

Using Genomics To Pick High Hanging Fruit: Integrated Projects Update

Matt Spangler
University of Nebraska-Lincoln

“New Traits” In the Genomic Era

- Healthfulness of beef
- Disease susceptibility
- Reproduction
- FEED INTAKE AND EFFICIENCY

The Participants



The Project

- Up to 5 Year/\$5M USDA NIFA funded project
 - April 1, 2011 to March 31, 2016
 - 2/3 fundamental and applied research
 - 1/3 extension and outreach
- Demonstration project involves 24 collaborating producers and a commercial feedlot

The Project

- Research objectives to improve beef cattle feed efficiency:
 - Genotyping will included high density (700 K) SNP or imputed from 50K
 - Develop national across-breed genomic selection program
 - Identify nutritionally driven (forage-concentrate) interactions

The Project

- Research objectives to improve beef cattle feed efficiency:
 - Evaluate the genetics of microbial population establishment and the effects on efficiency
 - Identify genes controlling metabolism
 - Efficiency differences associated with mitochondrial and nuclear genomes
 - Detailed evaluation of high and low RFI cattle, including a repository of tissues for future analysis

Cattle Production & Genotyping

Breed	SNP50	HD	#Animals	#SNP ¹	2013 Animals ²	2013 Projected ³	Total Animals
Angus	1,093	573	1,666	747,473	326		1,992
Charolais		24	24	N/A	13		37
Charolais x Ang						450	450
Commercial Crossbred					212		212
Gelbvieh x Ang		317	317	N/A			317
Hereford	368	502	870	684,458	275	200	1,345
Limousin		39	39	568,501	45	45	129
Normande							3
Pied x Ang x Simm					236		236
Red Angus		155	155	694,847	94		249
Red Angus x Ang		158	158	N/A			158
Simm x Ang	2,251	467	2,718	680,184		909	3,627
Wagyu	27	19	46	N/A		120	166
Total	3,789	2,254	5,993		1,204	1,724	8,921

¹Imputed using Beagle²SNP50 genotyped³Doesn't include data swap with TEASUG, Canadian Feed Efficiency Consortium or Genus collaboration

Four Data Sets (N=5,021)

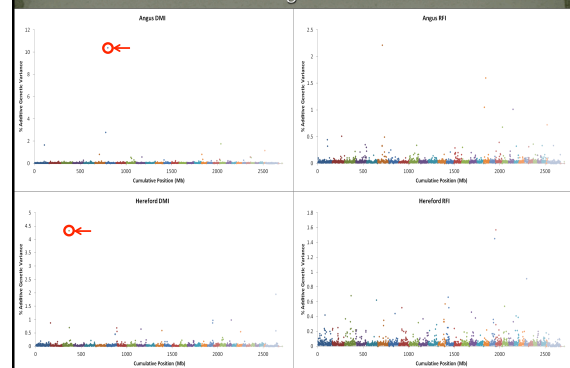
- Hereford Cattle fed at Olsens (HD)
 - 847 animals in 10 contemporary groups
- F1² composites fed at USMARC (50K)
 - 1,160 animals in 15 contemporary groups
- Legacy Simmental cattle fed at Illinois (HD)
 - 1,444 animals in 202 contemporary groups
- Legacy Angus fed at Circle A (HD) and Angus fed at MU
 - 1,580 animals in 102 contemporary groups

Heritabilities

Breed	DMI (lb)			MMWT (lb ³ /y)			ADG (lb/d)			RFI (lb/d)		
	VA	VE	h ²	VA	VE	h ²	VA	VE	h ²	VA	VE	h ²
Hereford	3.2	4.6	0.41	79	78	0.50	0.09	0.23	0.27	1.60	1.90	0.45
USMARC	1.9	3.4	0.35	84	97	0.47	0.07	0.16	0.30	0.91	0.94	0.49
Simmental x Angus	1.4	3.7	0.27	28	36	0.48	0.04	0.13	0.23	0.96	2.02	0.32
Angus	4.1	7.5	0.35	125	130	0.49	0.06	0.24	0.19	1.30	4.80	0.21

- Additive genetic variance tends to be lower in composite animals
- Larger residual variance for Angus (and lower heritability) could reflect feeding at two different locations using Calan Gates versus GrowSafe systems

GWAS of DMI and RFI in Angus and Hereford



Results Summary

- Additive genetic variance similar between Angus and Hereford
- Lower heritability might reflect feeding locations and systems
- Largest effect QTL appear to differ between Angus and Hereford

Visualization Aids in Technology Adoption

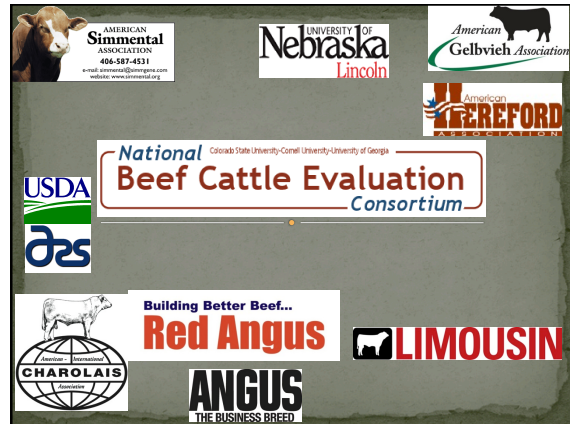
- Since the release of EPD to the beef industry some 30 years ago use is still lacking despite the efforts of many



$$\begin{bmatrix} \mathbf{X}\mathbf{R}^T\mathbf{X} & \mathbf{X}\mathbf{R}^T\mathbf{Z} \\ \mathbf{Z}\mathbf{R}^T\mathbf{X} & \mathbf{Z}\mathbf{R}^T\mathbf{Z} + \mathbf{A}^{-1}\mathbf{0}\mathbf{G}_0^{-1} \end{bmatrix} \begin{bmatrix} \mathbf{b} \\ \mathbf{a} \end{bmatrix} = \begin{bmatrix} \mathbf{X}\mathbf{R}^T\mathbf{y} \\ \mathbf{Z}\mathbf{R}^T\mathbf{y} \end{bmatrix}$$

Weight Trait Project

The WTP is an organized effort to facilitate DNA technology transfer and while at the same time providing a national focus for integration of molecular information into beef genetic evaluation and selection.



Survey—USDA NAAS

- 7,500 surveys, 55 questions
 - 868 returned
 - 467 used
 - **59.9% commercial**
 - 11.5% seedstock
 - 12% both
 - 13.3% stockers
 - 3.2% feedlot

Knowledge of Feed Efficiency

- 32.6% chose the correct definition for feed-to-gain
- 16.4% of producers had heard the term residual feed intake (RFI)
- 14.3% of producers were familiar with residual average daily gain (RADG).
- How to improve feed efficiency?
 - A majority (54.8%) identified genetic improvement of rate of gain
 - Improved diet formulation was identified 40.6%,
 - Feed additives such as ionophores or beta-agonists 28.4%,
 - Growth promoting implants 35.2%
 - ~50% of producers did not know the consequence of selection for increased average daily gain on the cowherd
 - 13.4% suggested no harmful effects

Willing to Pay?

- Producers were asked how much more they would be willing to pay for a bull if a reliable method of evaluation were available to document its genetic merit for feed efficiency.
 - 23% producers indicated that they would not pay any more for a bull
 - 13.6% indicated they would increase their purchase price by more than US\$500
 - 11.8% indicated an increase of US\$201-\$300
 - 10.5% would increase their bid by US\$101-\$200.

Knowledge of Genomics

- 62% responded that they did not know what class of traits should benefit the most from marker assisted selection.
- 13.1% responded correctly that this class includes traits which are difficult and/or expensive to measure and that have significant costs or returns associated with them.
- More than two-thirds of producers could not identify what was the primary benefit of adding molecular breeding value data to EPD calculations.
 - Only 20.8% cited increase in EPD accuracy as the correct answer.

Importance over last 5 years

- A large majority (81.4%) of producers identified calving ease/birth weight
- Reproduction (65.2%),
- Growth traits (64.3%),
- Temperament (63.3%),
- Milk (51.5%),
- Lifetime productivity (36.0%),
- Maintenance efficiency (31.5%),
- Feed efficiency (30.3%).
- Average daily gain was most frequently identified (41.7%) by commercial producers as the selection criterion that they use to improve feed efficiency.

Moving Forward

- During the coming five years, producers identified calving ease/birth weight (69.3%), growth traits (66.1%), reproduction (65.8%), temperament (58.5%), milk (47.5%), lifetime productivity (42.4%), feed efficiency (36.7%), and maintenance efficiency (31.1%).

Grants are a platform

- Continued collection of phenotypes is critical
 - Training
 - Re-training
 - Phenotypes needed to improved accuracy past PA+MBV
- Who we collect phenotypes on is also important

Selection based on economics

- Selection must be towards increased profit.
- Selection index approach.
 - DMI can fit as critical input into current revenue based terminal index values

