (MGS) quintiles for 3 indexes (MFP$76, NM94, NM06)
  - ***Example:*** Cows in group$_{11}$ had sire and MGS in the lowest quintile
- Cows with birth dates from 1993 through 1999 and calving dates from 1995 through 2005

Data *(cont.)*

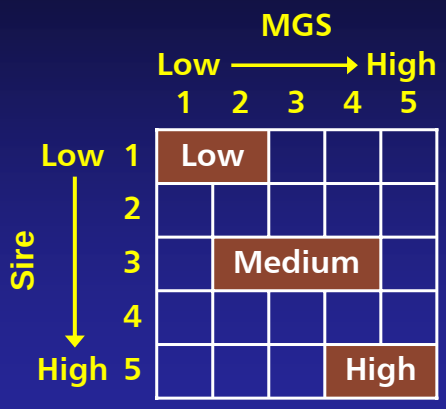
- Cows excluded if they changed herds, had missing lactation records within their first 5 parities, or were in herds with <5 cows
- Final data set
  - 1,756,805 cows in 26,106 herds for yield traits, PL, SCS, and pregnancy rate
  - 692,656 cows in 9,967 herds for calving difficulty
  - 270,564 cows in 4,534 herds for stillbirth

Methods

- Least-square differences between cow groups examined for 8 first-parity traits standardized to mature equivalence
  - Milk yield
  - Fat yield
  - Protein yield
  - PL
  - SCS
  - Pregnancy rate
  - Calving difficulty
  - Stillbirth
- Analysis on a within-herd basis with cow birth year in model

Methods *(cont.)*

- Results reported only for 3 levels of selection intensity
  - Low ($group_{11}$ + $group_{12}$)
  - Medium ($group_{32}$ + $group_{33}$ + $group_{34}$)
  - High ($group_{54}$ + $group_{55}$)



Least-squares results

Trait	Index	Selection intensity Low	Medium	High	High-low difference
Milk, kg	MFP$76	10,443	11,053	11,570	1,127
	NM94	10,443	11,012	11,417	973
	NM06	10,961	11,083	11,180	219

Least-squares results

Trait	Index	Selection intensity Low	Medium	High	High-low difference
Milk, kg	MFP$76	10,443	11,053	11,570	1,127
	NM94	10,443	11,012	11,417	973
	NM06	10,961	11,083	11,180	219
Fat, kg	MFP$76	374	400	424	50
	NM94	384	400	411	27
	NM06	391	401	411	21

Least-squares results

Trait	Index	Selection intensity Low	Medium	High	High-low difference
Milk, kg	MFP$76	10,443	11,053	11,570	1,127
	NM94	10,443	11,012	11,417	973
	NM06	10,961	11,083	11,180	219
Fat, kg	MFP$76	374	400	424	50
	NM94	384	400	411	27
	NM06	391	401	411	21
Protein, kg	MFP$76	299	319	336	37
	NM94	304	318	328	24
	NM06	314	320	325	11

Least-squares results *(cont.)*

Trait	Index	Selection intensity Low	Medium	High	High-low difference
PL, mo	MFP$76	29.8	30.7	31.9	2.1
	NM94	27.8	29.9	33.6	5.8
	NM06	27.9	30.5	34.2	6.3

Least-squares results *(cont.)*

Trait	Index	Selection intensity Low	Medium	High	High-low difference
PL, mo	MFP$76	29.8	30.7	31.9	2.1
	NM94	27.8	29.9	33.6	5.8
	NM06	27.9	30.5	34.2	6.3
SCS	MFP$76	2.83	2.91	2.95	0.12
	NM94	2.99	2.92	2.86	−0.13
	NM06	3.03	2.91	2.82	−0.21

Least-squares results *(cont.)*

Trait	Index	Selection intensity Low	Medium	High	High-low difference
PL, mo	MFP$76	29.8	30.7	31.9	2.1
	NM94	27.8	29.9	33.6	5.8
	NM06	27.9	30.5	34.2	6.3
SCS	MFP$76	2.83	2.91	2.95	0.12
	NM94	2.99	2.92	2.86	−0.13
	NM06	3.03	2.91	2.82	−0.21
Pregnancy rate, %	MFP$76	29.5	28.5	28.1	−1.4
	NM94	28.7	28.3	28.7	0.0
	NM06	27.9	28.3	29.1	1.2

Least-squares results *(cont.)*

Trait	Index	Selection intensity Low	Medium	High	High-low difference
Calving difficulty, (1–5 scale)	MFP$76	1.76	1.75	1.70	−0.06
	NM94	1.81	1.75	1.68	−0.13
	NM06	1.85	1.72	1.66	−0.19

Least-squares results *(cont.)*

Trait	Index	Selection intensity Low	Medium	High	High-low difference
Calving difficulty, (1–5 scale)	MFP$76	1.76	1.75	1.70	−0.06
	NM94	1.81	1.75	1.68	−0.13
	NM06	1.85	1.72	1.66	−0.19
Stillbirth, %	MFP$76	12.1	11.6	11.3	−0.9
	NM94	14.5	13.3	11.2	−3.3
	NM06	13.6	11.9	9.0	−4.6

Conclusions

- Phenotypic improvement for all traits included in current USDA index from selection on that index
- Some improvement large enough to be noticeable to producers in a single generation
  - Increases in PL and pregnancy rate
  - Declines in SCS and stillbirth

Conclusions *(cont.)*

- Reduced concern by consumers about animal welfare issues through use of a comprehensive composite index
- Greater profit from selection on current index than from selection on indexes with fewer traits or on individual traits