National Program for the Genetic Improvement of Feed Efficiency in Beef Cattle: Aims and Current Results

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Why Improve Efficiency?

- A feed efficiency improvement of approximately 10% (2 pound reduced RFI) across the entire feedlot sector would reduce feed costs $1.2 Billion in 2011 (Weaber, 2011)
- Fewer resources used = improved global food security
- "Efficiency" = Output/Input or visa versa
  - Inherent multiple-trait selection

Poultry Improvement
250% improvement in efficiency since 1957

The Participants

University of Missouri · Illinois · Iowa State University · Washington State University · University of Nebraska Lincoln · K-State Research and Extension · GeneSeek · USDA · VETERINARY MEDICINE & BIOMEDICAL SCIENCES

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USDA United States Department of Agriculture National Institute of Food and Agriculture

20 investigators 10 institutions

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

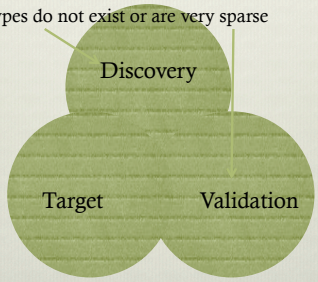
- **Research objectives to improve beef cattle feed efficiency**:
  - Genotyping will included high density (700 K) SNP or imputed from 50K
  - Develop national across-breed genomic selection program
  - Identify nutritionally driven (forage-concentrate) interactions

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

Why didn't we start with these traits?

Phenotypes do not exist or are very sparse



USDA FE Project

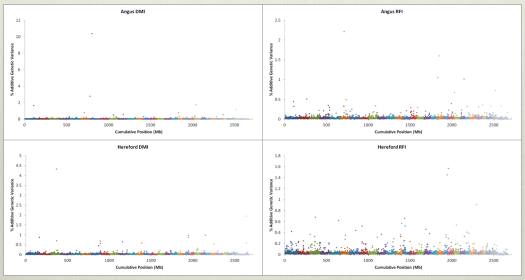
Breed	SNP50	HD	#Animals	#SNPs[1]	2013 Animals[2]	Total Animals[2]
Angus	1,093	510	1,603	747,473	435	2,038
Charolais		24	24	N/A		24
Charolais×Ang					450	450
Commercial Xbred					220	220
Gelbvieh		369	369	N/A		369
Hereford	361	491	852	684,458	300	1,152
Limousin		37	37	568,501	45	82
Normande					3	3
Pied×Ang×Simm	236		236	N/A		236
Red Angus		155	155	694,847	3	158
Simm×Ang	2,251	589	2,840	690,184	909	3,749
Wagyu		35	35	N/A	150	185
Total	**3,941**	**2,210**	**6,151**		**2,515**	**8,666**

1 Imputed from 50K
2 Additional Resources include potential international collaborations

HD (770K) Results for Angus and Hereford

- US Consortium for the Genetic Improvement of Feed Efficiency in Beef Cattle

Breed	Trait	σ^2_G (lb^2)	σ^2_E (lb^2)	h^2	Largest QTL % σ^2_G	Largest 10 QTL % σ^2_G
Angus (N=1579)	DMI	4.12	7.51	0.35	10.39	21.02
	RFI	1.30	4.76	0.21	2.21	9.11
Hereford (N=847)	DMI	3.23	4.57	0.41	4.33	12.58
	RFI	1.57	1.94	0.45	1.57	8.04



Results Summary

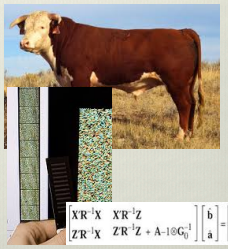
- Additive genetic variance similar between Angus and Hereford
- Lower heritability might reflect feeding locations and systems
- Largest effect QTL appear to differ between Angus and Hereford

Extension Program Goals

- Highly integrated with research component
  - Technology transfer
- Involves stakeholders early in the process
- Engages all segments of the industry
- Demonstrates progress in efficiency change by stakeholders by project conclusion
- Industry education component (tied to research results)

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



$$\begin{bmatrix} X'R^{-1}X & X'R^{-1}Z \\ Z'R^{-1}X & Z'R^{-1}Z + A\text{-}1\otimes G_0^{-1} \end{bmatrix} \begin{bmatrix} \hat{b} \\ \hat{a} \end{bmatrix} = \begin{bmatrix} X'R^{-1}y \\ Z'R^{-1}y \end{bmatrix}$$

Process

$$MBV = \sum_{i=1}^{s} x_i \hat{\beta}_i$$

Breed Specificity

(Kachman et al., 2013)

Breed	WW	YW
AN	0.36 (0.07)	0.51 (0.07)
AR	0.16 (0.16)	0.08 (0.18)

Across Breed Predictions

Pooled Training Data for REA

- If breeds are contained in training, predictions work well
- If not, correlations decrease

	Pooled Training (AN, SM, HH, LM)
AN	0.43 (0.07)
SM	0.34 (0.09)
HH	0.33 (0.08)
GV	0.17 (0.11)

BEEF EFFICIENCY

RESEARCH - EDUCATION - EXTENSION

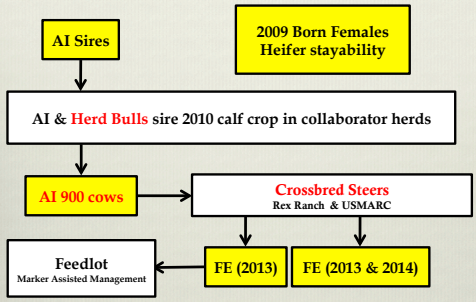
www.BeefEfficiency.org

Extension Field Project

- Field demonstration project will demonstrate utility of molecular EPD for FE and component traits and "test drive" the technology

In seedstock herds:

- 50K MA-EPD for WW, YW, and carcass in early years
- MA-EPD for feed intake/ efficiency in Y4

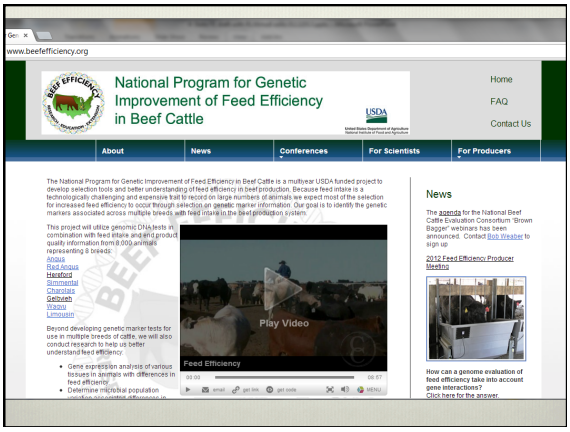


Marker assisted management

- Identify nutrition or management by genetic interactions
- Determine practical sources of information
  - Reduced panel tests
  - Genetic information
- Management based on genetic knowledge
  - Nutrition and management
  - Sorting into outcome or management groups

Industry Feedback

- Advisory board that includes demonstration project participants, plus representatives of feedlot sector.
- Will meet annually to give feedback.



Resources Today

- www.beefefficiency.org
- Conference presentations
- Annual June "WTP" meeting
  - Archived presentations
- Updates on NCBA's Cattlemen-to-Cattlemen
  - Three segments filmed in 2011 and 2012 archived on website
  - Additional segment planned for 2013
- NCBA Cattlemen's College (February 1,2012)
  - Presentations archived on website

To stay informed

Contact one of the team members, or

Click the **"Contact Us"** button on the website

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"New Traits" In the Genomic Era

- Healthfulness of beef
- Disease susceptibility
- Tenderness
- Adaptation
- FEED INTAKE AND EFFICIENCY
- The list will continue to grow
- INFORMATION OVERLOAD!

Summary

- We need to think about efficiency in terms of economic returns
- Index values will require both inputs (FI) and outputs (WT) along with body composition
- Genomics could play a large role here
  - Not fully brought to fruition
  - A genomics approach is robust to the definition of efficiency