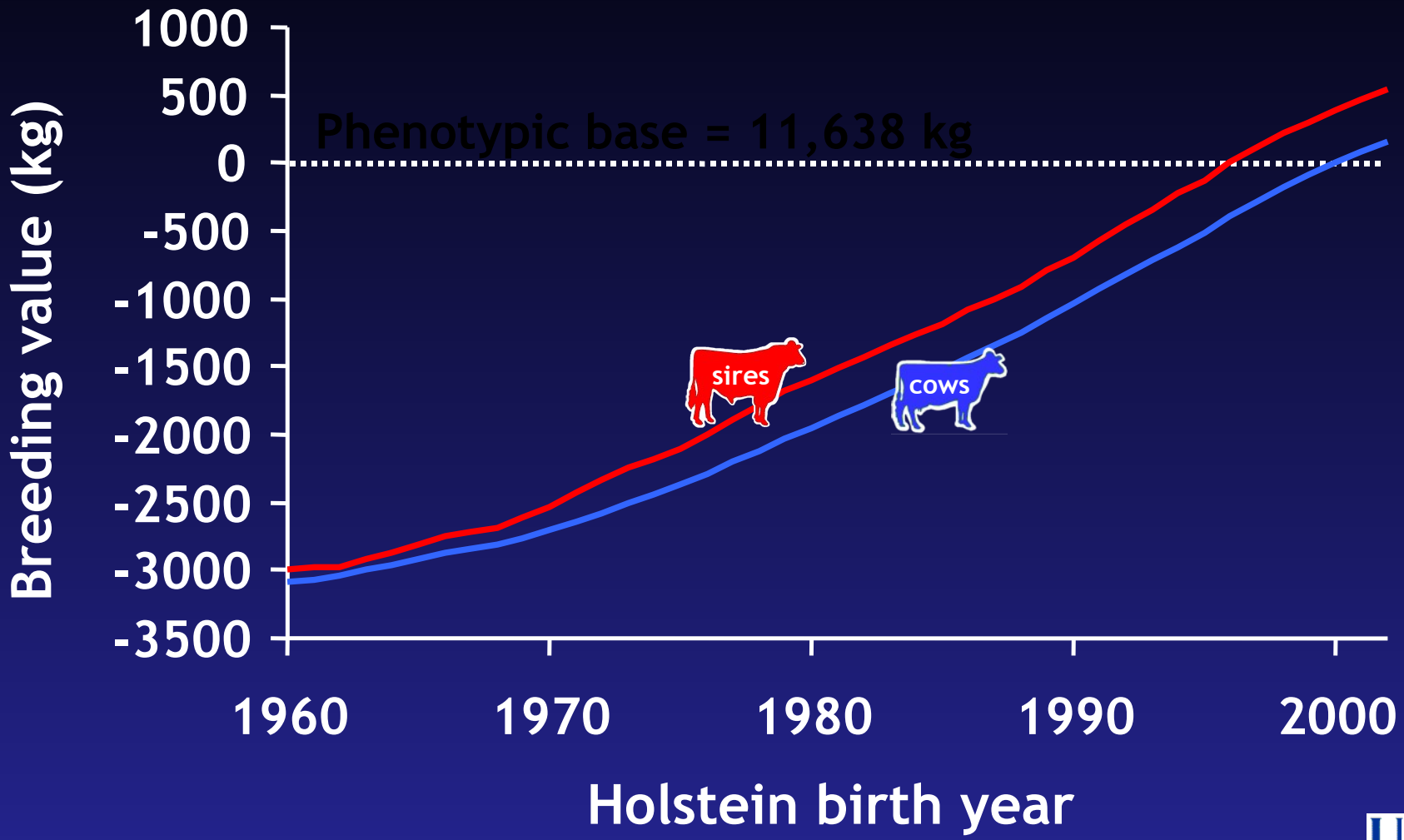
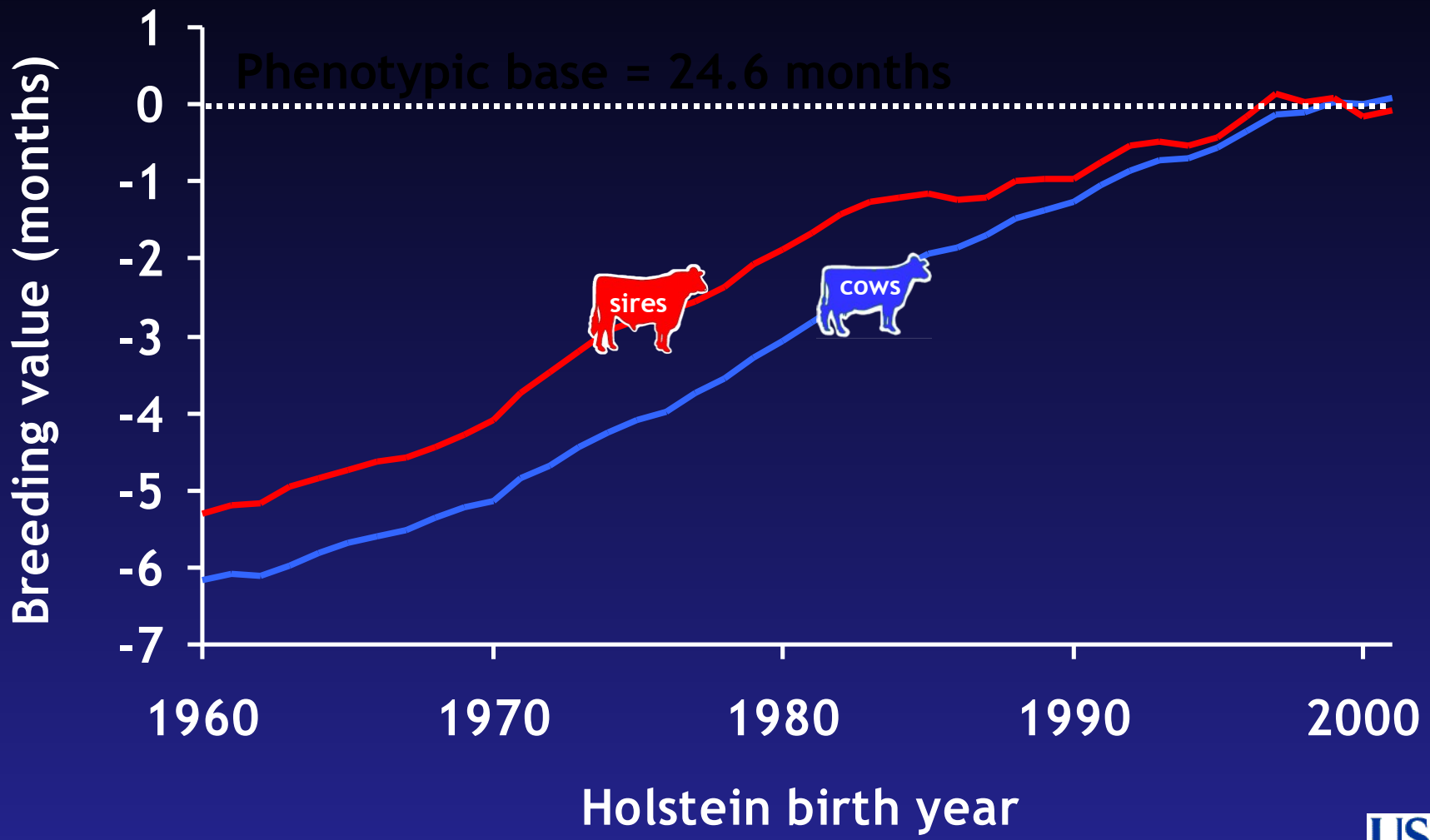
Validation of Producer-Recorded Health Event Data and Use in Genetic Improvement of Dairy Cattle

J. B. Cole
Animal Improvement Programs Laboratory
Agricultural Research Service, USDA, Beltsville, MD
jcole@aipl.arsusda.gov

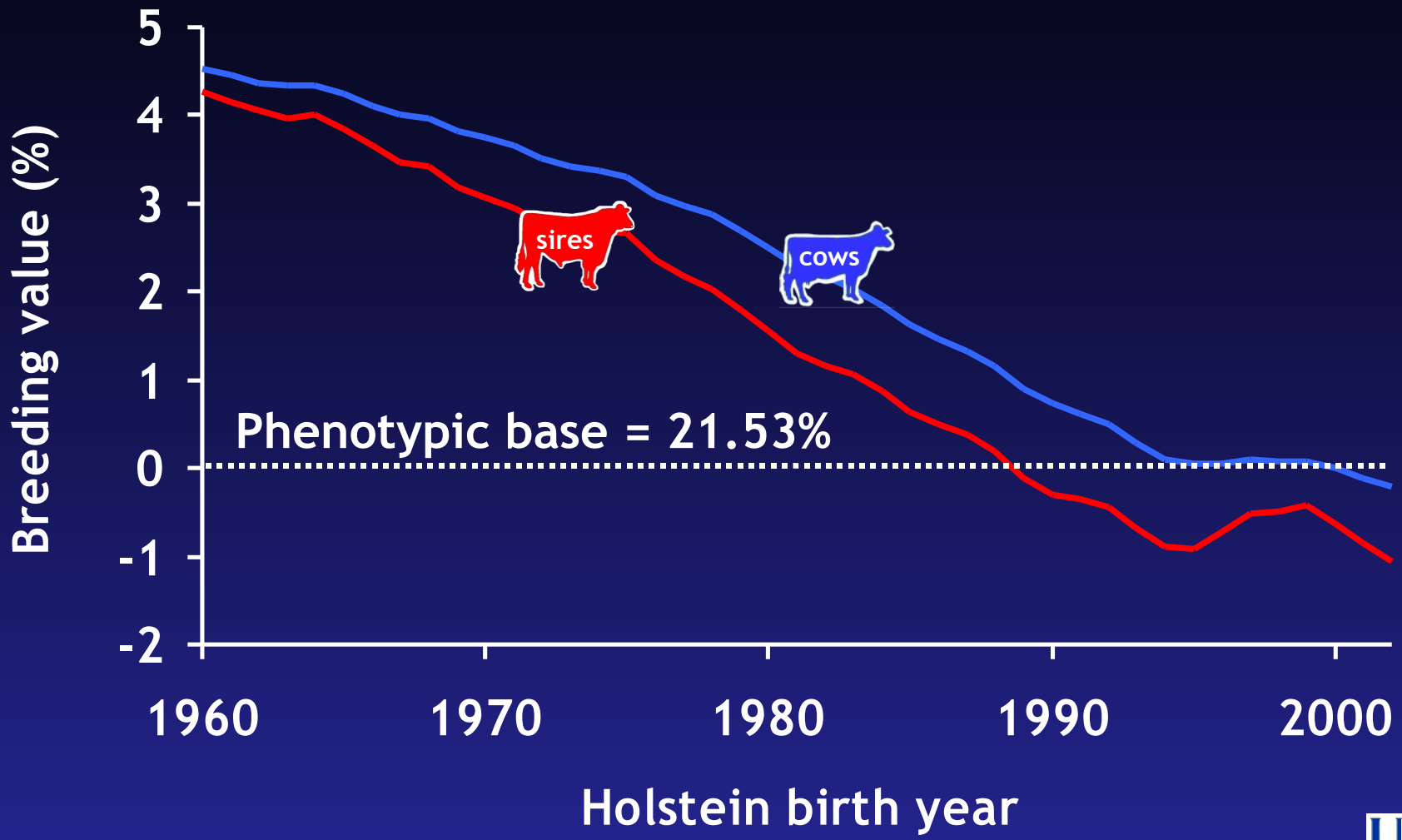
Genetic trend – Milk



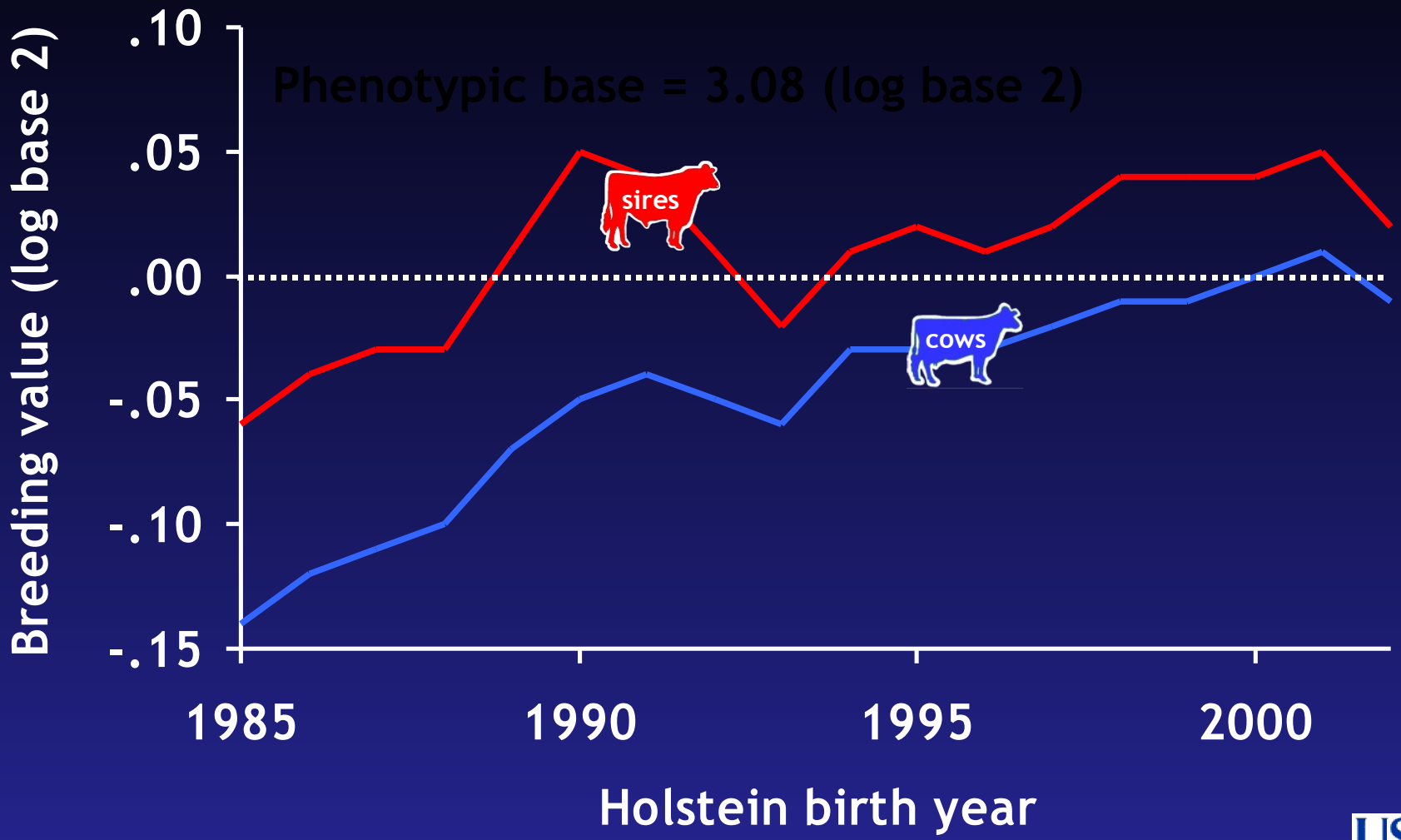
Genetic trend – Productive life (mo)



Genetic trend – Daughter pregnancy rate (%)



Genetic trend – Somatic cell score



Index changes

	Relative emphasis on traits in index (%)						
Trait	PD$ (1971)	MFP$ (1976)	CY$ (1984)	NM$ (1994)	NM$ (2000)	NM$ (2003)	NM$ (2006)
Milk	52	27	-2	6	5	0	0
Fat	48	46	45	25	21	22	23
Protein	…	27	53	43	36	33	23
PL	…	…	…	20	14	11	17
SCS	…	…	…	-6	-9	-9	-9
UDC	…	…	…	…	7	7	6
FLC	…	…	…	…	4	4	3
BDC	…	…	…	…	-4	-3	-4
DPR	…	…	…	…	…	7	9
SCE	…	…	…	…	…	-2	…
DCE	…	…	…	…	…	-2	…
CA$	…	…	…	…	…	…	6

Current health traits

- Calving Traits: Easier calving, less dystocia, fewer stillbirths (h^2 = 3-9%).
- Daughter Pregnancy Rate: Improved female fertility (h^2 = 4%).
- Productive Life: Longer working life (h^2 = 8.5%).
- Somatic Cell Score: Improved resistance to mastitis (h^2 = 10%).

Overview

- Selection using field-recorded traits is efficient and well-documented.
- Genetic variability exists for health traits of economic interest.
- Data for routine evaluations are limited.

Why select for improved health?

- Longer-lived (more profitable) cows.
- Decreased cost of production.
- Reduced herd turnover.
- Improved animal welfare.
- Genetic gains are cumulative!

Desirable properties of health traits

- Reasonably large genetic variability or heritability.
- Significant economic value.
- Reasonable cost of measurement and recording.
- Consistent methods for measurement and recording.
- (Shook, J Dairy Sci. 1989 May; 72(5): 1349-1362)

Challenges

- Low heritabilities and unfavorable correlations with yield.
- Low frequency of affected animals and uncertain diagnoses.
- Limited availability of data.

Producer-recorded health events

- There are a number of studies using producer-recorded data.
  - Lyons et al. (1991)
  - van Dorp et al. (1999)
  - Zwald et al. (2001)
  - Abdel-Azim et al. (2005)
- Those data may be usable for genetic evaluation.
- Under-reporting of disease events may be a problem.

The need for data validation

- Are data of sufficiently high quality that they can safely be used for decision-making?
- How do you assess data quality?
- Is mediocre or poor data better than no data at all?

Source of field data

- Producer-recorded health event data were provided by Dairy Records Managemetn Systems (Raleigh, NC).
- Data captured from on-farm PC-DART systems.
- ~2.5 million event records were included in the dataset.

The data

- 66,629 cows with health events in the DRMS file.
- 374,500 herdmates that did not appear in the DRMS file.
- 906 herds.
- 5,090 herd-years.

The edits

- Calvings between January 1, 1997 and December 31, 2003.
- Lactations 1-5.
- DYST or RETP within 7 d of calving set to calving date.
- RETP after 7 d set to METR.
- MILK after 30 d set to missing.

Most frequent events in DRMS data

	Frequency	Percent of Events*
Mastitis	496,531	19.27
Lameness	128,869	5.00
Metritis	126,269	4.90
Cystic ovary	81,936	3.18
Retained placenta	57,691	2.24
Digestive problem	47,156	1.83
Respiratory problem	39,918	1.55
Ketosis	25,541	0.99
Displaced abomasum	21,908	0.85

*Frequency and percent based on 2,577,004 health event observations.

Rate of disease incidence per lactation

Disease	Current	van Dorp et al.	Zwald et al.	Type
CYST	3.18	5.63	8	ID
DIAR	4.02	—	—	IR
DIGE	2.12	—	—	IR
DA	2.16	0.75	3	IR
DYST	2.36	—	—	IR
EDEM	1.34	1.83	—	IR
JOHN	4.58	—	—	ID
KETO	3.4	0.7	10	ID
LAME	4.92	2.3	10	ID
MAST 0-30	3.94	8.3	20	IR
MAST 31-150	3.9	—	—	IR
MAST 151-305	2.6	—	—	IR
METR	5	9.4	21	ID
MILK	1.18	2.18	—	ID
RETP	3.6	2.28	—	IR

Relationships among diseases

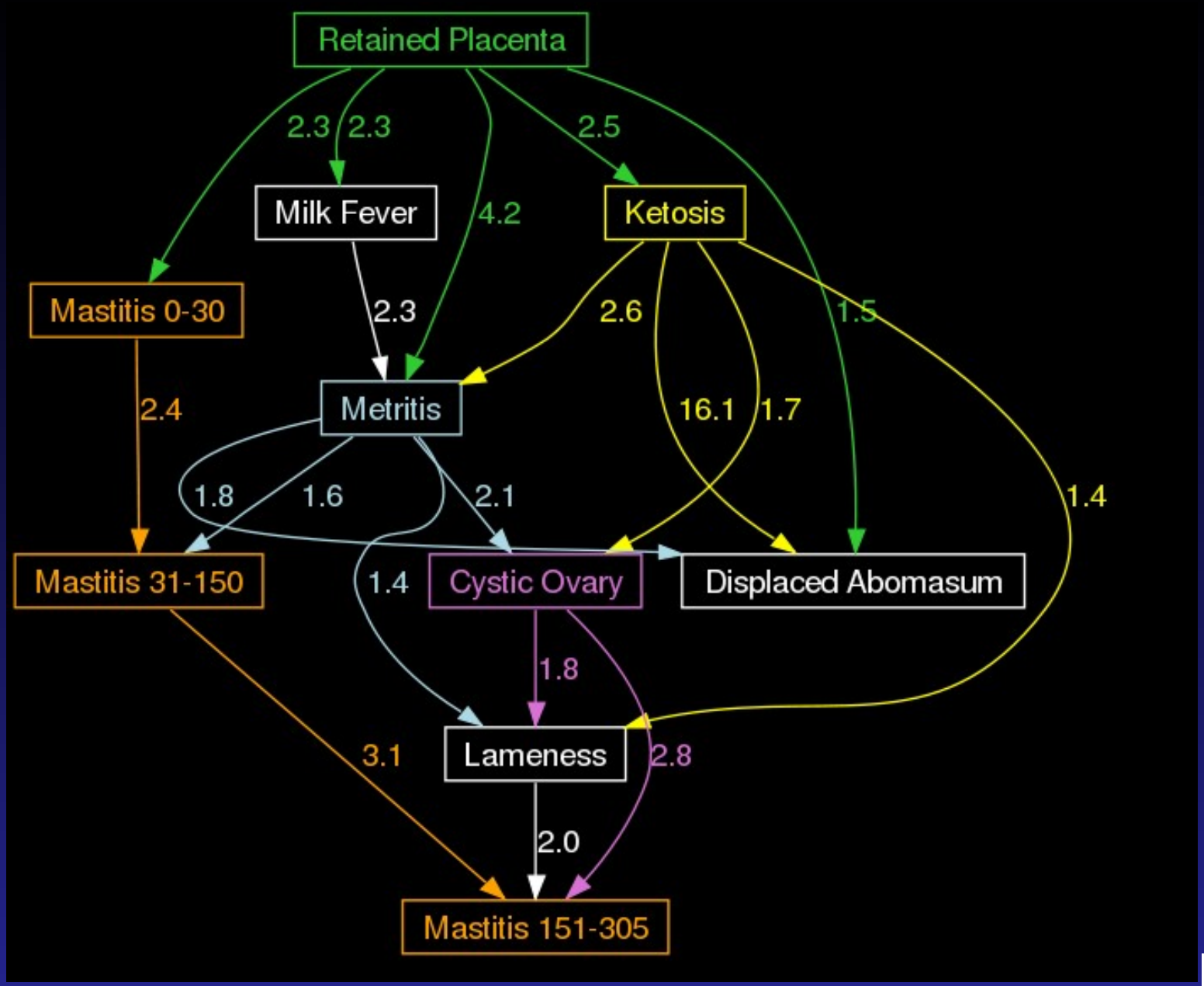
- Path analysis was conducted using a generalized linear mixed model.
- The model included fixed year and season, and random herd, effects.
- Diseases occurring prior to the disease of interest fit as covariates.
  - Retained if significant ($P < 0.05$).
- (van Dorp et al., Can J Vet Res. 1999 63: 185-192)

Temporal ordering of diseases

Disease	DIM	Min	Max	Cases
CYST	82	0	353	8,853
DIAR	153	0	365	3,009
DIGE	66	0	361	3,702
DA	31	0	356	4,258
DYST	1	0	260	23,844
JOHN	172	0	365	1,619
KETO	11	0	338	4,222
LAME	127	0	364	11,383
MAST 0-30	7	0	30	9,809
MAST 31-150	78	31	150	9,842
MAST 151-305	211	151	305	6,166
METR	16	0	357	14,438
MILK	1	0	30	789
RETP	1	1	7	7,115
STIL	1	1	1	11,499

Herd-level variation

Disease	Current	van Dorp et al.
CYST	1.57 ± 0.55	0.72 ± 0.37
DA	1.20 ± 0.46	0.59 ± 0.32
KETO	1.28 ± 0.48	1.41 ± 0.63
LAME	3.74 ± 1.42	2.34 ± 0.98
MAST 0-30	1.15 ± 0.32	1.50 ± 0.81
MAST 31-150	1.44 ± 0.37	1.33 ± 0.54
MAST 151-305	0.80 ± 0.27	0.76 ± 0.40
METR	2.01 ± 0.87	0.83 ± 0.40
MILK	0.28 ± 0.19	1.74 ± 0.67
RETP	1.10 ± 0.24	1.85 ± 0.77


Retained Placenta
2.3
2.3
2.5
Milk Fever
4.2
Ketosis
Mastitis 0-30
2.3
2.6
1.5
2.4
Metritis
16.1
1.7
1.8
1.6
2.1
1.4
Mastitis 31-150
1.4
Cystic Ovary
Displaced Abomasum
1.8
3.1
Lameness
2.8
2.0
Mastitis 151-305

Heritability of metabolic diseases

Disease	Current	Lyons	Zwald	Abdel-Azim
DA	0.10	0.16	0.15	0.09
KETO	0.05	0.10	0.06	—
MAST (any)	0.09	0.23	0.09	0.16
MAST 1	0.07	—	—	—
MAST 2	0.08	—	—	—
METR	0.08	0.06	0.07	0.14

Diseases and persistency
(Appuhamy et al., 2007)

- Mastitis in early lactation has a significant, negative effect on persistency.
- Mastitis in late lactation and post partum metabolic diseases have negative, effects on persistency.
- Persistency differs significantly between Holstein and Jersey cows.

Genetic relationships

- Negative correlations between PM and metabolic and udder diseases.
- Positive correlations between PM and fertility and foot diseases.
- Negative correlations between PF and metabolic.
- Positive correlations between PM and udder, fertility, and foot diseases.
- (Harder et al., J Dairy Sci. 2006 89: 3202-3212.)

Correlations between disease and persistency of milk and fat yield

	PM		PF	
Disease	HYS	Genetic	HYS	Genetic
DA	0.05	0.35	-0.09	0.15
KETO	—	—	—	—
MAST (any)	-0.13	0.18	-0.03	0.07
MAST 1	0.05	-0.10	0.08	0.01
MAST 2	-0.18	0.24	-0.05	-0.04
METR	0.07	0.24	0.09	0.15

Additional questions

- What latent relationships exist among disease traits?
- Can those relationships be used to develop composite traits for selection?
  - Improved frequency of occurrence
  - Lower heritability and larger PEV
- e.g. Generalized immunity versus ability to resist metabolic disease.

Format 6

- AIPL has developed a data exchange format to collect health data.
- It includes standard health codes.
- The objective is to collect data for research.
- It will facilitate selection for healthier cows.

Standard Health Event Codes

- Currently, no health event codes are used uniformly in dairy records systems.
- Standard codes have been developed based on frequency of occurrence in field data and consultation with veterinarians.

Health event codes

- Cystic ovary
- Diarrhea/scours
- Digestive problem/off feed
- Displaced abomasum
- Downer cow
- Dystocia
- Johne's disease (clinical)
- Ketosis/acetonemia
- Lameness
- Mastitis (clinical)
- Metritis
- Milk fever/hypocalcemia
- Nervous system problem
- Other reproductive problem
- Respiratory problem
- Retained placenta
- Stillbirth
- Teat injury
- Udder edema

Optional Health Event Detail

- Details of problems of high economic impact (e.g. clinical mastitis):
  - There is one mastitis event code.
  - Organism and quarter may be reported.
- Other codes may also use this field:
  - Dystocia: scores of 1 to 5.
  - BCS: scores of 1.00 to 5.00.

Some challenges

- Size of datasets both too large (e.g. for path analysis) and too small (e.g. for calculation of highly-reliable estimates of genetic merit).
- Estimation of economic impact of diseases for their incorporation into selection indices (e.g. Net Merit $) is very difficult.
- Buy-in from producers, software vendors, and herd health experts,