SEMEX®
Genetics for Life®

Immunity+™

Disease Resistant Genetics

Steven Larmer, PhD

Immunity+™

Disease Resistant Genetics

The only company offering immune genetics for greater disease resistance

SEMEX®
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Immunity+®

2013 USA Dairy Herd Management Innovation Award

2017 Canada Governor General's Innovation Award

2018 UK Royal Dairy Innovation Award Winner

Dr. Bonnie Mallard

Department of Pathobiology, University of Guelph

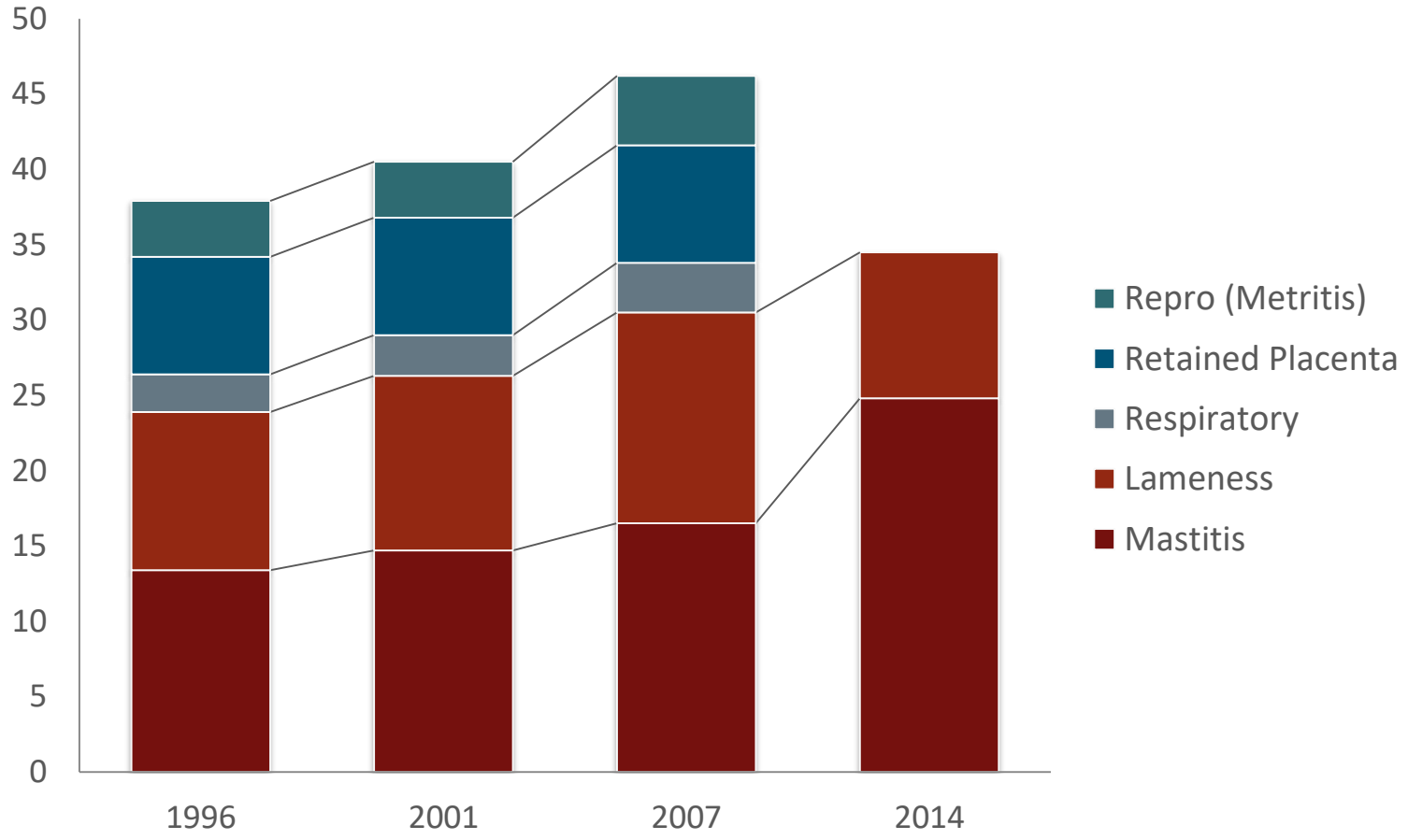
Genetic regulation of the immune system of livestock

22-yr research program Semex supported

Almost 100 research papers in referred journals on immune response

Several thousand animals tested in research, beta test & commercial herds

Disease Trends



NAHMS Dairy 2014 Part II: Changes in the Dairy Cattle Industry 1996-2014

Past Genetic Selection for Health

- **Few “true” direct health traits**
- **Selecting an end result**
  - Herd Life/Productive Life
  - Daughter Fertility/Daughter Pregnancy Rate
  - Daughter Calving Ease
  - SCS
- **Hope it achieves better health**
- **Low heritability traits**

Need a Better Approach

Selection for Higher Immunity

- It is the ultimate goal
- Even better than direct selection for individual diseases

A starting point for a healthier dairy

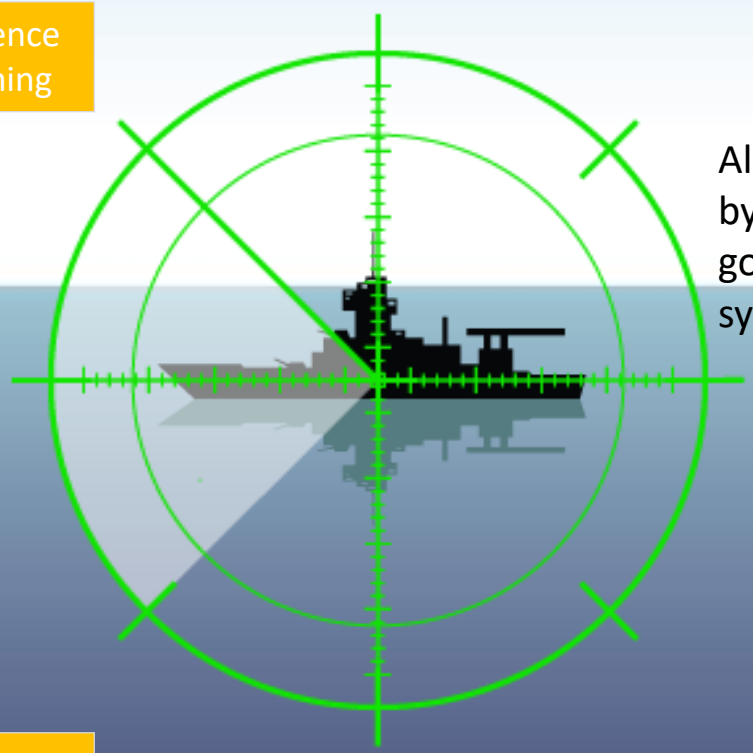
Changes the way dairies will select for health

What is Immunity?

Attacks from Air

Experience & training

Response: Air Defense

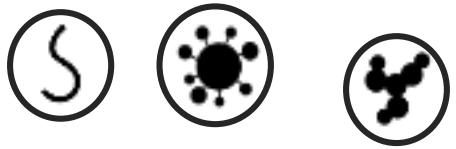


All actions controlled by central government defense system

Attacks from Water

Experience & training

Response: Naval Defense



Bacterial infections

- Mastitis, listerosis, brucellosis, E. coli scours, bacterial pneumonia, metritis, digital dermatitis

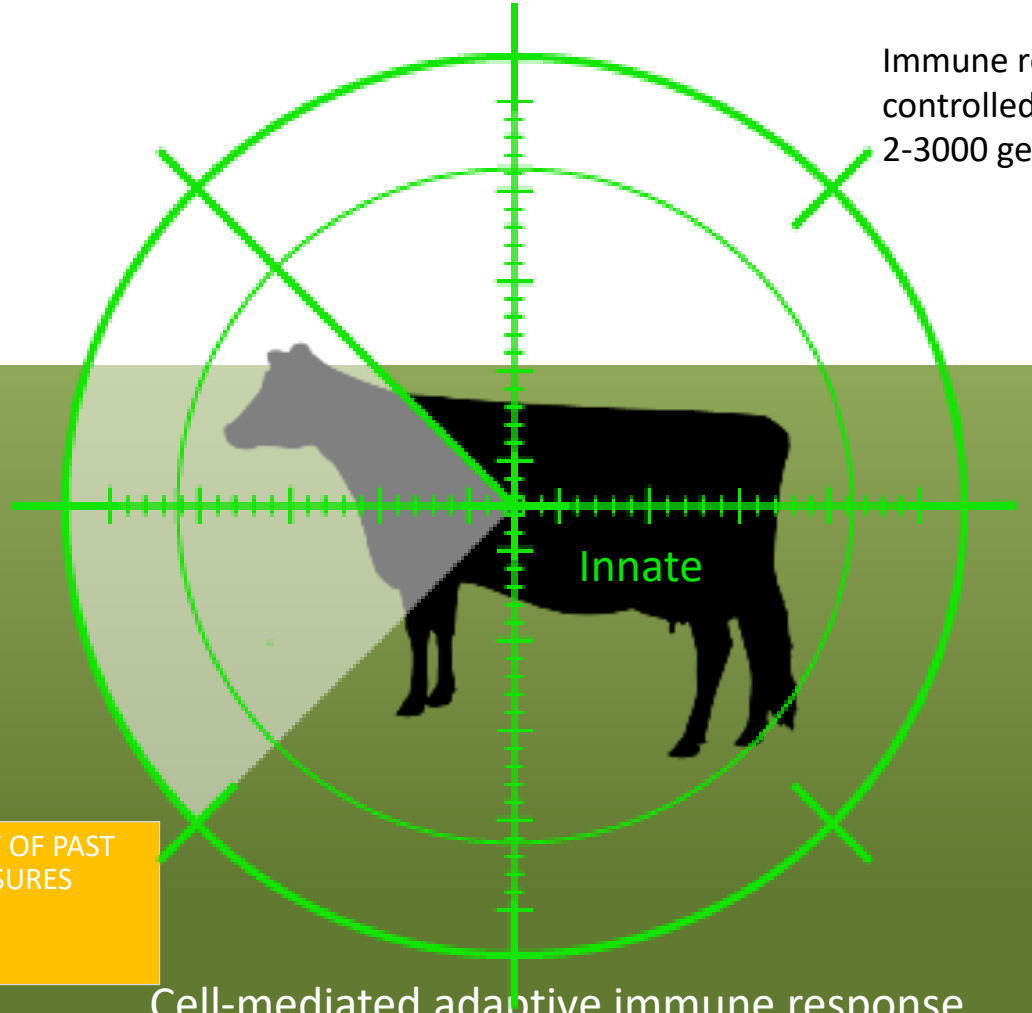
Viral & mycobacterial infections

- Viral pneumonia, BVD, IBR, leucosis, foot & mouth, tb, retained placenta, Johne's

MEMORY OF PAST EXPOSURES

Antibody-mediated adaptive immune response

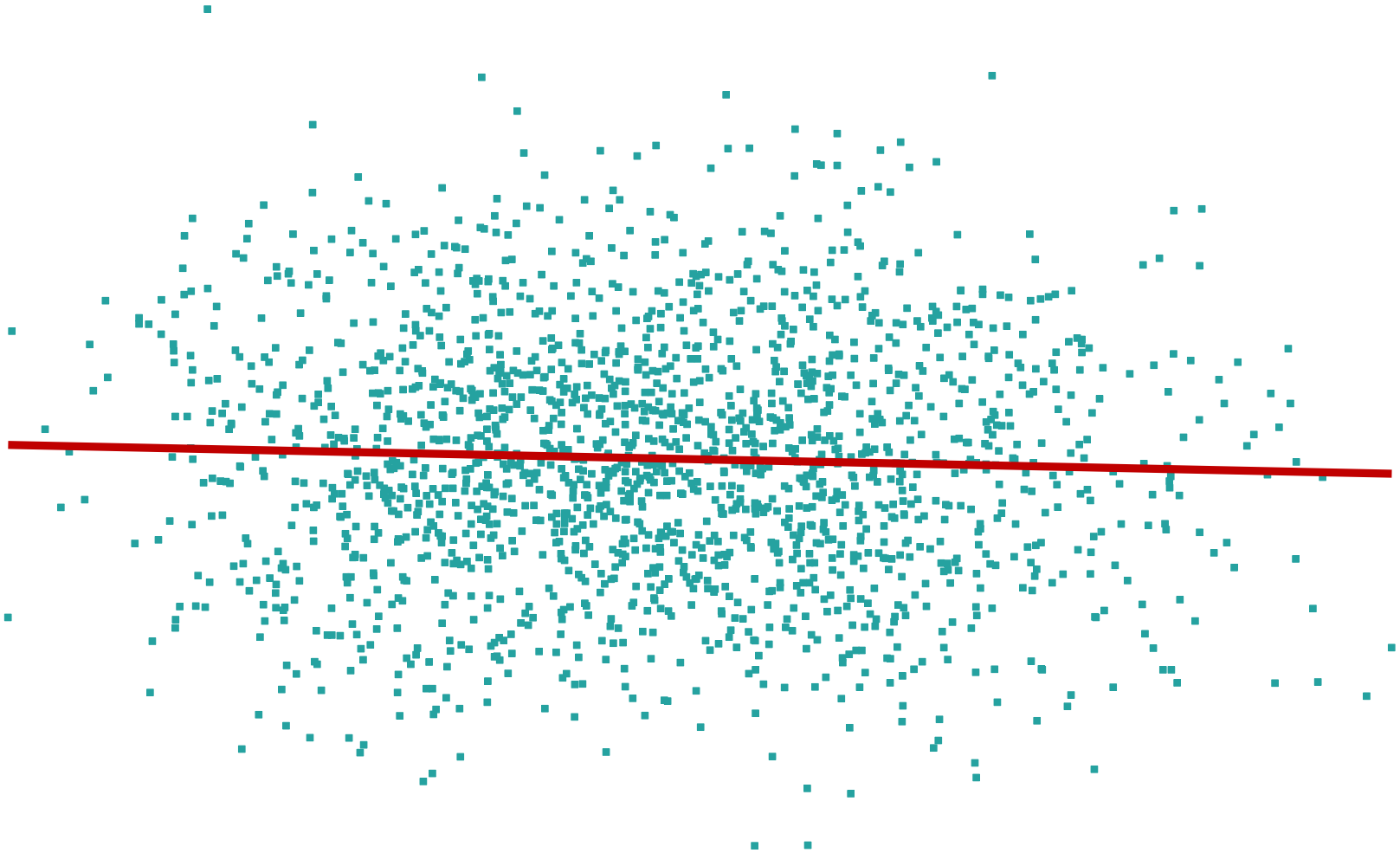
Immune response is controlled & directed by 2-3000 genes



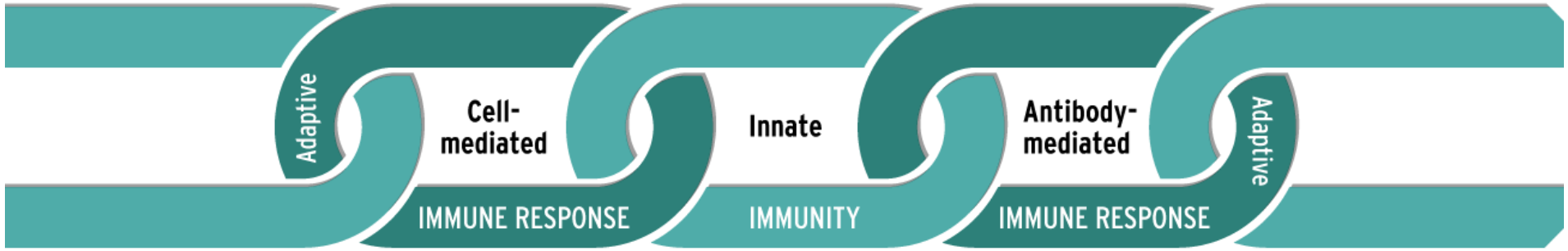
MEMORY OF PAST EXPOSURES

Cell-mediated adaptive immune response

AMIR and CMIR are slightly NEGATIVELY Correlated



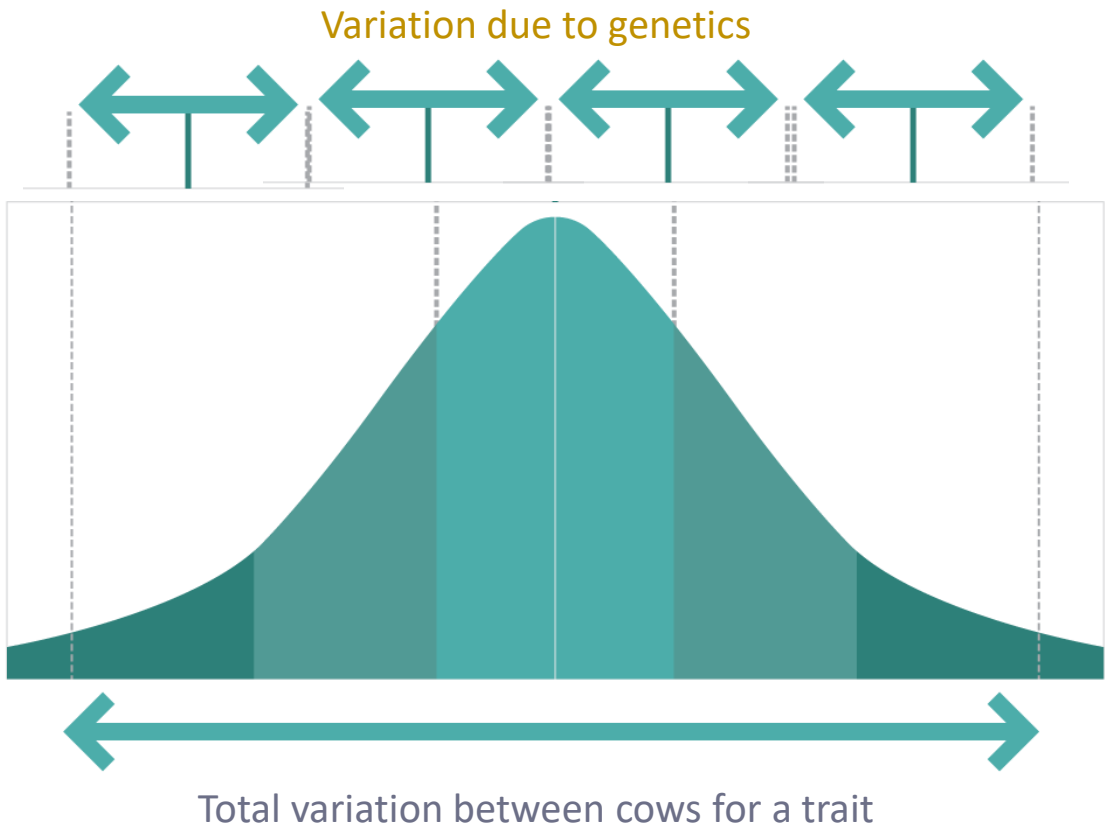
Broad-based Defence Against
Most Viral & Bacterial Infections



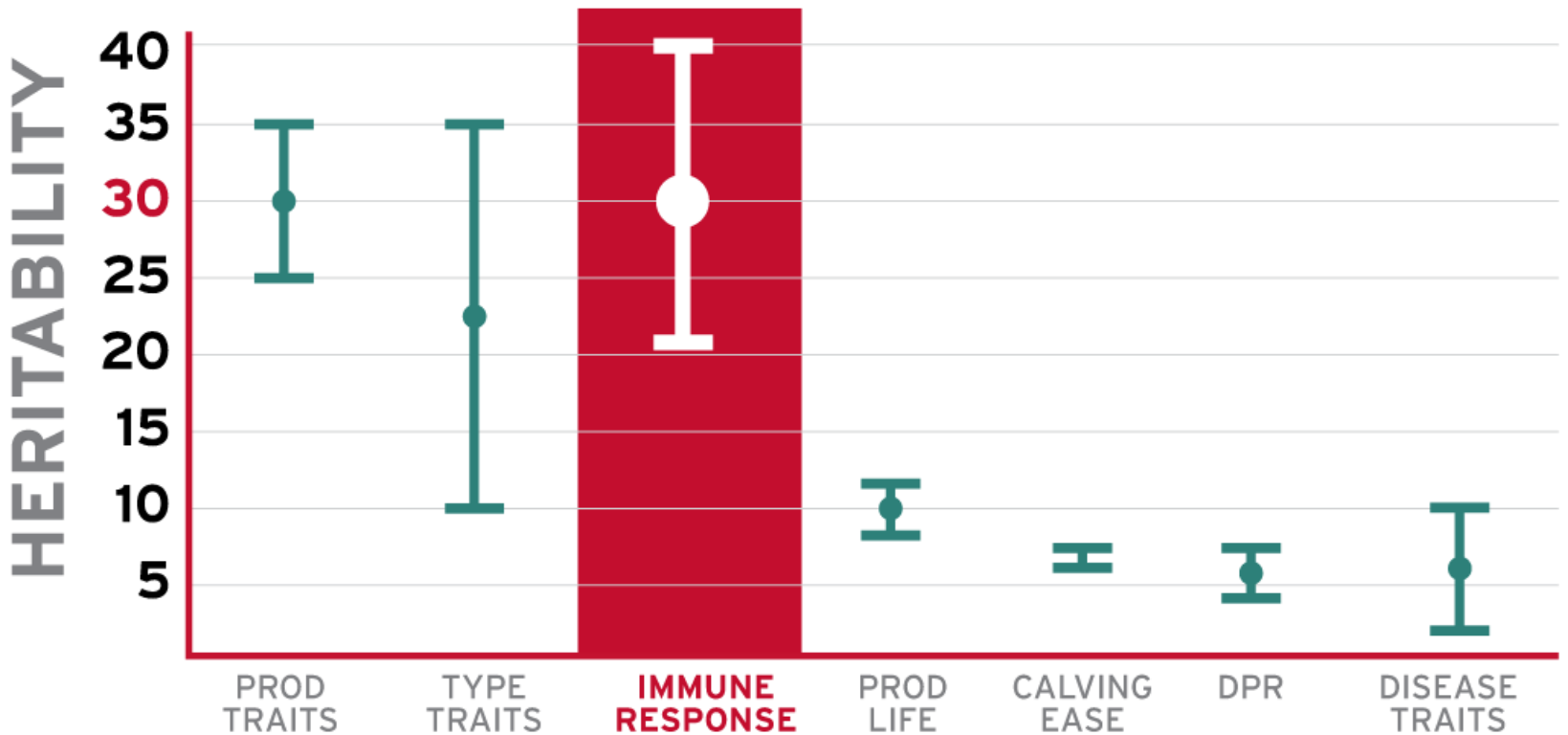
High Immune Response Technology

Heritability

% of total variation that's explained by genetics

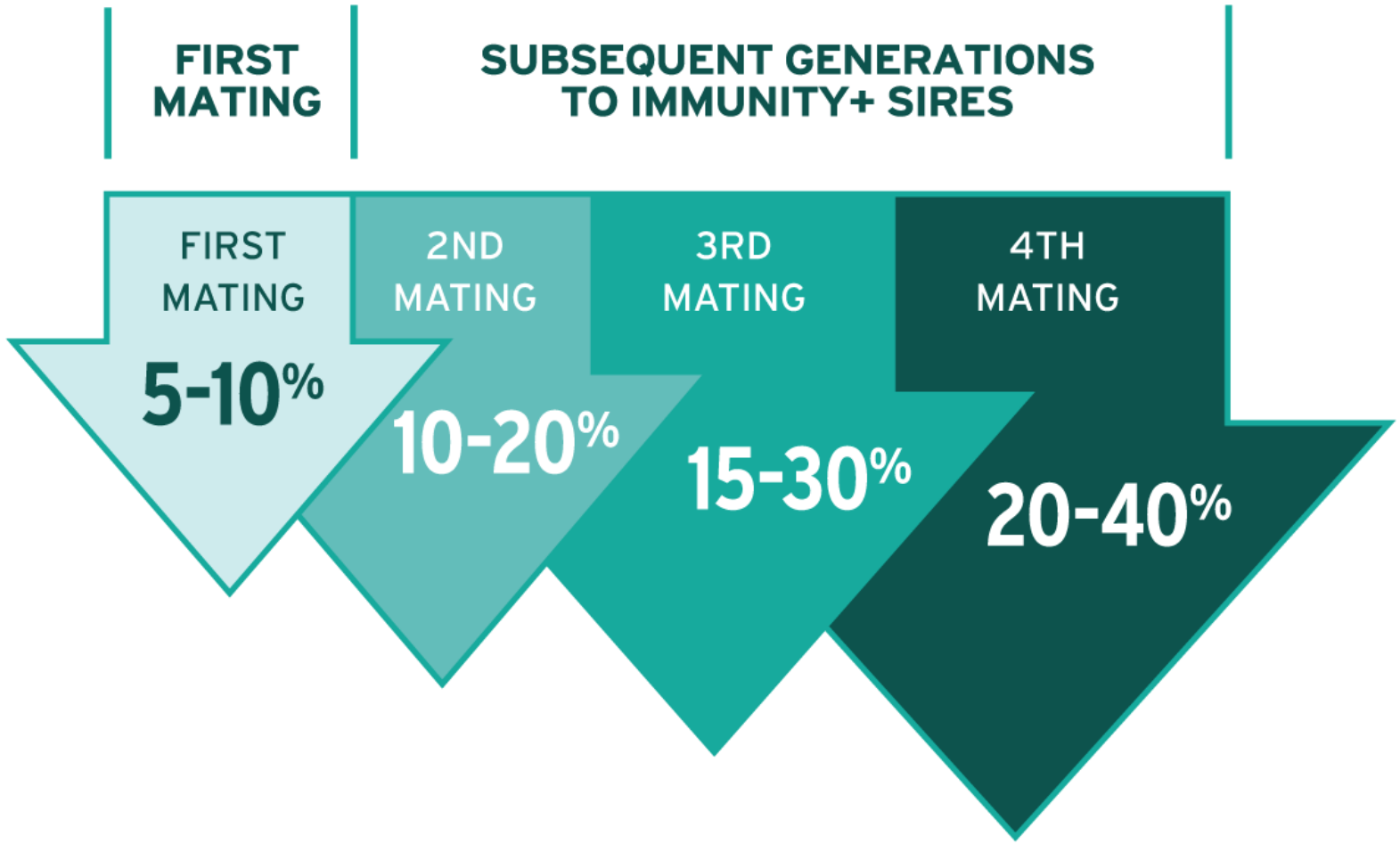


IMMUNE RESPONSE HERITABILITY IS NOW 30%

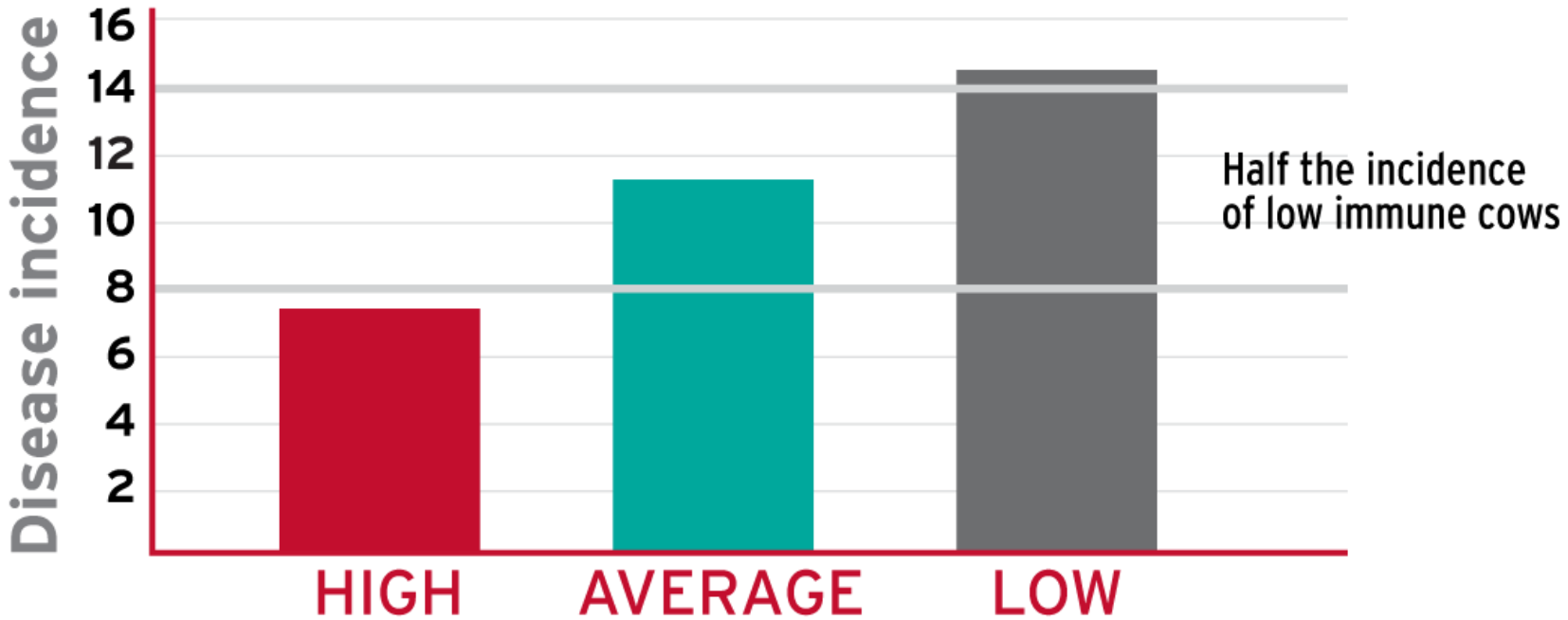


LESS DISEASE

Less disease generation after generation



RESEARCH SHOWS
HIGH IMMUNE RESPONSE COWS HAVE LESS DISEASE

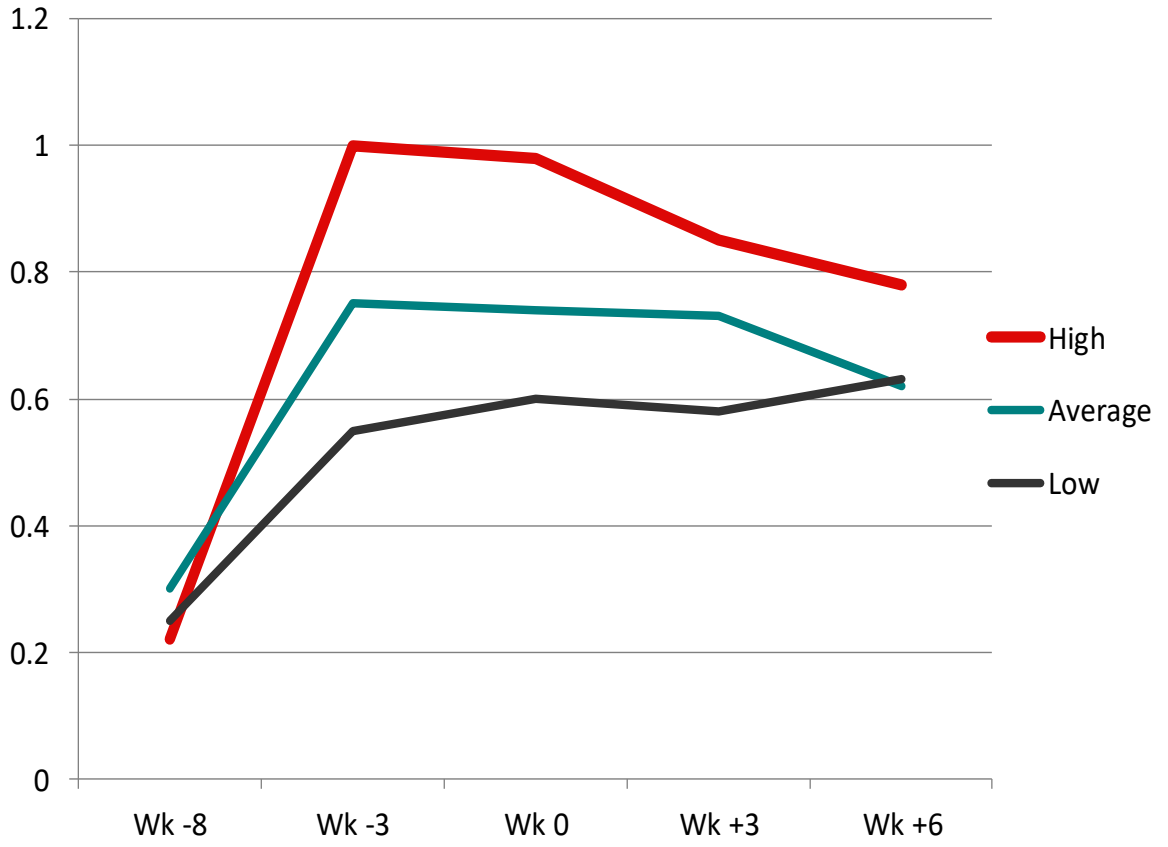


Studies across 64 herds in North America.

Wagter, et al. 2000 J. Dairy Sci. 83:488-498; Thompson-Crispi, et al. 2012. J. Dairy Sci. 95:3888-3893; Thompson-Crispi, et al. 2013. Clin Vacc Immuno. 20:106-112.

Vaccine Response

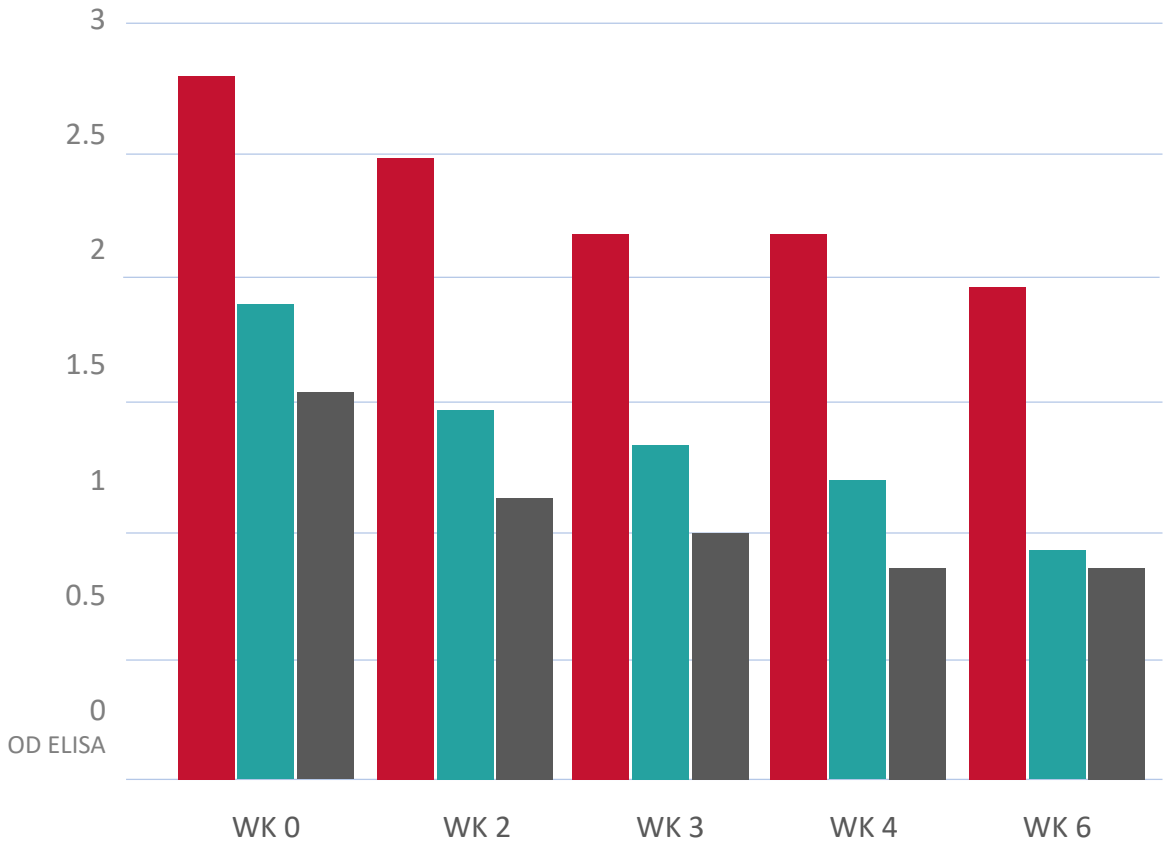
High immune cows respond better to commercial vaccines.



Wagter & Mallard et al. 2000 JDS 83:488

Quality Colostrum

High immune cows have higher quality colostrum with more antibodies.

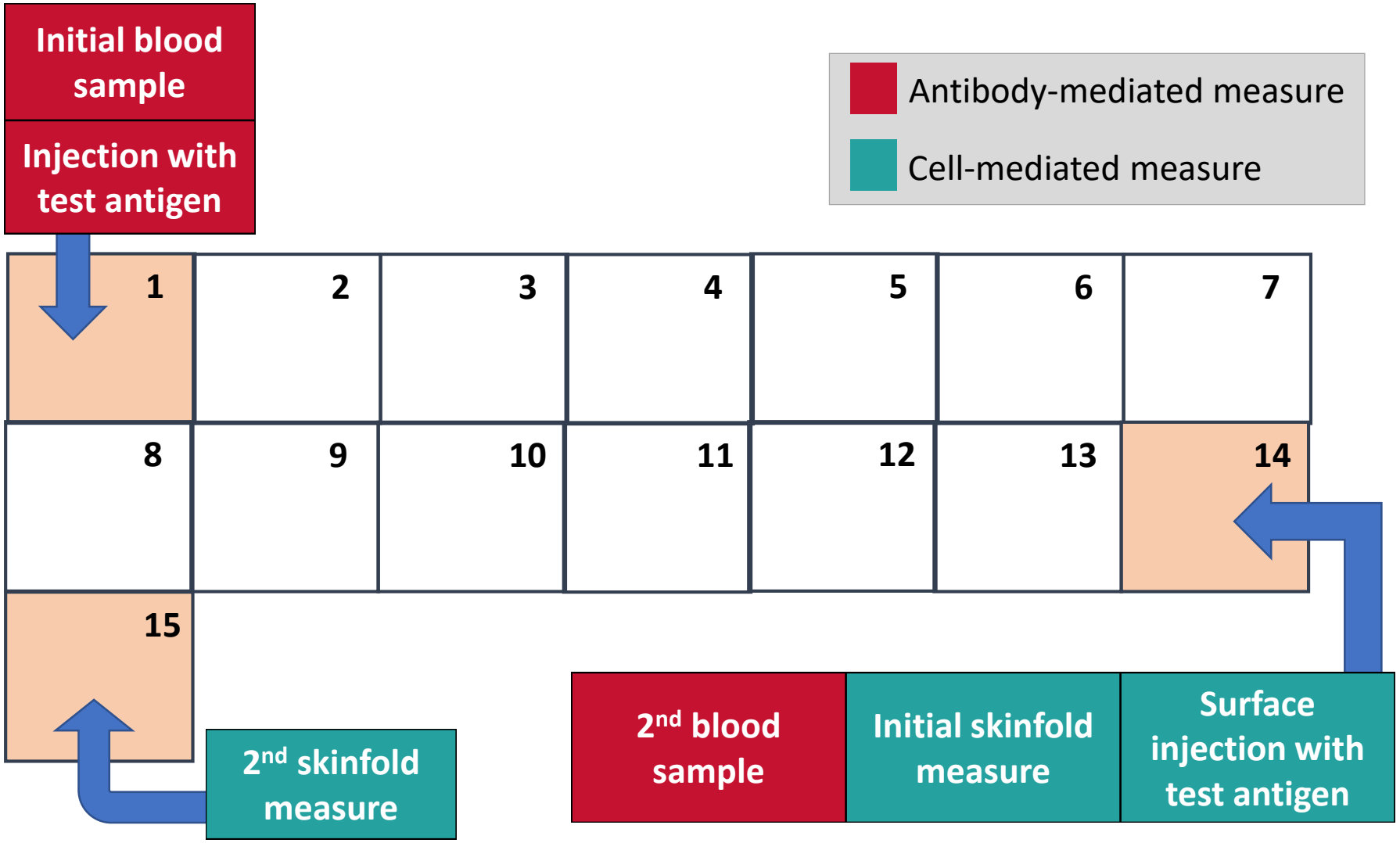


Wagter & Mallard et al. 2000 JDS 83:488

Testing For Immune Response

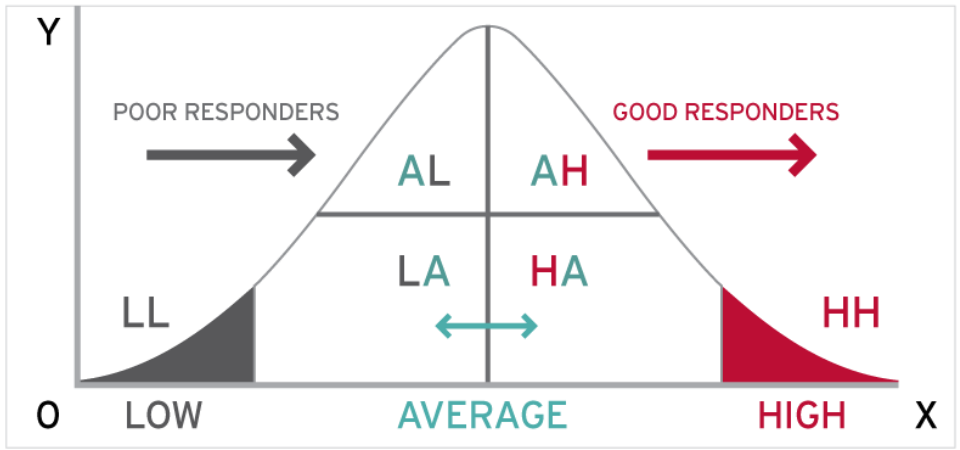
Two tests performed

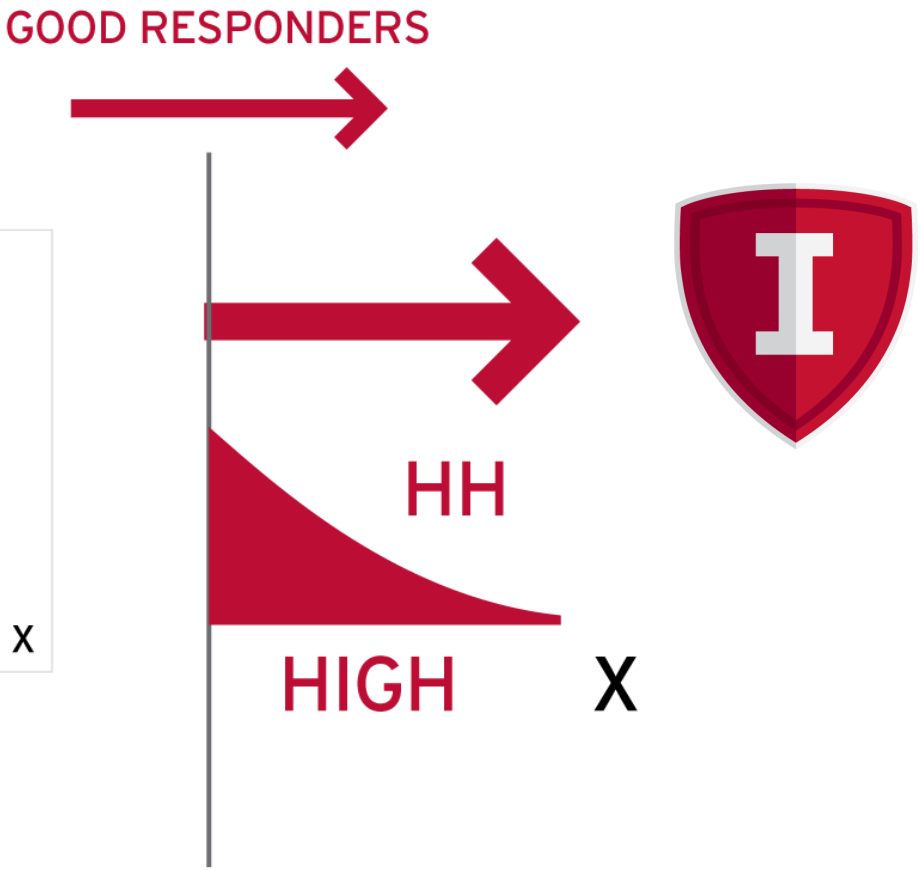
Testing for Immune Response



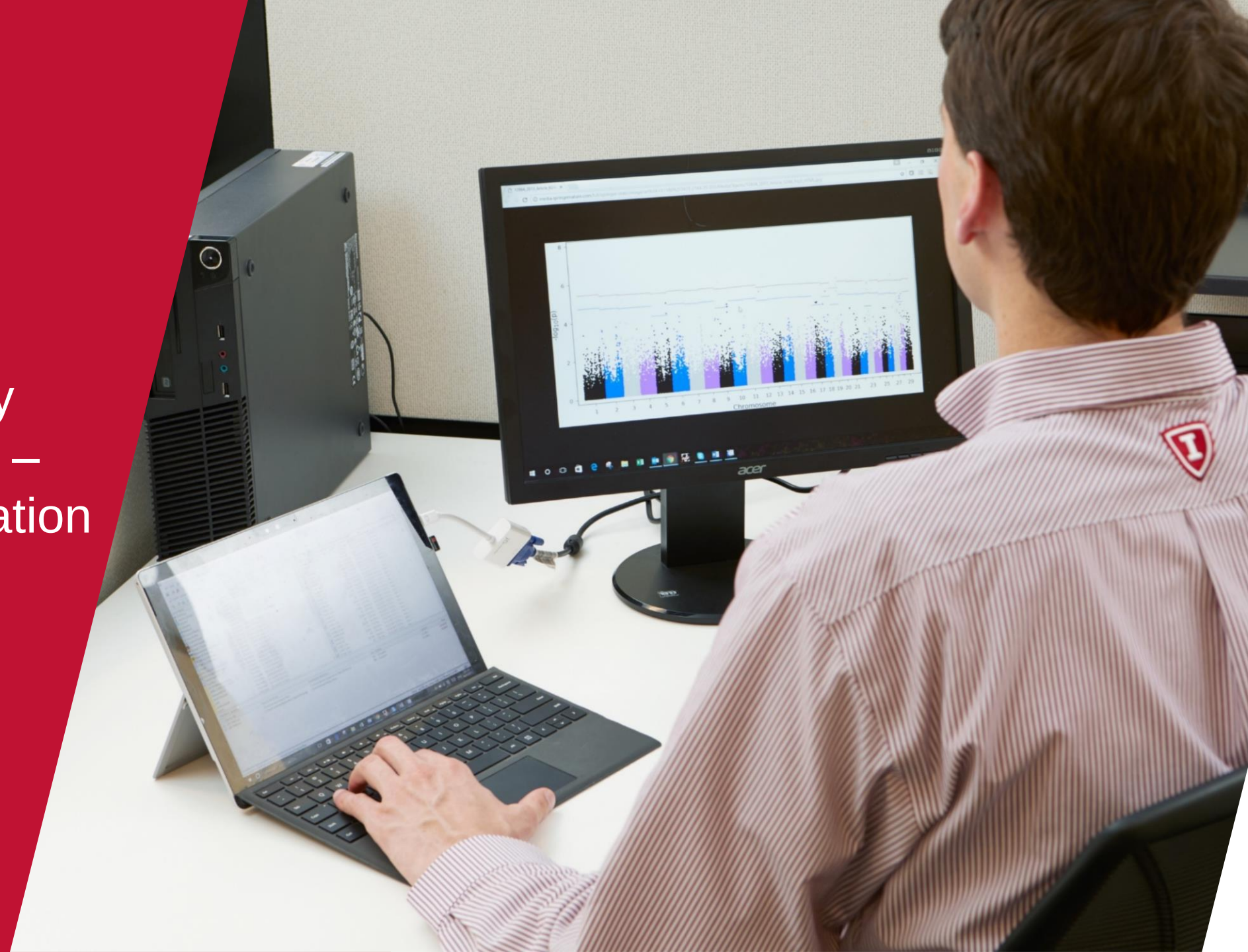
Bulls Designated as Immunity+

Approximately 10% of sires



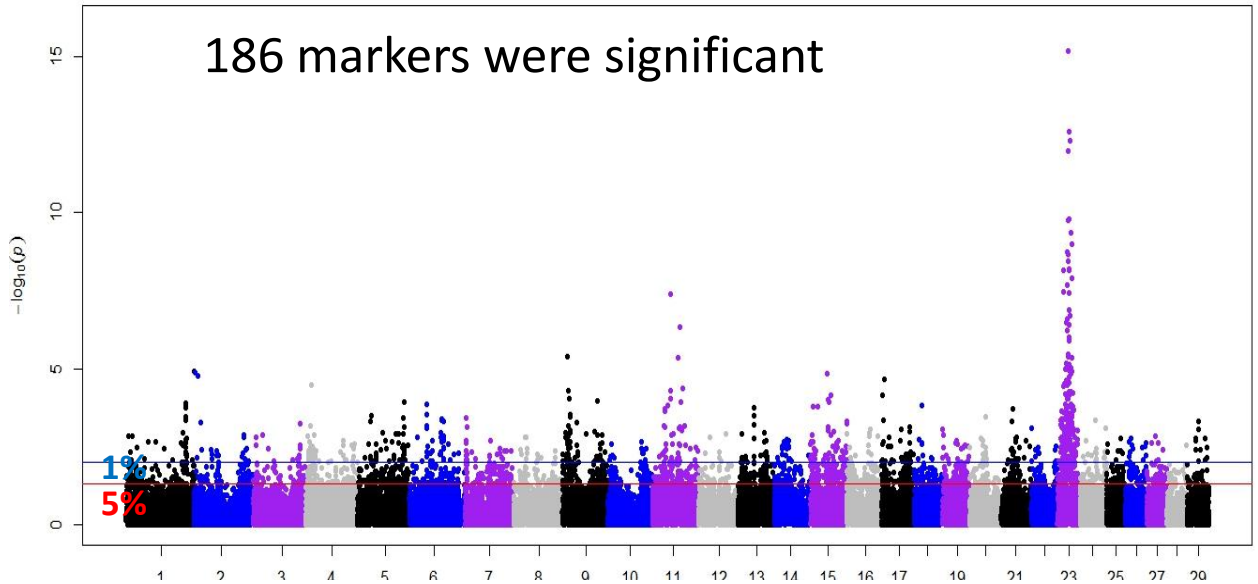


Initial Preliminary Research, AMIR – Genome Association



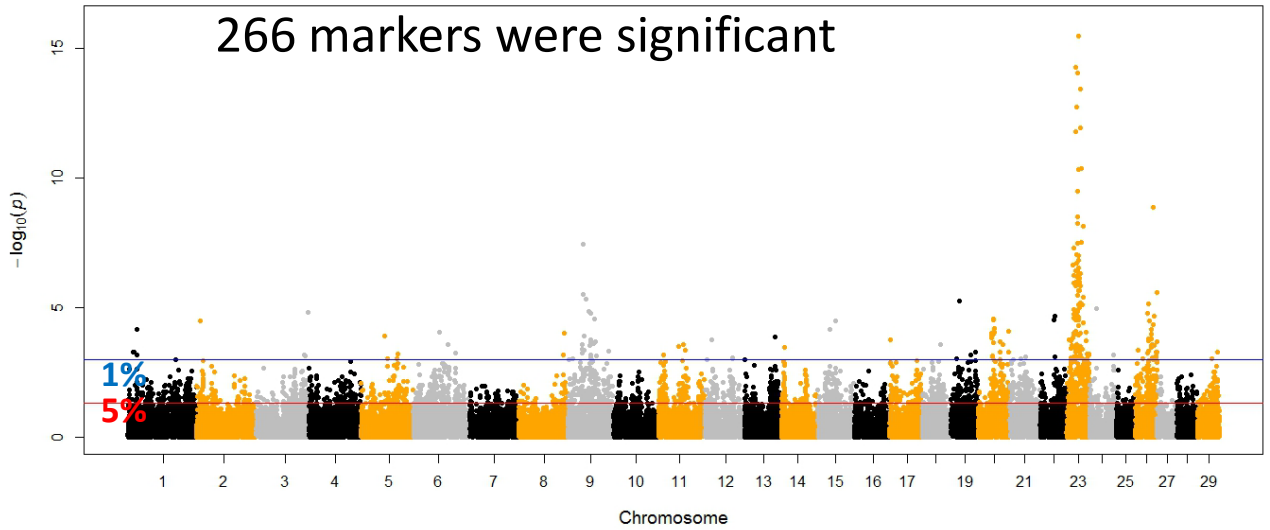
nitial Preliminary Research, AMIR – Genome Association

Female Study



Significant markers with just 163 cows

Male Study



Significant markers with just 631 bulls

Thompson-Crispi et al 2014 BMC Genomics. 15(1):559

Genome Wide Association Studies with Immune Response

- **Chromosome 23** contains the Bovine Major Histocompatibility Complex (BoLA)
  - Complex gene cluster responsible for regulating immunity in cattle
- Studies confirm the HIR measurements are hitting the correct target
- Show great potential for developing a genomic test for Immunity

Proven on Farm™

Methods

Extract Health Data

- Cows and heifers are controlled to ensure all groups (Immunity+, non-Immunity+, and Other (Non-Semex)) are of the same average age (Same pathogen exposure)

Fit Poisson Regression Model

- Model included effects of parity, herd, age and Immunity+ status (binary)

Calculate Immunity+ Effect

- Determine odds ratios and relative proportions across groups

Proven on Farm™ – 35 Commercial Dairies
(~30,000 Cows, ~75,000 Heifers)

HEALTH EVENT	IMMUNITY+ Prevalence	Non-Immunity+ Prevalence	Reduction
Mastitis	28.5%	31.7%	**10.0%**
Persistent Mastitis	4.4%	5.3%	**17.0%**
Lameness	21.1%	24.0%	**12.1%**
Miscellaneous Illness	5.9%	6.5%	**9.2%**
Mortality	4.8%	6.0%	**20.0%**
Heifer Pneumonia	9.6%	9.8%	**2.1%**
Heifer Diarrhea	5.4%	5.7%	**5.3%**
Heifer Mortality	7.7%	9.2%	**16.3%**

Larmer et al., 2017 – Cattle Practice

Proven on Farm™– 35 Commercial Dairies (~30,000 Cows, ~75,000 Heifers)

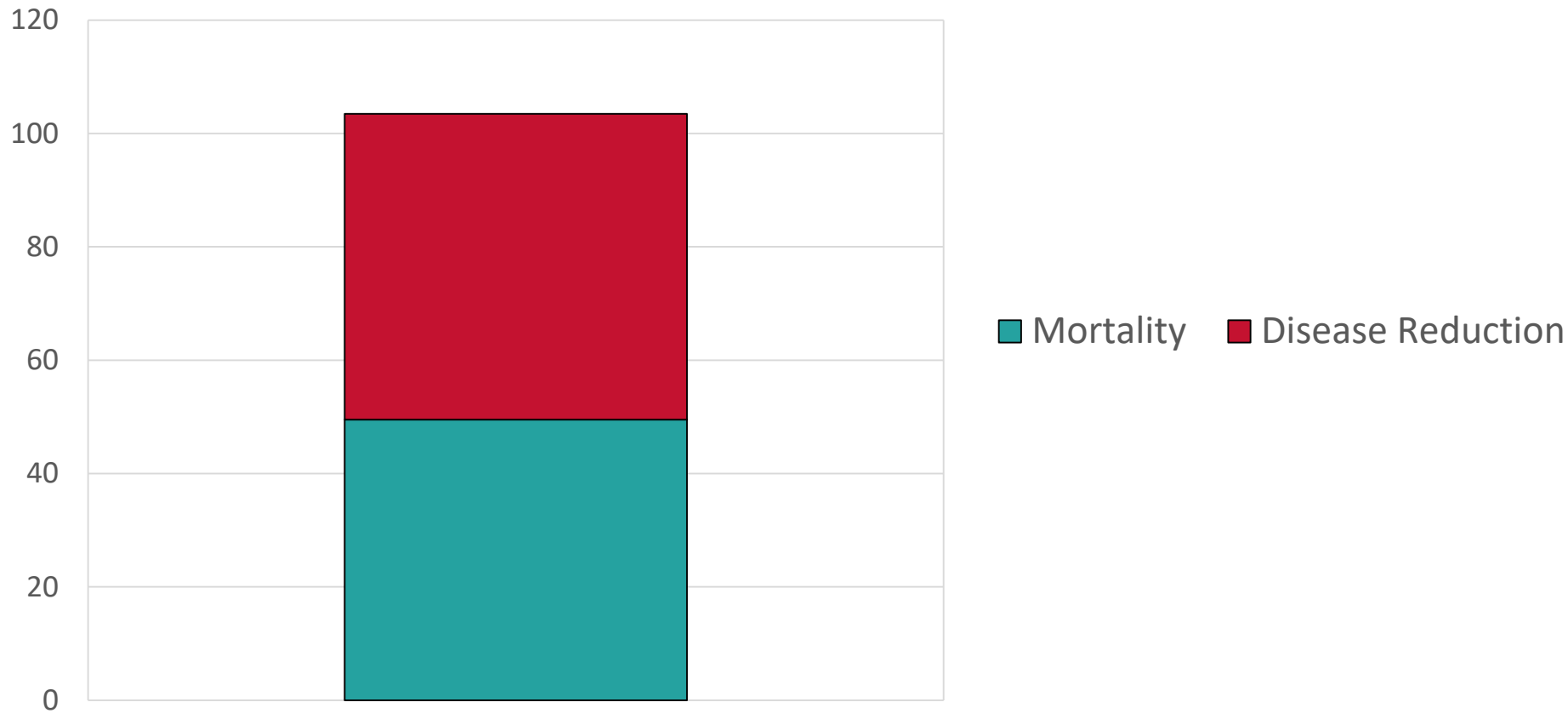
HEALTH EVENT	IMMUNITY+ Cost/1000 Cows	Non-Immunity+ Cost/1000 Cows	Reduction
Mastitis[1*]	$63,840	$71,000	**$7,160**
Lameness[1*]	$98,960	$112,560	**$13,600**
Miscellaneous Illness[1*]	$14,390	$15,860	**$1,470**
Mortality[1]	$105,600	$132,000	**$26,400**
Heifer Pneumonia[2]	$13,240	$13,520	**$280**
Heifer Diarrhea[3]	$5,720	$6,040	**$320**
Heifer Mortality[1]	$118,580	$141,680	**$23,100**
TOTAL	**Per Lactation*		**$72,330**

[1]Guard, C. *The costs of common diseases of dairy cattle – CVC in San Diego Proceedings*

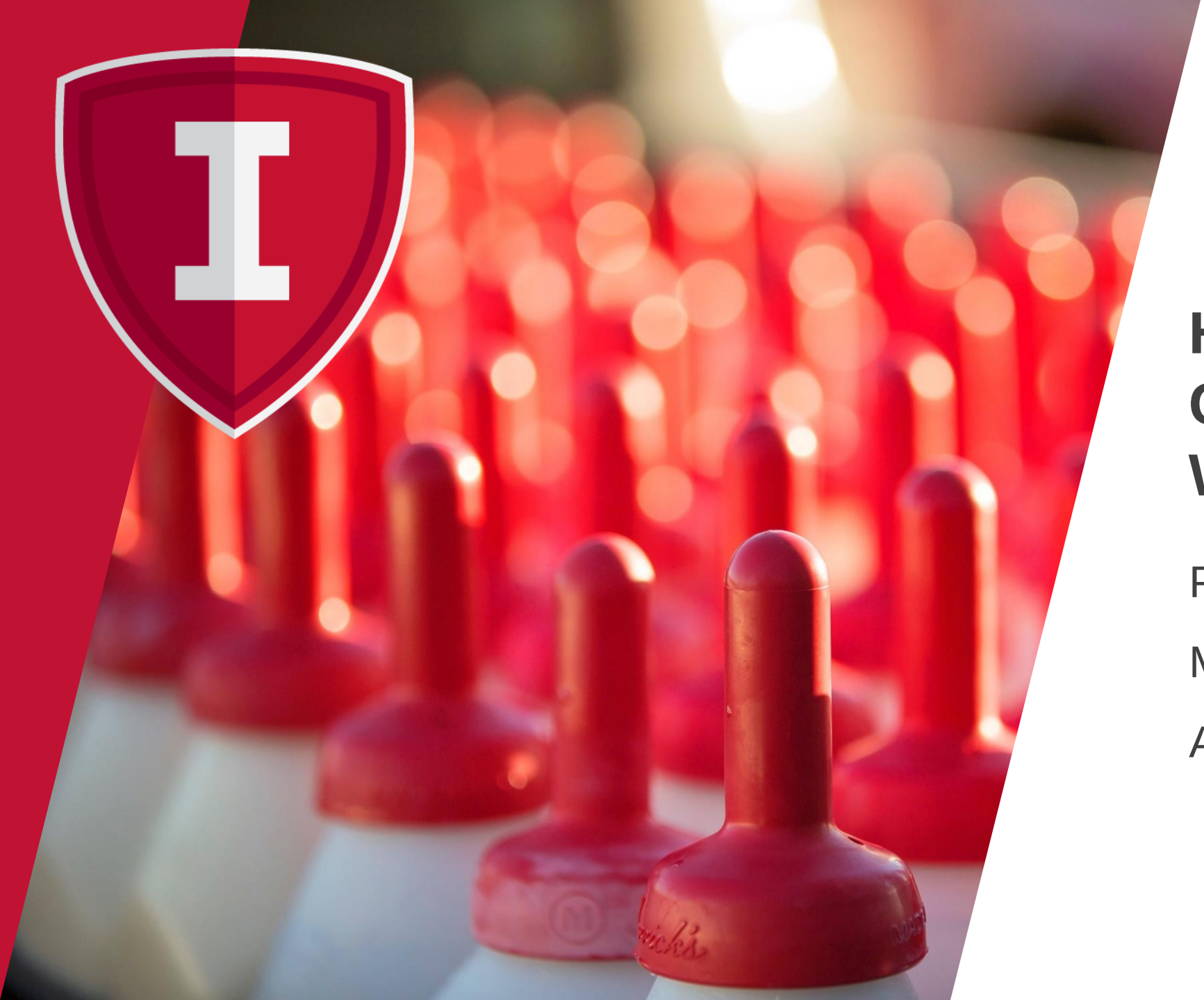
[2]*Pneumonia in heifer calves costs more than $100/head – Vet Times*

[3]Mohd, N et al. *Estimating the costs of rearing young dairy cattle… - Preventative Vet Med*

Total Economic Benefit



Total Lifetime Savings of $103,450 per 1,000 cows without considering increased colostrum quality and vaccine response



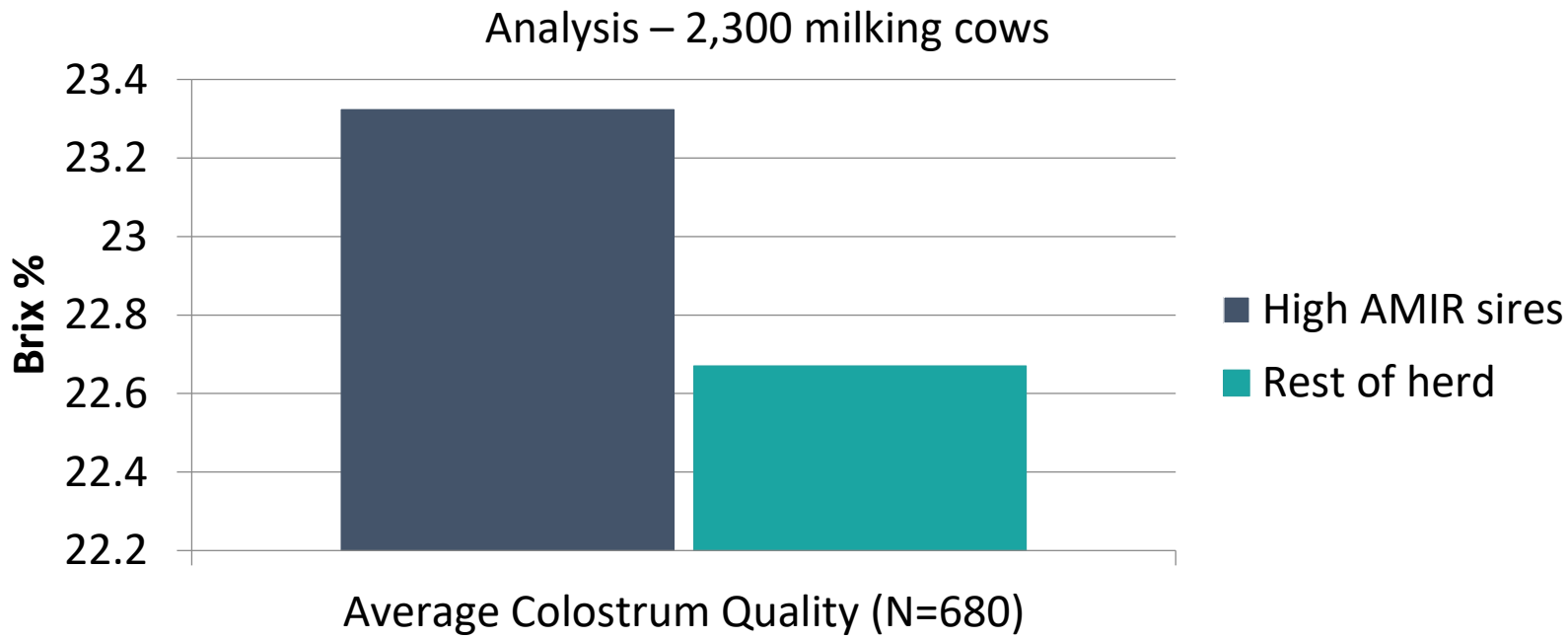
HIGH QUALITY COLOSTRUM WITH GENETICS

PROVEN RESULTS

MORE ANTIBODIES

A HEALTHY START

Proven on Farm™– Colostrum (2016)



Correlation between colostrum quality and overall immune response: **0.55**

High AMIR sires <22% = **0%** Rest of herd = **27%**

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A SEMEX EXCLUSIVE

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