The New USDA Blueprint for Animal Genome Research 2018–2027: A Quantitative Geneticist's Perspective

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Genome to Phenome

- **This is a prediction problem, and prediction is what geneticists do!**

  - **1950s: Pedigree + Performance**

  - **2010s: DNA + Pedigree + Performance**

  - **2020s: "Omics" + Sensors + Pedigree + Performance?**

- **Producers increasingly need tools to predict performance, not only genetic merit!**

  - **Precision management of animals and other resources**

Genome to Phenome: Improving Animal Health, Production, and Well-Being – A New USDA Blueprint for Animal Genome Research 2018–2027

Caird Rexroad[1]*, Jeffrey Vallet[1], Lakshmi Kumar Matukumalli[2], James Reecy[3], Derek Bickhart[4], Harvey Blackburn[5], Mark Boggess[6], Hans Cheng[7], Archie Clutter[8], Noelle Cockett[9], Catherine Ernst[10], Janet E. Fulton[11], John Liu[12], Joan Lunney[13], Holly Neibergs[14], Catherine Purcell[15], Timothy P. L. Smith[6], Tad Sonstegard[16], Jerry Taylor[17], Bhanu Telugu[18], Alison Van Eenennaam[19], Curtis P. Van Tassell[20] and Kevin Wells[20] on behalf of the Agricultural Animal Genomics Community

What are we actually trying to improve?

Feed Intake

Calves produced

CO_2 emission

Lifetime profit

Body size

"Efficiency"

Functional longevity

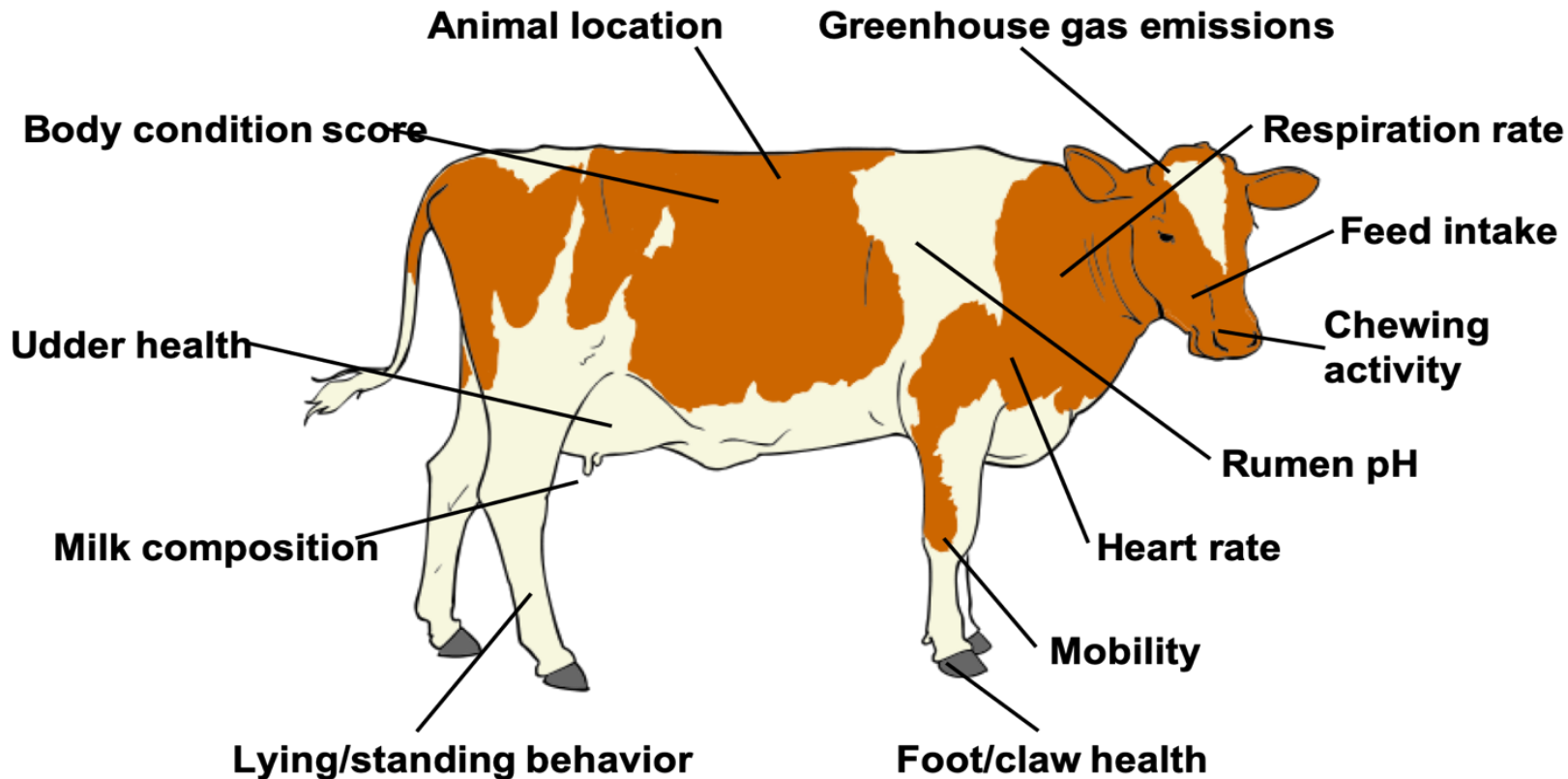Live weight

Methane production

Income over feed cost

Mid-infrared milk spectrum
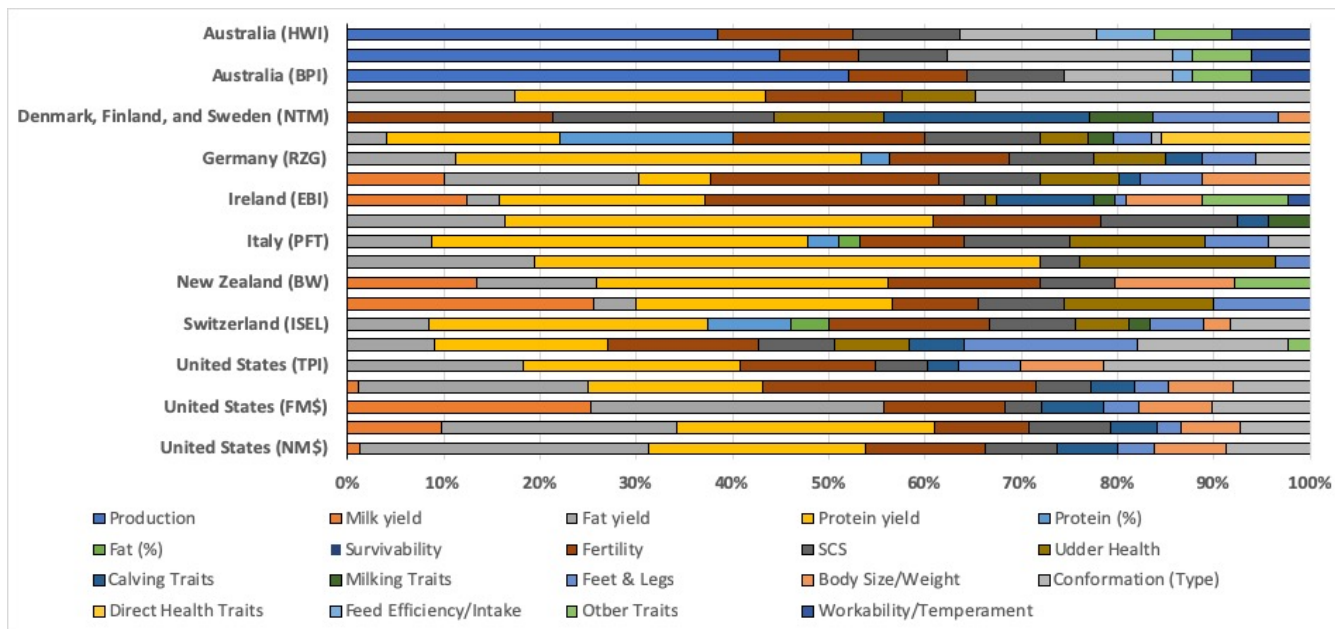
Microbiome

Body condition score

Phenotype is king!

Source: Villarreal (2010; https://en.wikipedia.org/wiki/File:Cow_clipart_01.svg).

More traits, more problems?

- **Combining many measurements into a decision tool is a familiar problem to quantitative geneticists**

Source: After Cole & VanRaden (2017; PMID: 29103719).

Do more data make prediction more difficult?

- **Genetic prediction**

  - **Volume of data not a problem *per se***

  - **New data may need more complex models**

  - **Causal inference remains challenging, but is needed to bridge gaps**

  - **Advancements will be incremental**

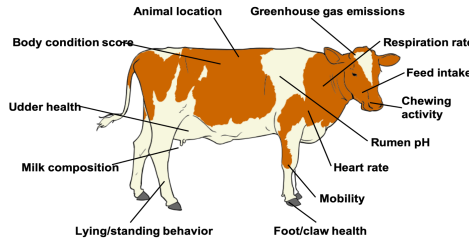- **Phenotypic prediction**

  - **Real-time or near-real-time calculation needed**

  - **Data transfer speeds may be limiting**

  - **Information may be siloed on the farm**

  - **Collaboration with industry is critical!**

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Understanding Genome Biology to Accelerate Genetic Improvement of Economically Important Traits

Harnessing the Microbiome

Applying Precision Technology

Animal location
Greenhouse gas emissions
Body condition score
Respiration rate
Feed intake
Udder health
Chewing activity
Rumen pH
Milk composition
Heart rate
Mobility
Lying/standing behavior
Foot/claw health

Where is the human capital?

Creating Big Data Tools

Developing Advanced Genomic Tools, Technologies, and Resources for Agricultural Animals

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Disclaimer

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Questions?

AIP web site:
http://aipl.arsusda.gov/

Holstein and Jersey crossbreds graze on American Farm Land Trust's Cove Mountain Farm in south-central Pennsylvania

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