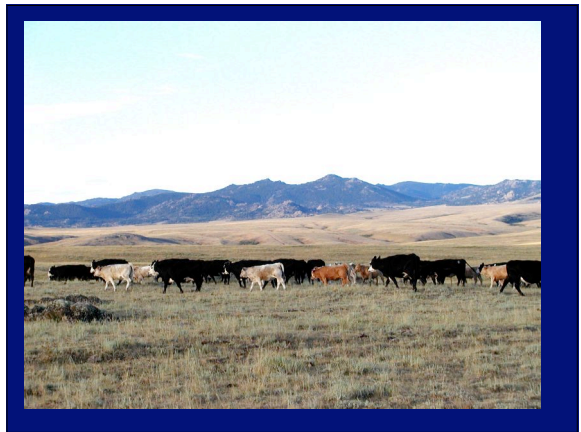UNITED STATES DEPARTMENT of AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
ARS NATIONAL PROGRAMS

"Today's Beef Cattle Genetics Research and Education Engine: *Ready and Primed for the Industry's Future?*

Ronnie D. Green
National Program Leader
Food Animal Production
USDA / ARS
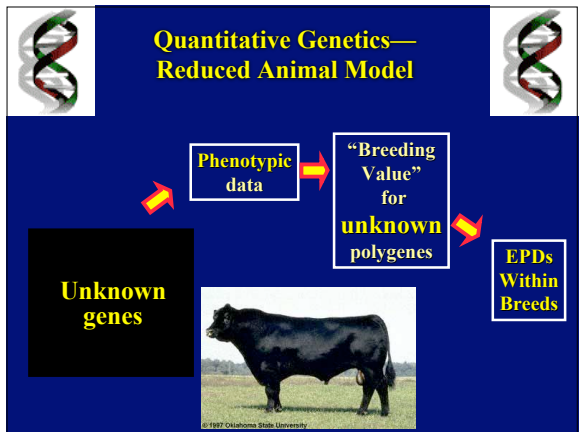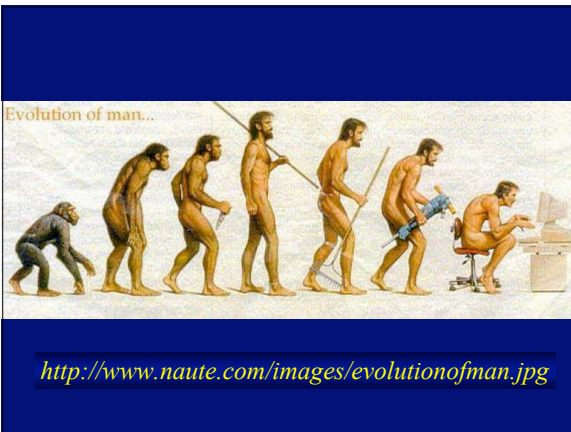

ANGUS
THE BUSINESS BREED
AMERICAN ANGUS ASSOCIATION
3201 Frederick Avenue • St. Joseph, MO 64506 • (816) 383-5100 • Fax (816) 233-9703 • E-mail: angus@angus.org

Late 1950s-Early 1960s

American **HEREFORD** ASSOCIATION

Whole Herd TR

BEEF IMPROVEMENT FEDERATION
Improving the beef industry through performance evaluation

January 1967
Denver, CO

Evolution of man...

http://www.naute.com/images/evolutionofman.jpg

Quantitative Genetics—Reduced Animal Model

Phenotypic data → "Breeding Value" for **unknown** polygenes → EPDs Within Breeds

Unknown genes

© 1997 Oklahoma State University

Slide 1:

AMERICAN ANGUS ASSOCIATION℠— THE BUSINESS BREED
3201 Frederick Avenue • St. Joseph, MO 64506 • (816) 383-5100 • Fax (816) 233-9703 • E-mail: angus@angus.org

Breed Average EPD and $Values - Spring 2007

	PRODUCTION						MATERNAL					CARCASS				ULTRASOUND			$VALUES			
	CED	BW	WW	YW	YH	SC	CEM	Milk	MW	MH	$EN	CW	Marb	RE	Fat	IMF	RE	Fat	$W	$F	$G	$B
Current Sires[1]	+5	+2.3	+39	+73	+.4	+.32	+6	+19	+32	+.5	+7.34	+5	+.14	+.14	-.001	+.08	+.18	+.003	+22.54	+17.25	+13.70	+29.15
Main Sires	+5	+2.3	+42	+78	+.3	+.37	+6	+20	+35	+.5	+5.93	+6	+.16	+.15	+.000	+.08	+.17	+.004	+23.45	+21.79	+12.63	+30.19
Supplemental Sires	+5	+2.0	+43	+80	+.4	+.41	+7	+22			+3.50	+7	+.23	+.21	-.001	+.15	+.30	+.006	+24.58	+23.40	+14.91	+34.54
Current Dams[1]	+3	+2.4	+35	+63	+.4	+.19	+5	+17	+31	+.5	+11.12					+.04	+.09	+.002	+20.77	+9.86	+12.48	+22.73
Non-Parent Bulls	+5	+2.3	+40	+74	+.4	+.32	+6	+20			+6.01					+.13	+.22	+.005	+23.48	+19.07	+14.81	+32.28
Non-Parent Cows	+5	+2.3	+40	+74	+.4		+6	+20			+6.34					+.15	+.24	+.005	+23.39	+18.51	+14.92	+32.43

[1] at least one calf recorded in herd book within the past two years

American Angus Association℠ 3201 Frederick Ave. St. Joseph, MO 64506
Contact us: phone 816.383.5100 fax 816.233.9703 e-mail
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Slide 2:

Evolution of man...

http://www.naute.com/images/evolutionofman.jpg

Slide 3:
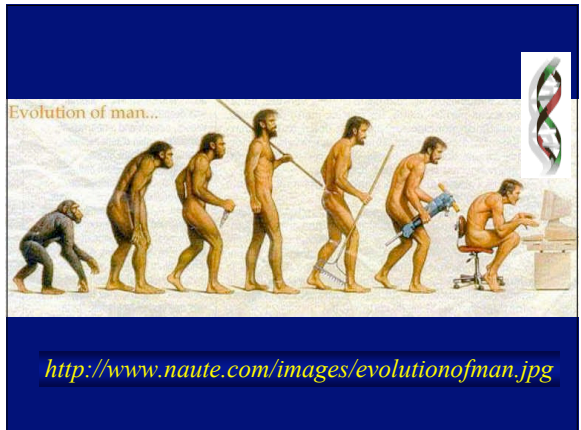
From gene to genome

- **Gene**
  - **The functional and physical unit of heredity passed from parent to offspring**
- **Genome**
  - **The DNA comprising the complete genetic complement of an organism**
- **Genomics**
 - **1986 -- a new scientific discipline of mapping, sequencing, and analyzing genomes**

Slide 4:

Slide 5:
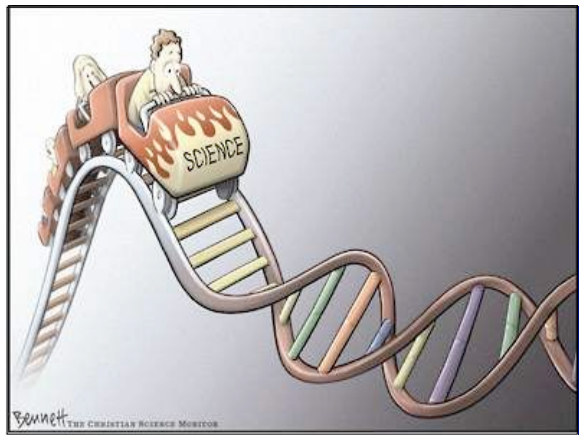
Important genes affecting production traits -- bovine

➢ **Leptin - fat deposition / DMI**

➢ **DGAT – milk production**

➢ **BGHR – milk components**

➢ **Thyroglobulin - marbling**

➢ **Calpastatin - tenderness**

➢ **Calpain - tenderness**

➢ **Somatostatin -- marbling**

Slide 6:

genome.gov
National Human Genome Research Institute
National Institutes of Health

Horse
Sheep
Salmonids
Catfish
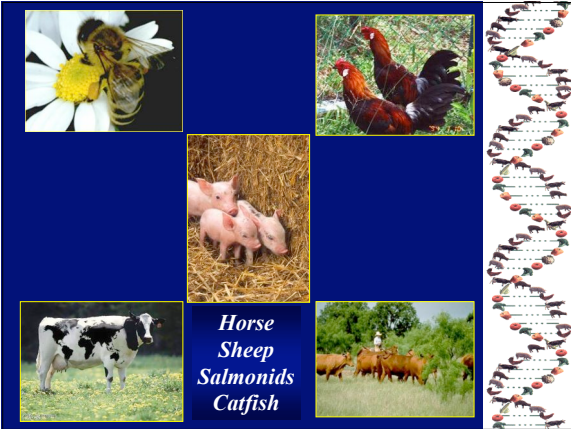
International Collaboration

– *NIH / NHGRI -- $25M*
– *USDA -- $11M*
– *State of Texas – $6M*
– *Genome Canada -- $5M*
– *U.S. Beef Councils -- $1.2M*
– *Australia -- $1M*
– *New Zealand -- $1M*

Project Total ~ $50M

Bovine Genome Sequence – Final Assembly – v. 3.1

- **~7.2-X coverage of the genome**
- **Total of 27.9M sequence reads**
- **Avg. trimmed read length - ~700 bp**
- **Size of the genome 2.87B base pairs**
- **N50 supercontig size - ~1M bp**
- **Used the International Integrated Map to order the assembly (*Snelling et al., 2007*)**
- **Released to GenBank and available through BCM web-site at:**
  www.hgsc.bcm.tmc.edu/projects/bovine

Bovine SNP Project

- **Current Status of Project:**

  – **Genotyping completed on total of ~500 animals (19 breeds) for total of 40K SNP**
  – **(Breeds include:**
    - **Angus, Hereford, Limousin, Charolais, Red Angus, Piedmontiese, Romagnola, Brahman, Santa Gertrudis, Beefmaster, Nellore, Gir, N'Dama, Sheko, Holstein, Jersey, Brown Swiss, Norwegian Red, Guernsey)**

Bovine HapMap Consortium

BFGL and AIPL – BARC
Collaborators: Taylor and Moore

… to genomic selection.
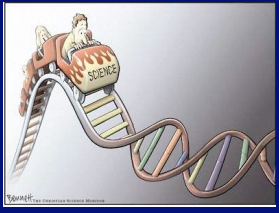
Cost-effective whole genome
SNP genotyping

+

Long-range LD in livestock

+

Advanced statistical genetics
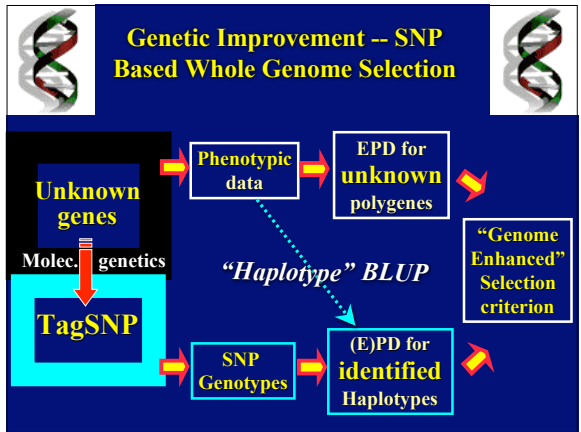(e.g. Meuwissen & Goddard)

Genomic selection
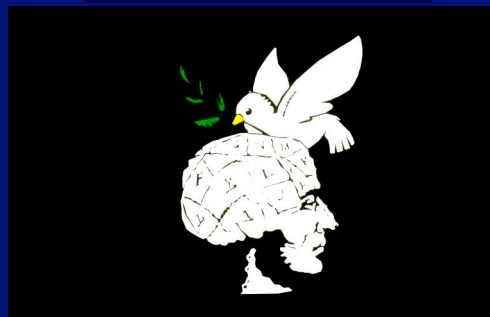
Could have major impact in animal and human genetics !

Slide 1

Cost effective whole genome SNP genotyping …100K SNP for $200?

2.5 mm

0.2 cents per genotype

Slide 2

Genetic Improvement -- SNP Based Whole Genome Selection

Unknown genes

Molec. genetics

TagSNP

Phenotypic data → EPD for **unknown** polygenes →

"Haplotype" BLUP

SNP Genotypes → (E)PD for **identified** Haplotypes →

"Genome Enhanced" Selection criterion

Slide 3

PHENOMICS…….

Adaptability / Functionality???

Slide 4

Genomics Research

- Production traits
- Meat quality, healthfulness, and yield
- *Feed efficiency – expensive to measure*
- *Reproduction- dissect components*
- *Genetic resistance to disease*
- *Stress resistance*
- Select for multiple traits
- Management "by genotype" – *precision mgt*

Slide 5

NEWS**FOCUS**

Closing the Net on Common Disease Genes

Huge data sets and lower cost analytical methods are speeding up the search for DNA variations that confer an increased risk for diabetes, heart disease, cancer, and other common ailments

Slide 6

Genomics Research – Host-Pathogen Interaction

- *FMD, Avian Influenza, BSE/TSEs*
- *PRRS, BRD, BVD, Johne's*
- *Parasite resistance*
- New vaccine development
- New drug targets / immunomodulators
- *Gut "Microbiome" / metagenomics??*

Animal Genomics "Blueprint"

Science to Practice Priorities

1) Whole-genome enabled animal selection.
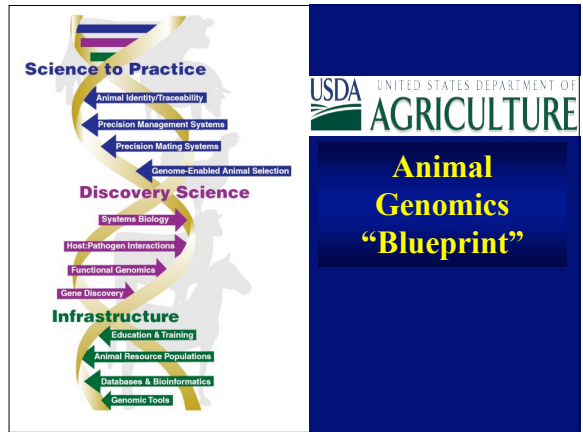
2) Prediction of genetic merit of individual animals from genome-based data combined with phenotypes.

3) Integration of genomic data into large-scale genetic evaluation programs and the use of genomic information to design precision mating systems.

4) "Precision management systems" to optimize animal production, health, and well-being.

5) Genomic capabilities that enable parentage and identity verification (traceability).

We are at a Critical Juncture.

Industry Dissension

➢ BSE / food safety / biosecurity.

➢ Trade policy.

➢ National animal identification.

➢ Country-of-origin labeling.

➢ Increasing consolidation / integration and impacts on market structure / price discovery.

➢ Producer-funded promotion and research.

## Societal and Industry Shifts – "Macro"

➢ Increased call for decreasing the "environmental footprint" of production.

➢ Competition for energy sources and feedstuffs for alternative energy production.

➢ Increased attention to animal well-being and welfare.

➢ Increased brand / process/ historical identity of products.

➢ Increased purchasing power for "non-traditionally produced" beef products.

Societal and Industry Shifts – "Micro"

- "Push to narrow the gene pool" – *yet disagreement on abandonment of heterosis in the cow herd.*

- Need for information continues to accelerate – with commercial industry desiring tools for functionality, health and adaptability ERTs.

- Desire to move from a "breed" world to a "gene pool" perspective.

- Mining the genome in the post-genome sequence world is here to stay – but – we are not well structured to handle current and future data.

SAVAGE, Md. and MINNEAPOLIS - June 11, 2002

MetaMorphix signs deal to develop genetic selection tool using cattle genome -- *Exclusive agreement with Cargill's Caprock Cattle Feeders and Excel Corporation expected to result in superior beef for consumers*
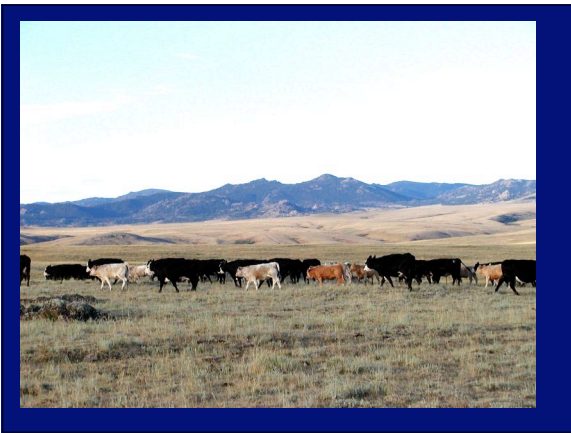
Financial "Re-Direction"

National Beef Cattle Evaluation Consortium

NBCEC presents... Position Paper on the Use of Insulin-like Growth Factor I (IGF-I) as an Indicator Trait in a Genetic Evaluation for Feed Efficiency

The National Beef Cattle Evaluation Consortium (NBCEC) is an organization of animal breeding researchers at Colorado State University, Cornell University, and the University of Georgia. The focus of these researchers is on genetic evaluation of beef cattle. These three universities have had a long history of research in this area and have provided the beef industry in the U.S. with their genetic evaluations for over two decades. The consortium was formed at the request of the beef industry to reduce duplication in research efforts and to coordinate future research in this area. The consortium officially began July 1, 2001 with funding from a Special Research Grant authorized by Congress and administered through Cooperative State Research, Education, and Extension Service.

The NBCEC also conducts national programs in Extension and graduate student training in animal breeding. To accomplish these objectives and to better meet research needs, several research groups at other universities were asked to participate as affiliate members of the consortium. These currently include Iowa State University, Kansas State University, and University of Kentucky.

Members:
Colorado State University - M. Enns
Cornell University - J. Pollak
University of Georgia - J.K. Bertrand

Affiliates:
Iowa State University - D. Garrick
University of Kentucky - Darrh Bullock

Beef Cattle Breeding and Genetics

Renaissance?

2007

BEEF IMPROVEMENT FEDERATION
Improving the beef industry through performance evaluation

Beef Cattle Breeding and Genetics

Renaissance

Renaissance Questions

➢ Where are the scientists and educators with the practical knowledge of industry needs going to come from?

University Trailblazers

Growing up in agriculture sparked a lifelong interest in serving the industry for these five individuals.

Guy Lonergan
Mark Allan
Darrell Mark
Duane Wulf
Dan Moser

Renaissance Questions

➢ How will we fill the huge deficit of quantitatively skilled people needed to be able to make sense of all of these new data? *We need to re-open the textbook on beef cattle quantitative genetics!*

➢ Who is going to educate the public using what kinds of models and platforms?

➢ What is going to be the role of breed associations in the future? Today is eerily reminiscent of the LMA discussion of the past decade relative to sale barns?


Renaissance Questions

➢ Are we looking closely enough at what is evolving in this arena in other regions of the world – principally Australia / New Zealand and Brazil? What about in competing industries?

➢ *Is it possible that animal agriculture in the U.S. could be shipped off shore? Careful study of the real agenda of various "social conscience" groups is warranted.*

➢ Is there adequate funding available in today's research, higher education, and outreach system to address these challenges?
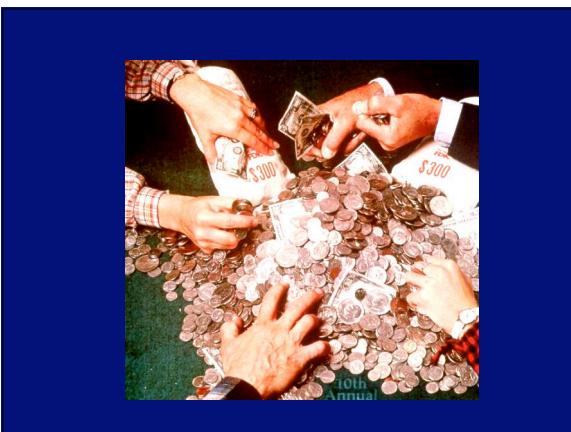

Agricultural Research, Education and Outreach

USDA ARS   **CSREES**

1. **National Institute of Food and Agriculture** *(NIFA)* -- New $1B agency of be built over next 7 years to provide competitive grants for basic agricultural research – would be outside of USDA REE?

2. *CREATE-21* -- Reformation of current USDA REE agencies plus Forest Service research in to new structure – would abolish ARS, CSREES, ERS, and NASS. Requires doubling of current REE budget to retain capacity now in ARS. Seeks to increase competitive grants funding.
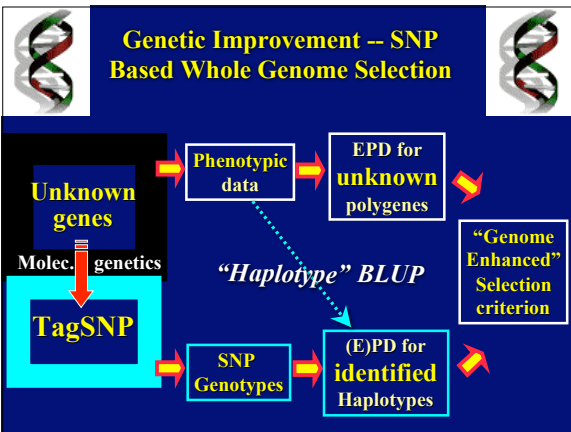
INPUT
OUTPUT

$3.50 or higher?
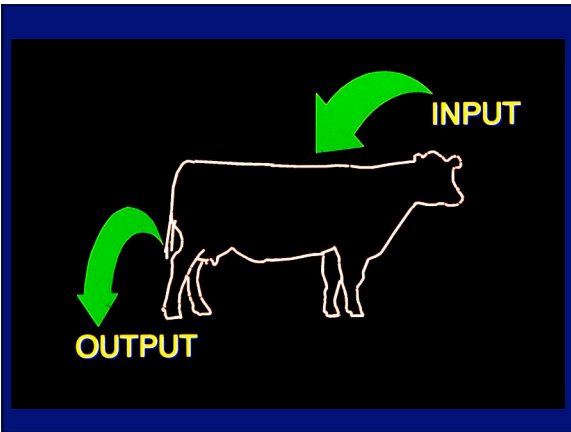
Leadership for 2047?

BEEF IMPROVEMENT FEDERATION
Improving the beef industry through performance evaluation

Sal Forbes
Frank Baker
Ferry Carpenter

Jim Brinks
Bob DeBaca
H.H. Stonaker

Genetic Improvement -- SNP Based Whole Genome Selection

Unknown genes

Molec. genetics

TagSNP

Phenotypic data

SNP Genotypes

EPD for **unknown** polygenes

"Haplotype" BLUP

(E)PD for **identified** Haplotypes

"Genome Enhanced" Selection criterion

"Carpe diem….."