INTRODUCING NEW GENETIC SELECTION TRAITS:

Calf Health & Milking Speed

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CALF HEALTH:

Available Data, Trait Exploration, & National Evaluations

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CDCB
COUNCIL ON DAIRY CATTLE BREEDING

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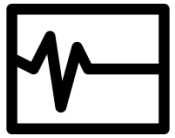
SCHOOL OF MEDICINE

WHAT IS THE LANDSCAPE?



75% of pre-weaned calf mortality is due to diarrhea and respiratory disease

Heritability reports vary 0.02 – 0.21; lack of centralized records/reporting

Calf Wellness has been addressed commercially (Zoetis); not yet in U.S. National Evaluations

Pipelines already exist for the transmission of calf health data (Format 6)

HEALTH DATA FLOW

- Standardized health recording system, developed in 2008
- Enabled national evaluations for 6 Cow Health traits (est. 2018):
  - Displaced Abomasum (**DA**), Milk Fever (**MFEV**), Ketosis (**KETO**), Mastitis (**MAST**), Metritis (**METR**), Retained Placenta (**RETP**)

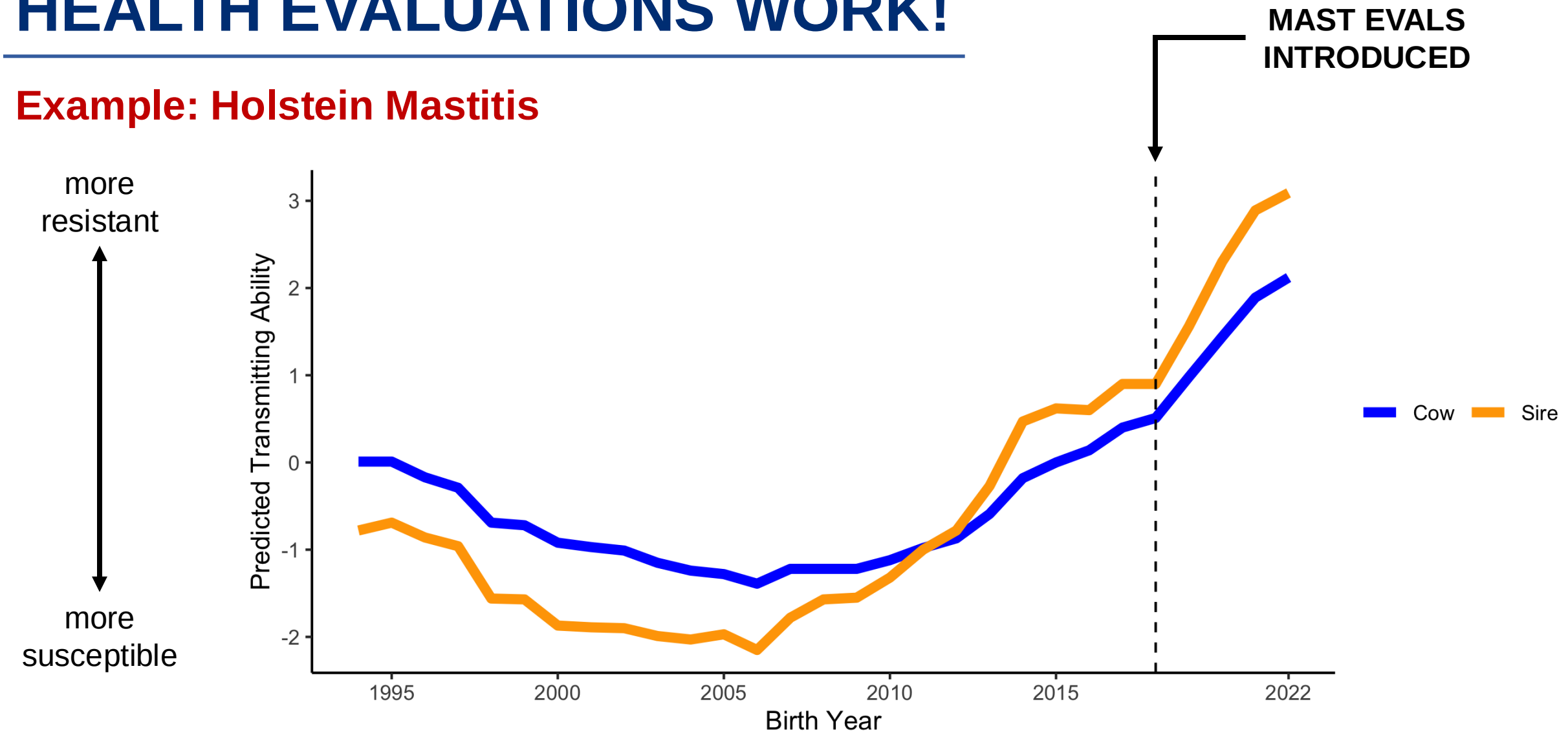
Description	Standard Code [1]	Usage [2]
Health traits		
Cystic Ovary	CYST	Y
Diarrhea/Scours	DIAR	N
Digestive Problem/Off Feed	DIGE	Y
Displaced Abomasum	DA--	Y
Downer Cow	DOWN	Y
Dystocia	DYST	Y
Johne's Disease/Paratuberculosis	JOHN	Y
Ketosis/Acetonemia	KETO	Y
Lameness	LAME	Y
Leukosis (bovine leukemia virus)	LEUK	Y
Mastitis (clinical)	MAST	Y
Metritis	METR	Y
Milk Fever/Hypocalcemia	MFEV [3]	Y
Nervous System Problem	NERV	Y
Reproductive problem other than CYST, DYST, METR, RETP	REPR	Y
Respiratory Problem	RESP	Y
Retained Placenta	RETP	Y
Stillbirth/Perinatal Survival	STIL	Y
Teat Injury	TEAT	N
Udder Edema	EDEM	Y
Management Traits		
Body Condition Score	BCS-	Y
Locomotion Score	LOCO	Y
Milking Speed	MSPD	Y
Temperament/Behavior	BHAV [3]	Y
Control Codes		
Delete records for the specified health event date	DELE	Y

Format 6 Codes for: 20 Health Traits & 4 Management Traits

https://redmine.uscdcb.com/projects/cdcb-customer-service/wiki/Format_6#

HEALTH EVALUATIONS WORK!

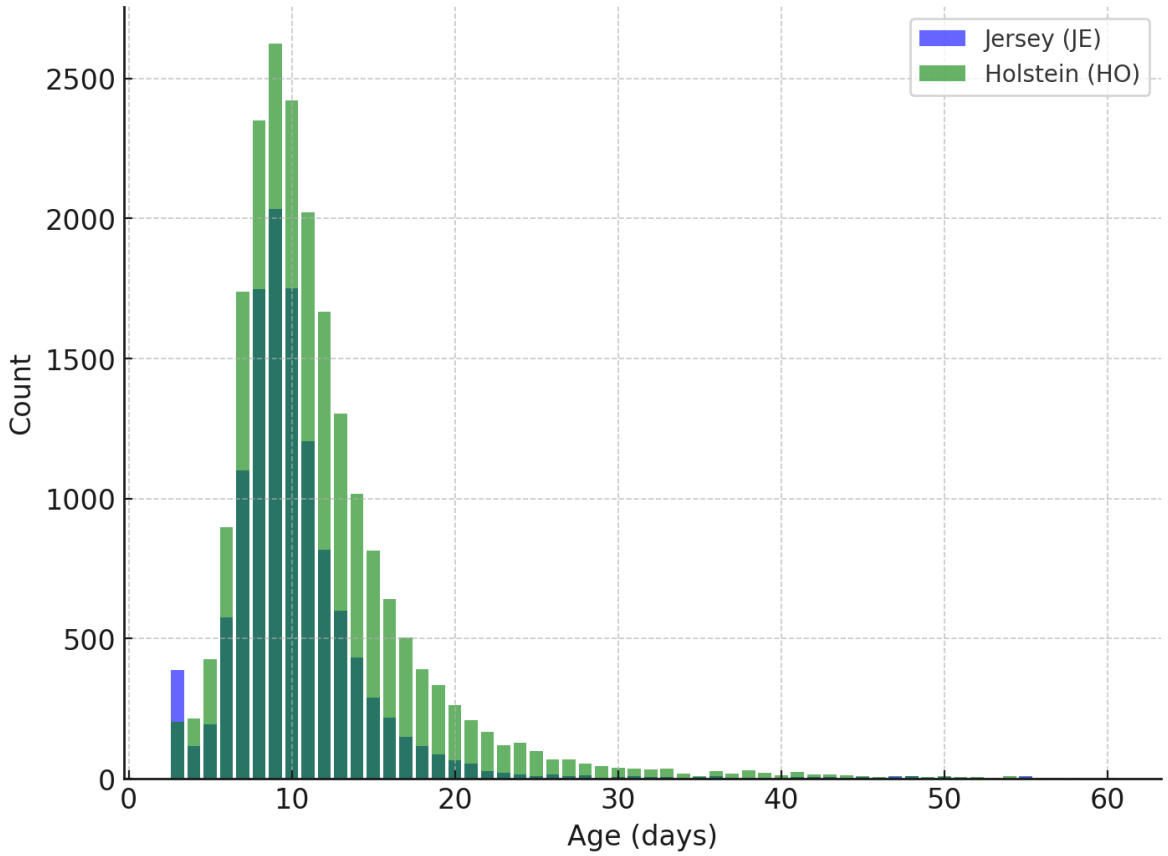
Example: Holstein Mastitis



CALF HEALTH PHENOTYPES

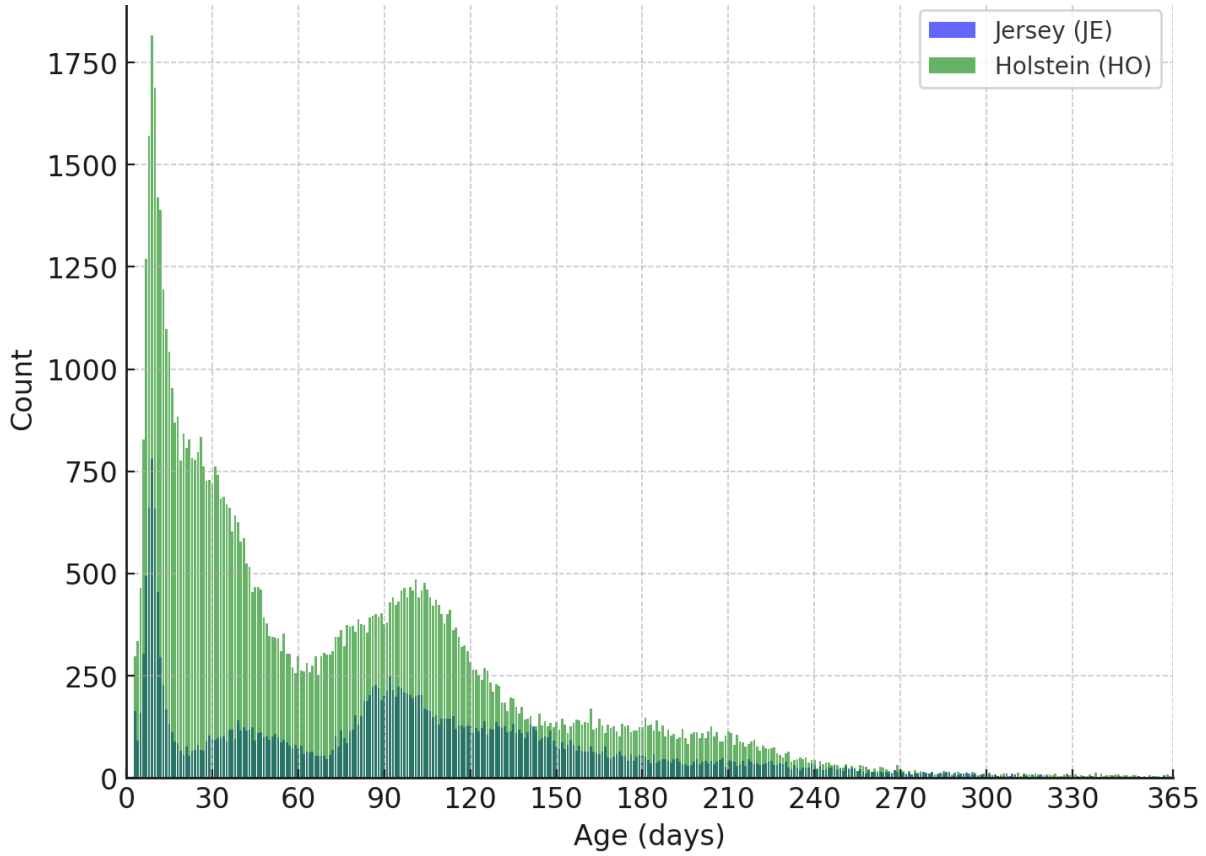
DIAR (N = 207,602)

h^2 = 0.026

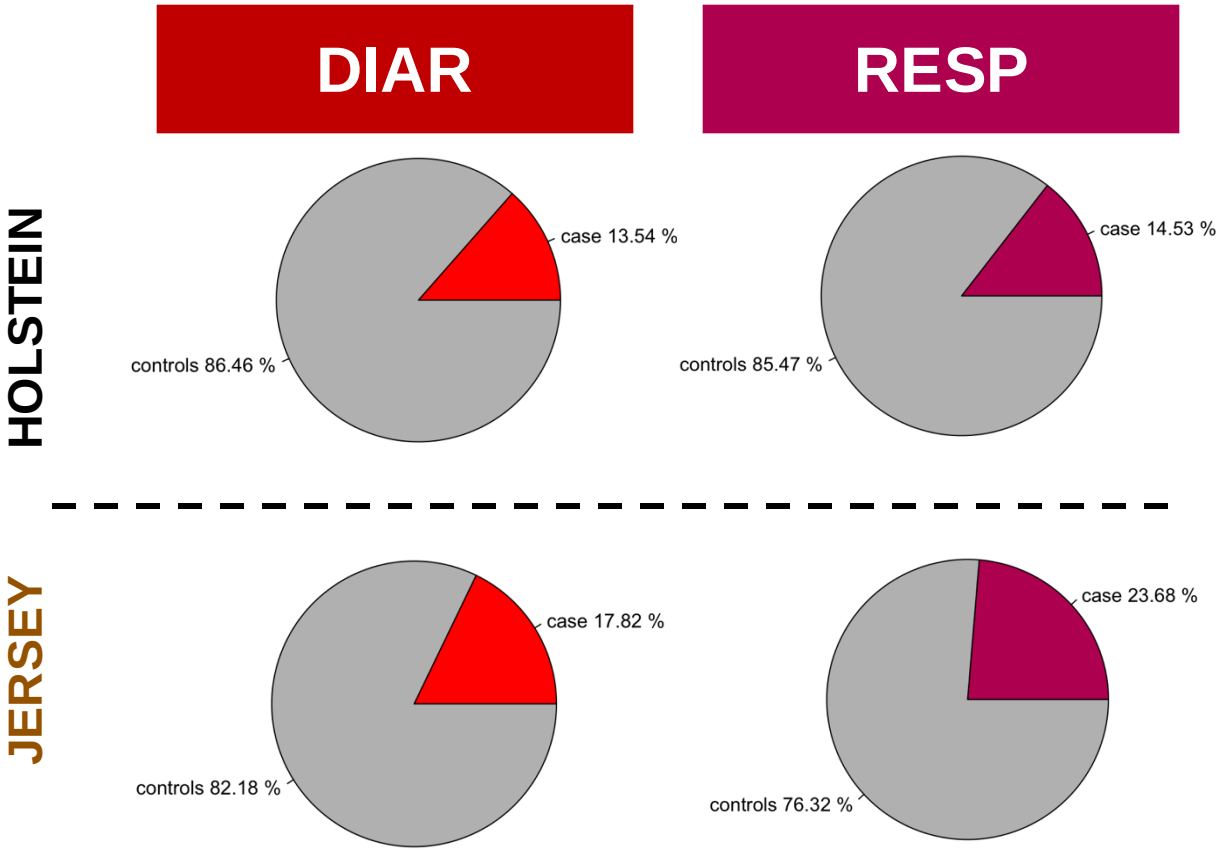


RESP (N = 681,741)

h^2 = 0.022



INCIDENCE, DEFINITIONS



- Incidence generally higher in JE
- Binary Trait
  - 0: Diseased
  - 100: Healthy

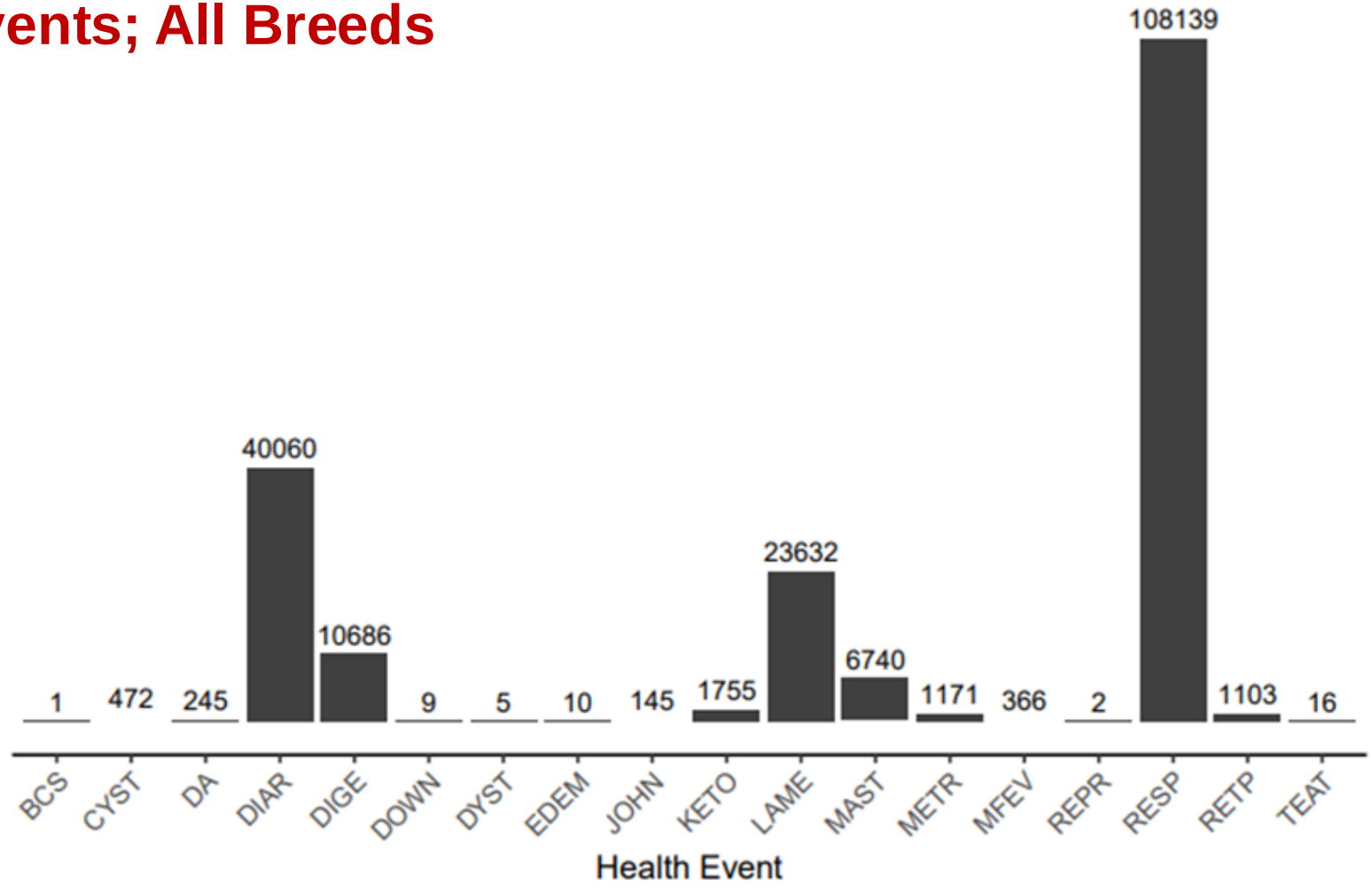
PRELIMINARY EVALUATIONS

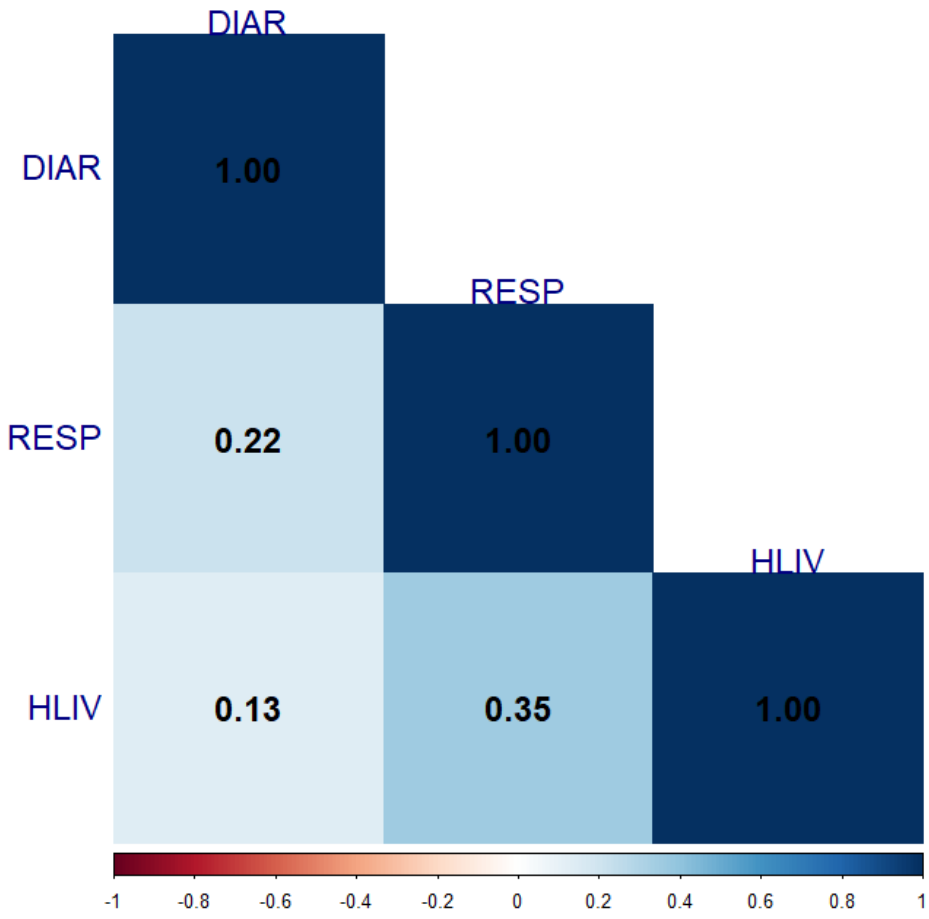
Animal Model; Covariates w/ HYS and Parity of Dam

Trait	Status	GPTA mean ± SD (REL)	tradPTA mean ± SD (REL)
DIAR-JE	old	0.07 ± 0.36 (34)	-0.01 ± 0.36 (15)
	yng	0.08 ± 0.47 (33)	0.06 ± 0.52 (15)
RESP-JE	old	0.04 ± 0.41 (42)	0.03 ± 0.42 (21)
	yng	-0.01 ± 0.48 (39)	-0.04 ± 0.51 (18)
DIAR-HO	old	-0.01 ± 0.25 (47)	0.00 ± 0.25 (19)
	yng	-0.03 ± 0.34 (45)	-0.04 ± 0.26 (12)
RESP-HO	old	-0.04 ± 0.36 (60)	-0.02 ± 0.35 (26)
	yng	-0.11 ± 0.51 (59)	-0.08 ± 0.36 (17)

MORE DATA = BETTER SELECTION TOOLS

Calf Health Events; All Breeds





Favorable correlations with heifer livability

KEY MESSAGES

- Data flow decreases after 2021; improving this will be crucial to calf health evaluations
- DIAR and RESP have sufficient heritability that evaluations are possible; SD and REL will improve with better data
- Fast turnaround time on this trait is likely thanks to existing infrastructure (Format 6)

MILKING SPEED:

Genetic & Genomic Evaluations, Data Flow, & Next Steps

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NAAB

DRMS
DAIRY RECORDS MANAGEMENT SYSTEMS

EVALUATIONS FOR MSPD

- Interbull-participating countries (N = 14) include milking speed in their “workability” evaluations
  - Australia, Canada, Denmark/Sweden/Finland, France, Germany/Austria/Luxembourg, Great Britain, Italy, Japan, the Netherlands, New Zealand, Norway, Poland, Slovenia, and Switzerland
- Nearly all phenotypes collected during first parity only and sometimes from a single classification
- If quantitative milk flow rates were available, classification data were discarded

DEVELOPING MSPD EVALS IN USA

OBJ. 1: Assemble a **high-resolution dataset pertinent to MS** representing different dairy breeds, equipment manufacturers, parlor types, and milking management strategies

OBJ. 2: Characterize MS for herds grouped by equipment manufacturer and parlor type and assess the impact of additional **system effects** on the phenotype

OBJ. 3: Characterize any **biological effects** that impact MS, especially concerning udder health

OBJ. 4: **Standardize** MS trait definition and estimate heritability to determine its suitability for selection

AVAILABLE DATA

DRMS DAIRY RECORDS MANAGEMENT SYSTEMS

Demographics

~300 herds
~250,000 cows
~320,000 lactations
~50 million observations

31 States
6+ Breeds
11 OEMs

DeLaval	80
GEA	75
Lely	47
Boumatic	46
AfiMilk	45
SCR	13
DairyMaster	10
AIC Waikato	5
AMS Galaxy	3
Jantec	2
Universal	2

Special thanks to Robert Fourdraine & John Clay

OBJ 1: ASSEMBLE DATA

Example: Data Cleaning

Summary stats on data

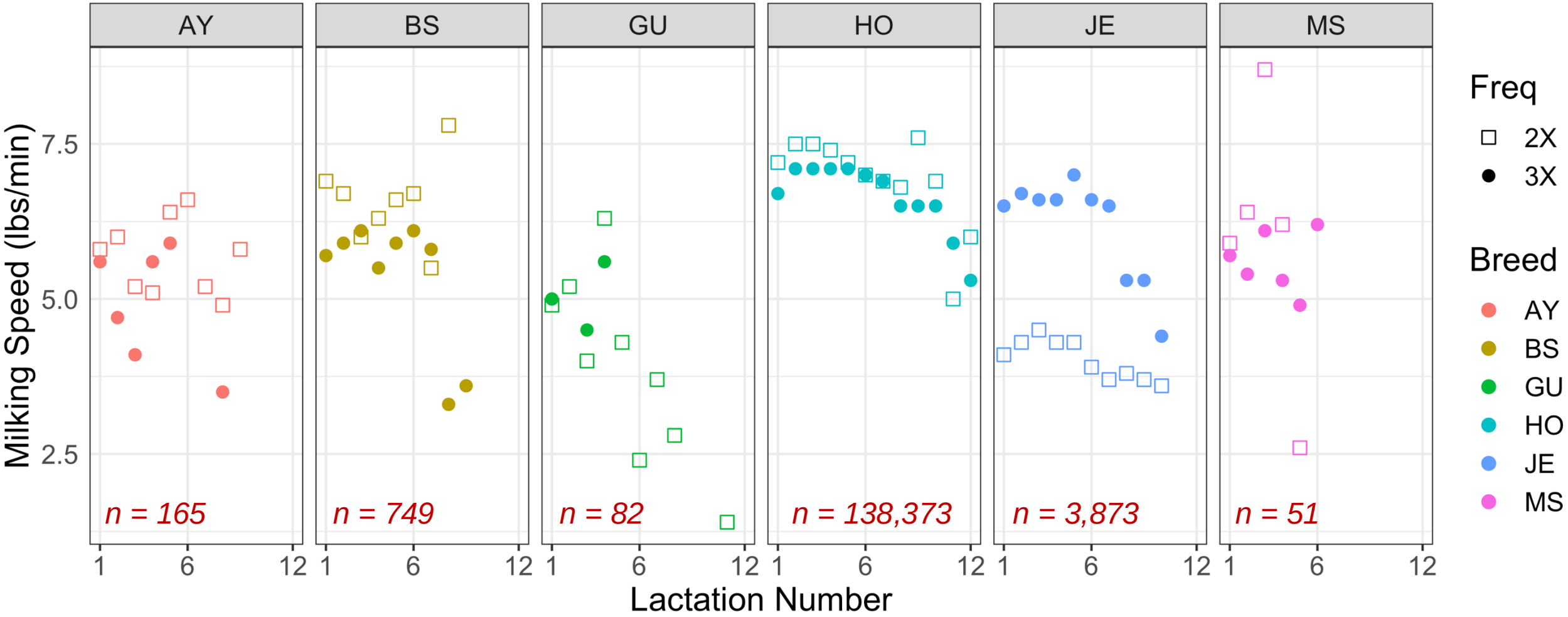
		N	Minimum	Q1	Median	Mean	Q3	Maximum	StDev	0 or missing	greater than 15
Milking Duration										0 or missing	greater than 15
	M1time	38877488	0	3.6	4.4	5.425	5.4	1440	30.1	3254587	85677
	M2time	38611378	0	3.5	4.3	5.772	5.2	1440	39.791	3493311	89253
	M3time	29804057	-1435.5	3.5	4.2	6.17	5.1	-1435.5	46.83	12223012	61510

OBJ 1: ASSEMBLE DATA

Example: Data Cleaning

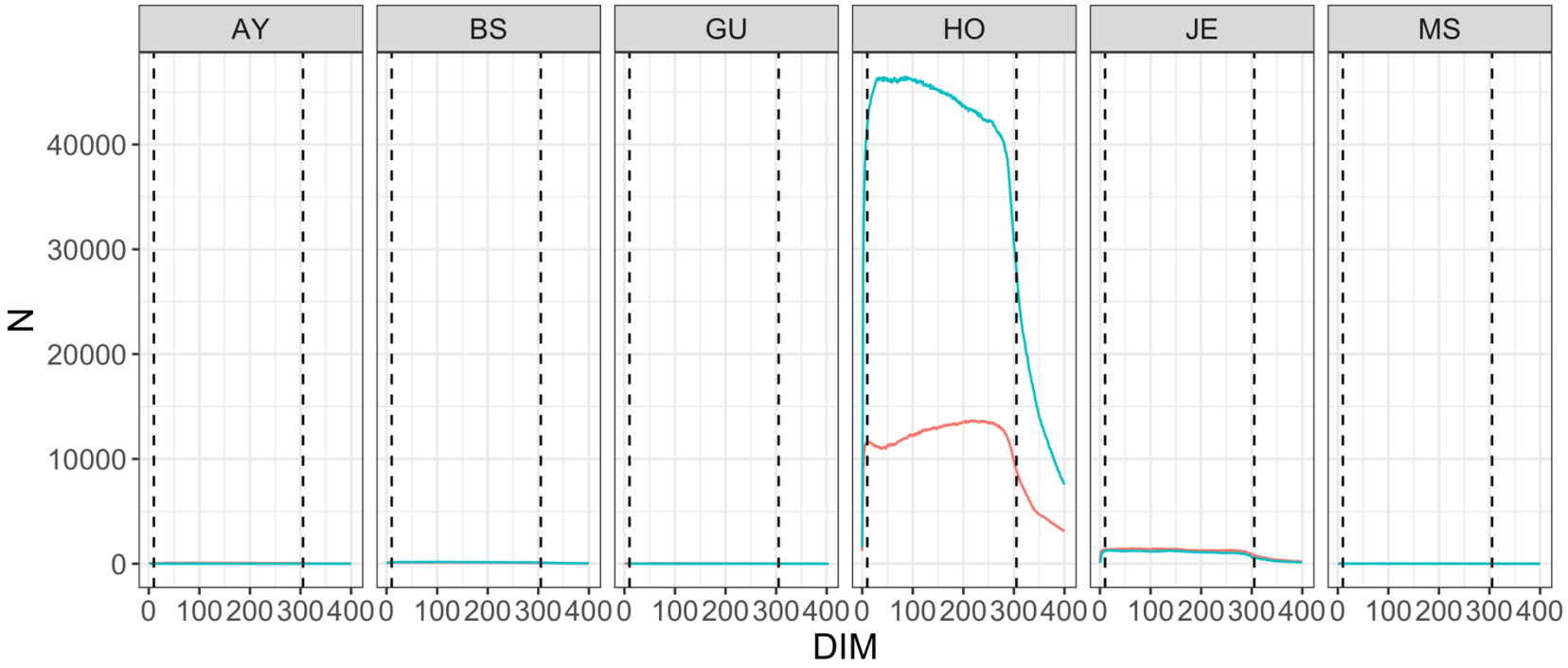
	AY		BS		GU		HO		JE		MS	
	2X	3X	2X	3X	2X	3X	2X	3X	2X	3X	2X	3X
Initial Records	28,412	1,632	67,850	93,193	20,233	495	6,154,246	21,772,400	633,289	599,840	2,119	5,334
After 1/1/2022	28,412	1,597	62,282	92,829	17,604	495	5,852,454	21,224,965	527,501	521,253	2,119	5,334
0 < duration < 15	25,374	994	45,509	57,621	12,130	398	5,138,997	15,803,428	475,668	392,451	1,354	3,661
0 < milk < 80	25,223	993	45,177	57,349	12,126	398	4,778,714	15,665,401	474,852	392,130	1,348	3,659
1 < MSPD < 15	24,646	956	39,324	56,806	10,972	389	4,611,960	15,422,775	463,138	378,765	1,333	3,613
>10 obs per cow	24,621	953	39,193	56,603	10,939	389	4,606,970	15,407,922	461,910	377,735	1,333	3,585
% reduction in data	13.3%	41.6%	42.2%	39.3%	45.9%	21.4%	25.1%	29.2%	27.1%	37.0%	37.1%	32.8%

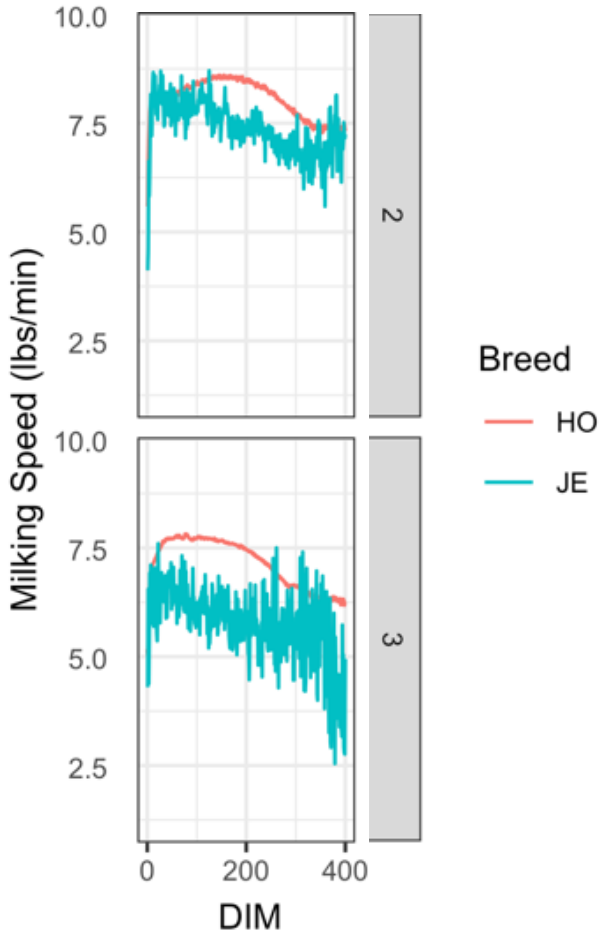
BREED, PARITY, FREQUENCY TRENDS



DATA SPARSITY IS A CHALLENGE

Example: BREED





UDDER HEALTH; MILK COMPONENTS

HOLSTEIN

	SCS	FAT %	PROTEIN %
2X	-0.02*	0.10***	0.13***
3X	-0.04***	0.04***	0.06***
AMS	-0.18***	-0.27***	-0.29***

JERSEY

	SCS	FAT %	PROTEIN %
2X	-0.13***	-0.07†	-0.24***
3X	-0.13***	-0.14***	-0.27***
AMS	-0.01	-0.05†	-0.03

- Average MS for all milkings on a test day
- Correlated with SCS, Fat, and Protein on respective test day
- No statistically significant association with clinical mastitis
- Linear correlations may mask trends for extremes (very slow, very fast)

PROPOSED TRAIT

HOLSTEIN (n = 1642 bulls, genetic corr with SCS = 0.37, NM$ = 0.10)
Total number of lactation records used = 50,406

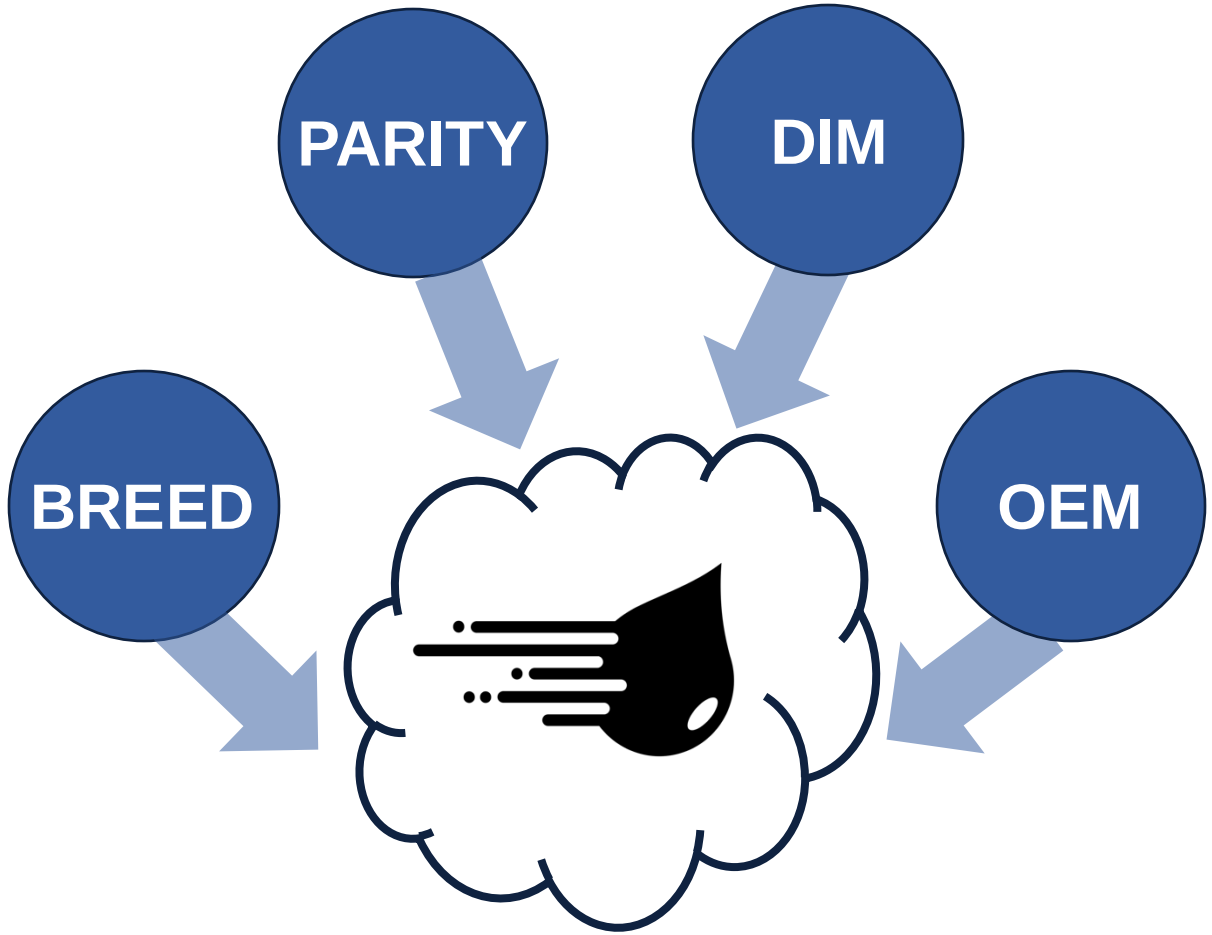
	PTA				REL			
Trait	Min	Mean	SD	Max	Min	Mean	SD	Max
MSPD	-0.95	0.09	0.31	1.17	50.10	69.07	13.07	98.70
SCS	-0.65	-0.18	0.16	0.67	50.30	95.21	6.88	99.90

- Stage of lactation effects were removed as fixed effects before averaging residuals into lactation records
- Genetic model included milking frequency, parity, OEM, herdyear, genetic groups, permanent environment
- Genomic PTAs were derived from the deregressed pedigree model PTAs. For young HO animals, MSPD predictions averaged 47% REL compared to ~70% for most other traits

ENSURING DATA FLOW

Minimum Required Data Novel to MSPD

Observation date (YYYYMMDD)
Milking Session Time (00:01 – 24:00)
Milking Frequency (01X, 02X, 03X, 04X, AMS)
Robotic or Manual Attachment (R or M)
Original Equipment Manufacturer (OEM) Code → **ICAR Device Reference IDs**
Milk Yield from Individual Milking (lbs * 10)
Milking Duration of Individual Milking (minutes * 10)
Abnormal Flags (Y or N)



Many factors influence quantitative MSPD measurements

THE BOTTOM LINE

- Methodology has been approved by CDCB Genetic Evaluation Methods (GEM) Committee & endorsed by CDCB Board of Directors
- Routine data flow is a key hurdle; a new Format has been developed in cooperation with DRPC
- Research continues, exploring the use of AMS data

THANK YOU

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