




Research updates on genomics and fertility



USDA United States Department of Agriculture National Institute of Food and Agriculture Award # 2012-02115 NIFA-AFRI Translational Genomics for Improved Fertility of Animals

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Genomic Selection for Improved Fertility of Dairy Cows with Emphasis on Cyclicity and Pregnancy





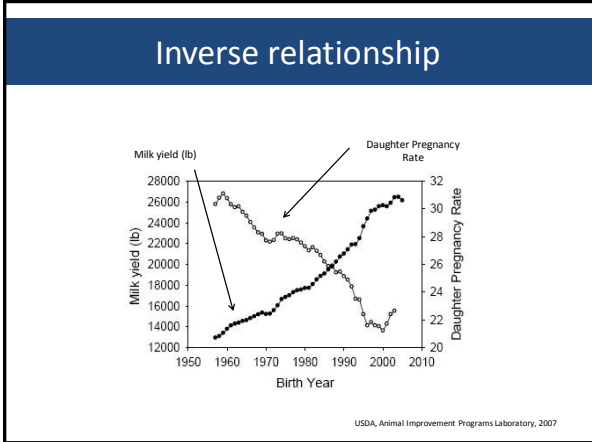
<http://agliflife.org/afri/dairycowfertility/>

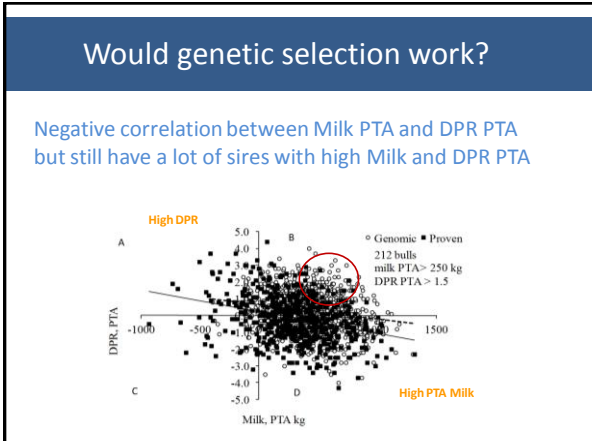
Limited Fertility

Failure to achieve and maintain a timely pregnancy:

- Increased breeding costs
- Increased avg DIM, decreased avg milk yield
- Increased culling for reproductive failure
- Delayed genetic progress
- Decreased profitability

 Norman et al., 2009; Santos et al., 2010; Galvao et al., 2013





Genomic Selection


Single Nucleotide Polymorphism (SNP) Markers

Sire 1 AGTCCATGGGGGTTGCAGAGTCAGACACAGTGGAGTCACACACATACACACGCTCTAA


Sire 2 AGTCCATGGGCGTTGCAGAGACAGACACAGTGGAGTCACACACATACAGACGCTCTAA

Sire 3 AGTCCATGGGGGTTGCAGAGACAGACACAGTGGAGTCACACACATACAGACGCTCTAA

Sire 4 AGTCCATGGGGGTTGCAGAGTCAGACACAGTGGAGTCACACACATACAGACGCTCTAA



Genomic Variation Associated with Phenotypic Traits



Pedigree: What is the inherited allelic combination?

Performance: Will take 2.5 years (female)

Genomics: A new player

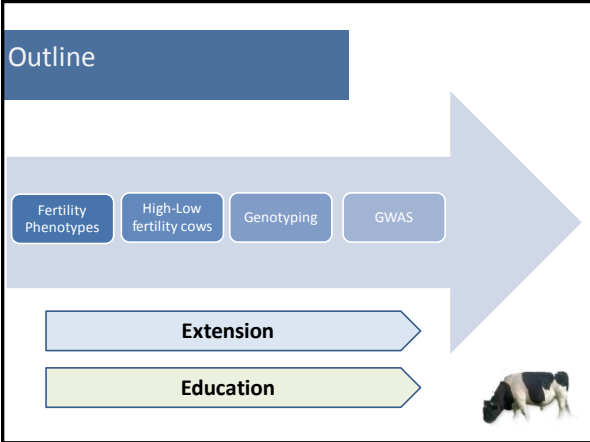
Progeny test: Will take 5 - 10 years

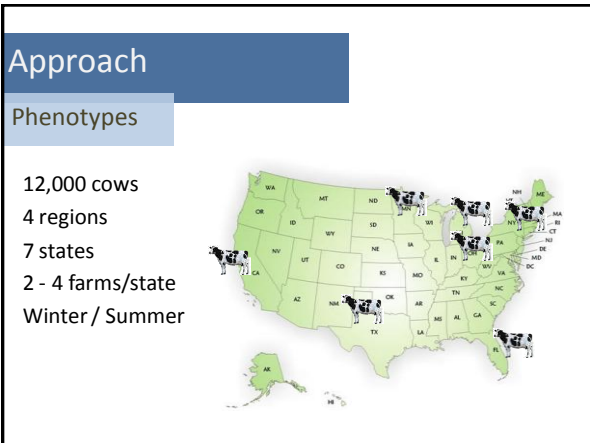
Genomic Evaluations

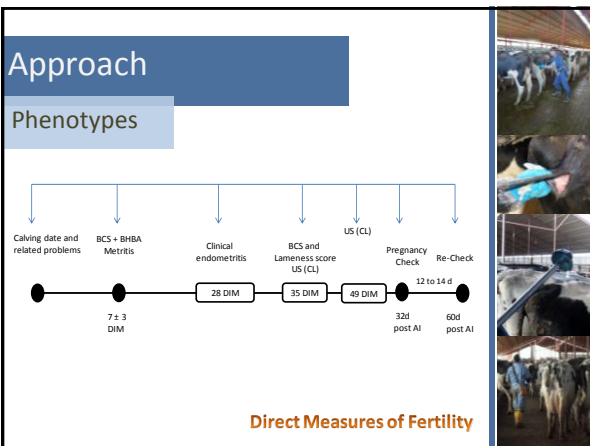
Different density for genotyping platforms (Chips)
SNP: 3k, 6k, 50k, 70k, 777k

Year	Females	Males
2007	~5,000	~2,000
2010	~15,000	~5,000
2013	~130,000	~15,000

Norman, 2014





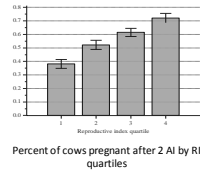


Approach

Cow selection

- **Reproductive Index (RI):**
Predicted probability that a cow will become pregnant after 2 AI as a function of the explanatory variables used in the logistic model

$$P(\text{pregnancy} | a, b) = \frac{e^{\hat{a} + bZ_i + mS}}{1 + e^{\hat{a} + bZ_i + mS}}$$

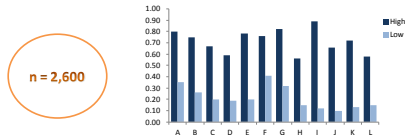


Approach

Cow selection

Subpopulations for extreme high and low fertility:

- **High-fertility cows** (n=1300): Pregnant cows on d 60 after first AI with the highest RI
- **Low-fertility cows** (n=1300): Non-pregnant cows on d 60 after two postpartum AI with the lowest RI



Approach

Genotyping

A high-density DNA analysis platform (777k) will be used to interrogate SNPs across our study population

```
AGTCCATGGGTTGCAGAGTCAGACACAGTGGAGTCACACATACACACGCTCTTAA
AGTCCATGGGTTGCAGAGTCAGACACAGTGGAGTCACACATACACACGCTCTTAA
AGTCCATGGGTTGCAGAGTCAGACACAGTGGAGTCACACATACACACGCTCTTAA
AGTCCATGGGTTGCAGAGTCAGACACAGTGGAGTCACACATACACACGCTCTTAA
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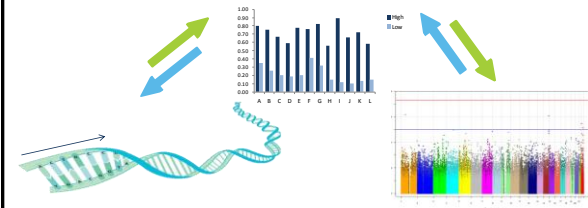
Bovine Genome:
3,000,000,000 bp



Approach

Bioinformatics

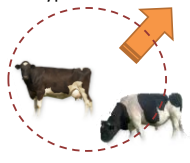
A GWAS will be conducted to detect genomic regions contributing to the variation of each phenotypic trait and the RI



Approach

Bioinformatics

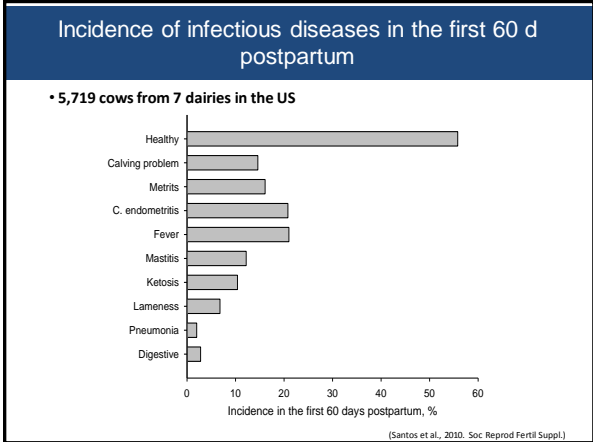
- A SNP-based gene-set enrichment analysis will be applied for the identification of **candidate genes**
- Genomic-estimated breeding values (**GEV**) will be developed for RI and other available phenotypes



Contributing Factors

- Peripartum is characterized by:
 - Decrease in DMI
 - High stress/calving
 - Low glucose
 - High fat mobilization
 - High ketosis
 - Low calcium
 - Immunosuppression
 - High incidence of Dz





Disease and Pregnancy 35d

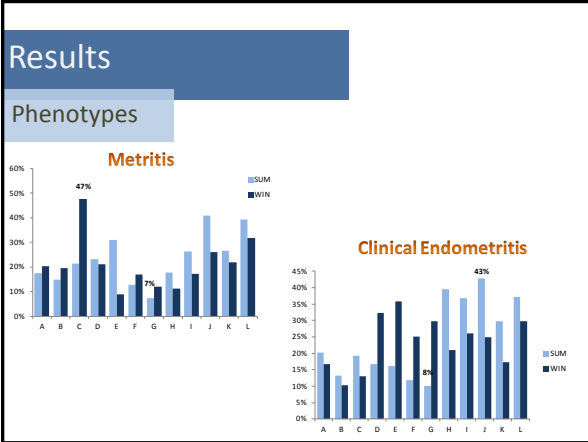
Health status	CR, %	Adjusted OR (95% CI)	P
Healthy	51.4	1.00	
1 case of disease	43.3	0.79 (0.69 – 0.91)	0.001
> 1 case of disease	34.7	0.57 (0.48 – 0.69)	<0.001
Type of health problem			
Calving problem	40.3	0.75 (0.63 – 0.88)	< 0.001
Metritis	37.8	0.66 (0.56 – 0.78)	< 0.001
Clinical endometritis	38.7	0.62 (0.52 – 0.74)	< 0.001
Fever postpartum	39.8	0.60 (0.48 – 0.65)	< 0.001
Mastitis	39.4	0.84 (0.64 – 1.10)	0.20
Clinical ketosis	28.8	0.50 (0.36 – 0.68)	< 0.001
Lameness	33.3	0.57 (0.41 – 0.78)	< 0.001
Pneumonia	32.4	0.63 (0.32 – 1.27)	0.20
Digestive problem	36.7	0.78 (0.46 – 1.34)	0.38

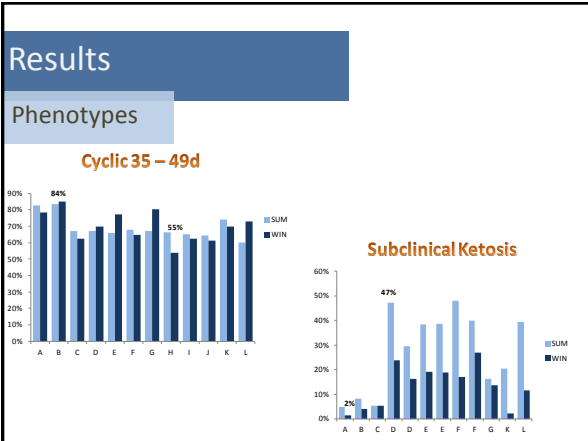
(Santos et al., 2010. Soc. Reprod Fertil Suppl.)

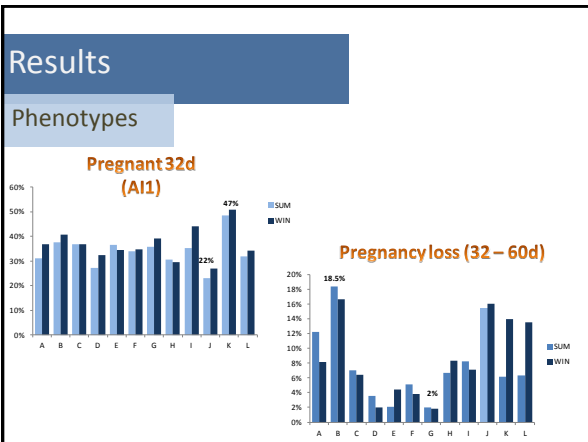
Disease and Pregnancy Loss 35-70d

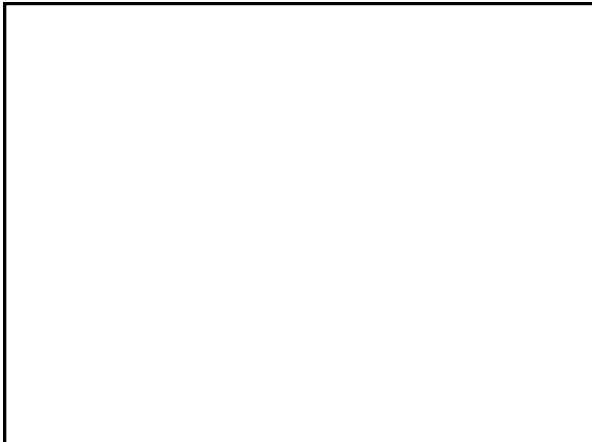
Health status	Loss, %	Adjusted OR (95% CI)	P
Healthy	8.9	1.00	---
1 case of disease	13.9	1.73 (1.25 – 2.39)	< 0.001
> 1 case of disease	15.8	2.08 (1.36 – 3.17)	< 0.001
Type of health problem			
Calving problem	15.9	1.67 (1.16 – 2.40)	< 0.01
Metritis	11.3	1.01 (0.71 – 1.60)	0.76
Clinical endometritis	15.1	1.55 (1.04 – 2.32)	0.03
Fever postpartum	18.0	2.00 (1.24 – 3.14)	< 0.01
Mastitis	19.8	2.62 (1.48 – 4.64)	< 0.001
Clinical ketosis	14.6	1.64 (0.75 – 3.59)	0.22
Lameness	26.4	2.67 (1.38 – 5.12)	< 0.01
Pneumonia	16.7	1.87 (0.40 – 8.69)	0.42
Digestive problem	15.8	1.81 (0.52 – 6.32)	0.35

(Santos et al., 2010. Soc. Reprod Fertil Suppl.)









Disease Repeatability

Disease/Disorder Lact 1	Level	Disease/Disorder Lact 2	P
Dystocia	Yes	37%	<0.01
	No	24%	
Twins	Yes	5%	<0.02
	No	2%	
Stillbirth	Yes	6%	0.12
	No	3%	
RP	Yes	13%	0.01
	No	6%	
Milk fever	Yes	39%	<0.01
	No	3%	
Metritis	Yes	20%	<0.02
	No	10%	
Ketosis	Yes	42%	0.01
	No	17%	
DA	Yes	11%	0.06
	No	2%	

(Vieira-Neto et al., 2015. ADSA Abstr.)

Disease Heritability

Disease/Disorder	Heritability (SE)
Cyclicity by 45 DIM	0.23 (0.15)
Sick within 45 DIM	0.29 (0.19)
Preg after 2 AI	0.58 (0.19)
DO	0.19 (0.13)
BCS 7 DIM	0.25 (0.16)
BCS 35 DIM	0.25 (0.18)

(Gonzalez-Pena et al., 2015. ADSA Abstr.)

Thanks!!!



Hanje Meyer Beacon 9792 **33,665 kg** (74,064 pounds) in 365 d

Sweetwater Dairy LLC, Madison, WI
120-cow herd, RMA 25,000 lb.
Peak yield of 264 lb.
9 recordings over 200 lb.



Gillette E Smurf - **216,891 kg** (478,163 pounds) at 15 yrs of age

450 cow-dairy, Embury, Ontario, CAN.
Avg 100 lbs for 20 lactations.
Mom produced 140,000 kg.
Daughter already produced 70,000 kg by the age of 9.
