Session 3—Schutz, M.M. mschutz@purdue.edu

Genetic selection for optimal milk yield and quality in US grazing systems

European Association of Animal Production

Michael M. Schutz,
Professor of Animal Sciences
Dept. Animal Sciences

27 August, 2012

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Overview

- Grazing systems in US
- Milk quality
- Genotype x Environment interaction
- Grazing merit index

US dairy operations by type

Source: USDA-APHIS, 2007

a. Percentage of operations (and percentage of cows on these operations), by operation type				
Operation Type	Percent Operations	Standard Error	Percent Cows*	Standard Error
Conventional	63.9	(1.4)	82.2	(0.9)
Grazing	3.1	(0.6)	1.7	(0.4)
Combination of conventional and grazing	31.1	(1.3)	14.9	(0.8)
Organic	1.7	(0.4)	1.2	(0.3)
Other	0.2	(0.1)	0.0	(0.0)
Total	100.0		100.0	

*As a percentage of January 1, 2007, cow inventory.

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US dairy operations by type &

Source: USDA-APHIS, 2007

c. Percentage of operations by operation type and by region

	Percent Operations			
	Region			
	West		East	
Operation Type	Percent	Std. Error	Percent	Std. Error
Conventional	72.4	(2.9)	63.2	(1.4)
Grazing	8.0	(2.4)	2.7	(0.6)
Combination	15.8	(2.0)	32.4	(1.4)
Organic	3.8	(1.3)	1.5	(0.4)
Other	0.0	(0.0)	0.2	(0.1)
Total	100.0		100.0	

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Typical advantages - Grazing Vs. Confinement dairying

Grazing	Confinement
• Lower facility and equipment costs • Lower feed/feed handling costs • Lower manure management costs • Better consumer perception • Higher levels of CLA (Conjugated Linoleic Acid) • Lower incidence of mastitis and ketosis • Decreased lameness • Organic market access	• Greater milk production per cow • Farm can operate on less owned land • Smaller carbon footprint per unit of output (Capper et al., 2009) • More controlled environment (shade, cooling, ventilation, insects, cleanliness) • Enhanced opportunities for cow grouping

There are many milk "QUALITY" criteria

- Fat yield
- Protein yield
- SCC
- Bacteria count
  - SPC
  - PI
  - LPC
- Blood in milk
- Cryoscope
- Antibiotic residue
- Sediment
- Iodine levels
- Specific proteins
- Fatty acid composition

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There are many milk "QUALITY" criteria

- Fat yield
- Protein yield
- SCC

Presently useful in genetic evaluation

- Bacteria count
  - SPC
  - PI
  - LPC
- Blood in milk
- Cryoscope
- Antibiotic residue
- Sediment
- Iodine levels
- Specific proteins
- Fatty acid composition

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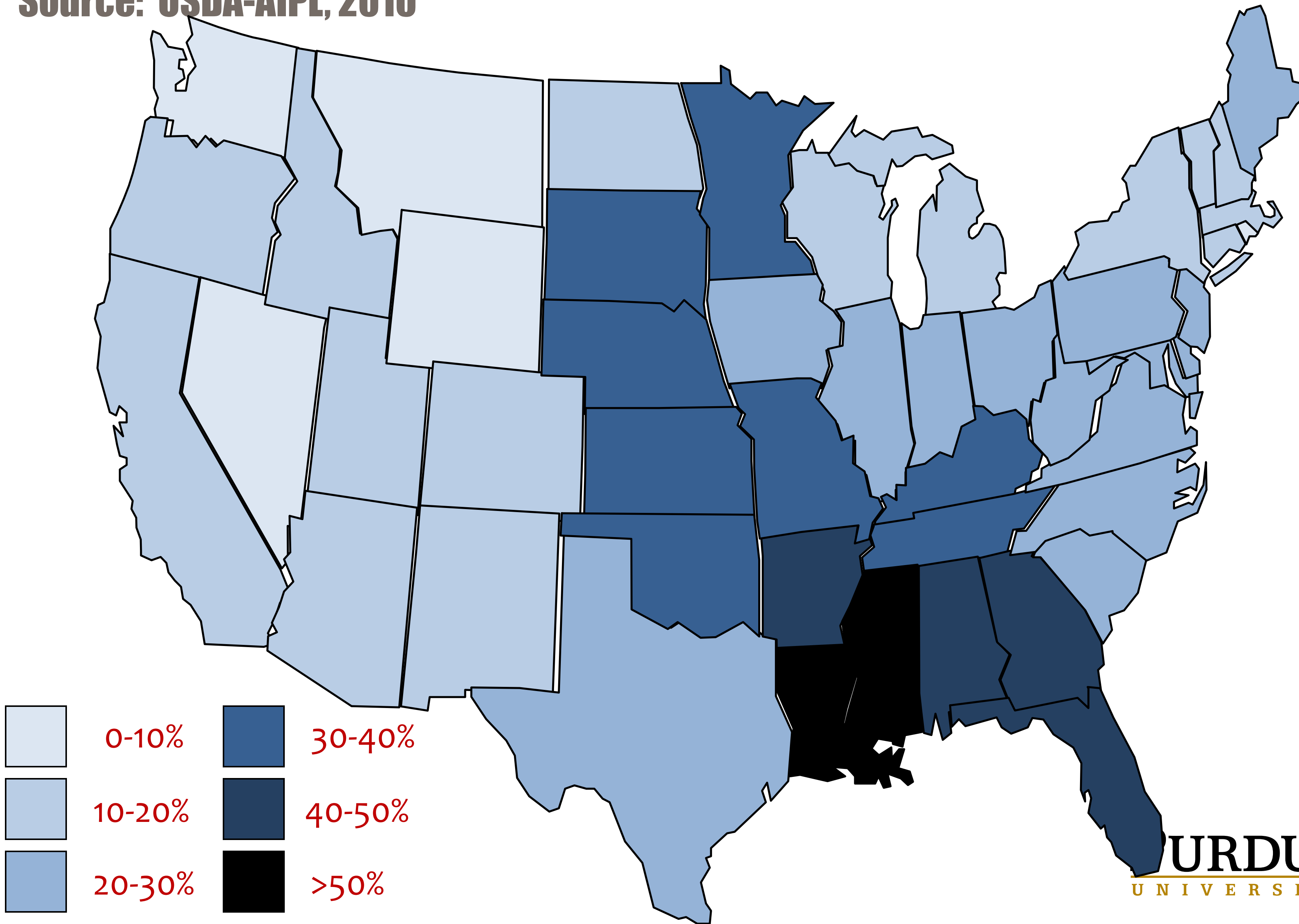
Percentage of herd test days over 400,000

Source: USDA-AIPL, 2010



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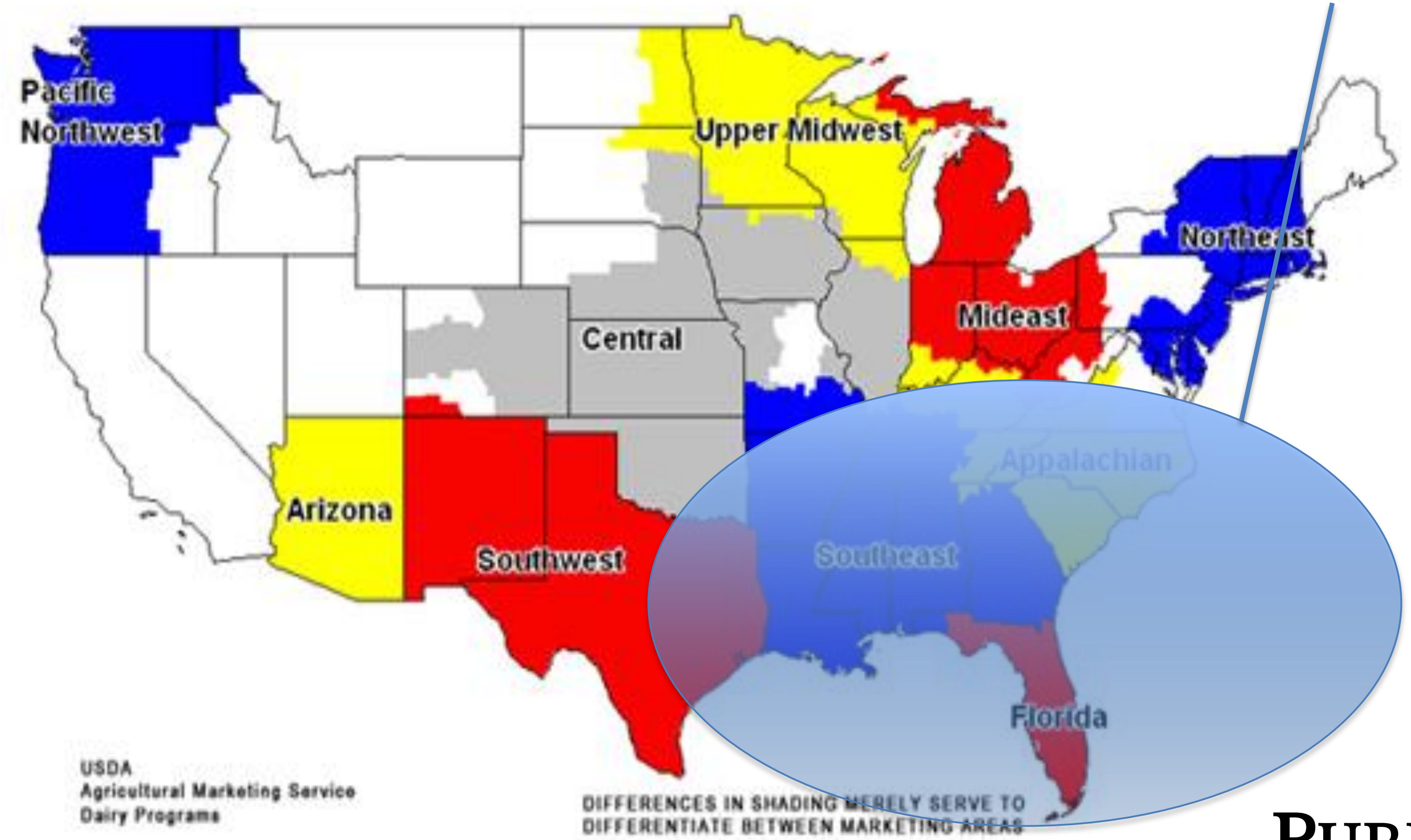
Federal Milk Market Orders

Source: USDA-AMS, 2010

No payment for protein content of milk so little incentive to increase.



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Genotype x Environment interaction

Do bulls rank differently (genetically) based on the performance of their grazing daughters compared to their confinement daughters?

Or

Are the same genes expressed in both environments and does the environment influence how the genes are expressed?

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Three cases of G × E

1. **There is no G × E!**
   – Sires rank identically based on daughters in 2 environments
2. **Re-ranking of the sires between the two environments may exist.**
   – Different genes may regulate the expression of a trait in the two environments
   – Genetic correlation is less than unity (<.80)
3. **There may be a scaling effect.**
   – The sire's rank is the similar, but the advantage of the higher ranking sires is reduced in the less favorable environment

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Purdue and Guelph (Canada)

- DHIA records of cows in 353 grazing herds in 15 Eastern US states and 22 herds in 2 Canadian provinces.
- Similar number of control herds.
- Requested herds that obtained at least 50% of forage from pasture for 6 months.

Heritabilities and genetic correlations for production under grazing or confined feeding in US and Canada.

	Heritability		Correlation
Trait	Grazing	Control	G vs C
Milk	19%	20%	+.89
Fat	19%	23%	+.88
Protein	17%	20%	+.91
SCS	13%	14%	+.89
Canada			
Milk	31%	37%	+.93
Fat	35%	39%	+.89
Protein	30%	36%	+.94
Udder score	13%	21%	+1.00

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Summary

- Bulls rank similarly for PTA in both environments for the individual traits we considered.

How well do sire PTA's predict cow performance in grazing vs. confined herds?

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Coefficients of regression of daughter performance on PTA for ME Milk and SCS

Quartile for Milk	ME Milk	LSCS
Grazing		
0 – 25%	0.542 (0.093)**	0.961 (0.131)
26 – 50%	0.811 (0.062) **	0.846 (0.081)
51 – 75%	0.820 (0.056) **	0.901 (0.069)
76 – 100%	0.816 (0.058) **	0.816 (0.066) **
Confinement		
0 – 25%	0.904 (0.063)	0.979 (0.078)
26 – 50%	0.884 (0.052) *	1.096 (0.061)
51 – 75%	1.033 (0.051)	0.923 (0.059)
76 – 100%	1.007 (0.064)	0.957 (0.067)

* Significantly different from 1 (P <0.05).
** Significantly different from 1 (P <0.01).

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Summary

- Bulls rank similarly for PTA in both environments for the individual traits we considered.
- Actual PTA values may overstate the true difference between bulls' daughters in grazing herds (scaling effect).

PTA difference:

500 lbs.

Grazing, perhaps:

395 lbs.

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- **How graziers value individual traits and their combinations may be critically important.**

Approach 1: Survey

- Survey mailed to 1,300 graziers
- Addresses from Extension cooperators, NRCS advisors, and commercial companies
- 120 surveys accounted for
  - 80 farmers
  - 23 states
- Producers asked to rank traits for amount of genetic selection pressure they felt should be applied to those traits.
- Traits were ranked from negative 5 (selection strongly for) to positive 5 (selection strongly against).

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Ranking of genetic selection trait preferences by graziers

Trait	Mean rankings[1]	Relative ranking
Milk	2.23	0.0741
Fat[2]	2.88	0.0957
Protein[2]	2.67	0.0888
Productive life	3.83	0.1271
Somatic cell score[3]	-3.18	0.1055
Body size[3]	-2.66	0.0884
Udder composite	3.56	0.1185
Feet and leg composite	3.16	0.1052
Calving ability	2.97	0.0988
Daughter pregnancy rate	2.95	0.0980

[1] Traits were evaluated on a scale from -5 (strong selection against) to +5 (strong selection for)
[2] Rankings for yield and percentage were averaged
[3] Traits were determined to have a negative response for all values regardless of indication

Economic and relative selection index weights for Grazing Merit and Lifetime NM$.

	Economic Value		Relative Value (%)	
Trait	GM	NM$	GM	NM$
Milk	0.04	0.00	7	0
Fat	1.44	2.89	10	19
Protein	1.90	3.41	9	16
Productive life	20.86	35.00	13	22
Somatic cell score	-186.57	-182.00	-11	-10
Body size	-34.91	-23.00	-9	-6
Udder composite	53.55	32.00	12	7
Feet and leg composite	41.54	15.00	11	4
Calving Ability	2.01	1.00	10	5
Daughter pregnancy rate	23.45	27.00	10	11

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Approach 2: Adjust Lifetime Net

Objective

To evaluate the suitability of NM$ for grazing production by replacing the input values found in the net merit equations with values more relevant to grazing production.

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Differences in key input values

	NM$	GM1$
• **Cull Price**	**0.5281**	**0.5460**
• **Death Rate**	**0.2005**	**0.1980**
• **Calf Value (calfval)**	**250.00**	**350.00**

Note: the slide lists each item as a bullet with its values, followed by a description line:

- **Cull Price** — Updated price based on average beef price of most recent 5 years.
- **Death Rate** — Reduced slightly to reflect increased survivability for grazing animals.
- **Calf Value (calfval)** — Raised to reflect bull calf worth due to prevalence of natural service.

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Differences in key input values

	NM$	GM1$
• **Fixed Replacement Cost**	**396.00**	**68.18**

Changed to reflect data included in Schroeder article on cost of raising replacement heifers

	NM$	GM1$
• **Somatic Cell Cost**	**18.00**	**13.79**

Altered based on 2008 Cornell Dairy Farm Business Summary for Intensive Grazing Farms – 77% of value

	NM$	GM1$
• **Mean for Productive Life (mean PL)**	**29.16**	**45.00**

Based on proceedings of 2009 Western Veterinary Conference

Differences in key input values

	NM$	GM1$
• **Mean for body weight**	**1500.00**	**1300.00**

Adjust to account for decrease in body size due to producer preference for smaller cows and cross-breeding

• **DPR Value**	**8.50**	**13.80**

Altered based on increase in the number of lactations for grazing animals

Additional change to reflect the increased importance of DPR in seasonal calving situations

Additional trait

Dairy Form

- **Grazing producers prefer smaller but durable cattle**

- **Added to offset loss in strength occurring as correlated response to selection against body size composite**

- **Calculated based on the correlation of dairy form with strength and adjusted for the percentage of body size composite that is appropriated to strength**

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Net Merit $ versus Grazing Merit $

Weights expressed as percentage of index

Trait	NM$	GM$1	GM$2
Milk Yield	0	0	24
Fat Yield	19	21	16
Protein Yield	16	17	4
Udder Composite	7	8	7
Somatic Cell Score	-10	-9	-8
Feet & Leg Composite	4	4	4
Daughter Pregnancy Rate	11	20	18
Body Size Composite	-6	-4	-3
Productive Life	22	8	7
Calving Ability$	5	3	3
Dairy Form	-	-6	-6

Rank correlations among active AI bulls

	NM$	CM$	FM$	GM$1	GM$2
NM$	1.00	0.98	0.97	0.98	0.93
CM$		1.00	0.90	0.97	0.86
FM$			1.00	0.94	0.96
GM$1				1.00	0.94
GM$2					1.00

Conclusions

1. **Little evidence for reranking of sires for milk yield and milk quality traits in grazing vs conventional systems, but apparent scaling effect present.**
2. **Probably not adequate to justify separate sire lineups, even with reduced cost of sire sampling through genomics**
3. **Need to make use of traits presently available on bulls whose daughters have records**
4. **Selection for milk quality equally important for graziers**
5. **Precedence exists for new indexes despite, correlations that are equal to or higher than those between NM$ and GM$1 and GM$2**