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Session 26, Paper 1

Turning science on robust cattle into improved genetic selection decisions

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Outline

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- Robustness?
- The tool kit
- Artificial evolution
- Breeding objectives
- Trait recording
- Genomic selection
- Implications


Robustness?

Perspectives

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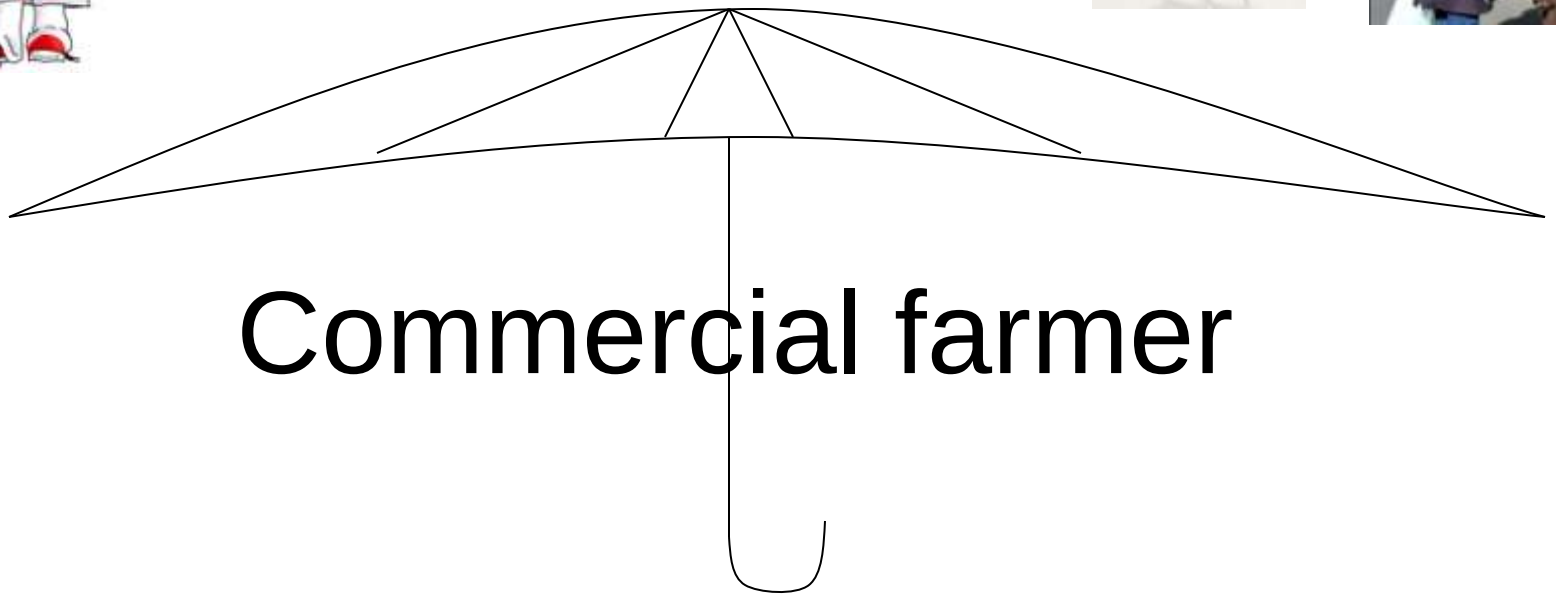
Academic

Hobbyist

Breeding company

Consumer

Society



World context

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- EU27 has less than 10% of world cattle
- India, Brazil, China, USA have highest numbers

- EU27 produces 25% of world milk (c.f. <10% cattle)
- EU27 dairy:beef cow ratio = 2:1

- NZ 1.5% of dairy cattle, <3% of milk

Robustness?

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- Option 1
  - Animals that are able to be healthy and perform well under a wide range of environmental conditions

- Option 2
  - Breeding for anything other than milk yield (dairy) and growth and carcase (beef) traits

The tool kit

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- Breed choice
- Cross breeding
- Imported genestocks
- More efficient breeding programs

Breed choice

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- Norwegian Red has lower milk yield but better functional performance than Holstein
- British beef breeds better adapted to seasonal fluctuations in feed availability than Continental beef breeds with better growth and carcase performance

Crossbreeding

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- Heterosis has bigger impact on functional traits than on growth or milk yield
- But
  - Complexity
  - Lost genetic diversity
  - Disruption to existing breeding company practices

Imported genestocks

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- Historically a production focus
  - Holstein – loss of robustness
  - Developing country disasters
- Global shift to more balanced breeding in dairy cattle
- Beef importations still largely focused on growth and carcase traits

More efficient breeding programs

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- Artificial evolution
- Breeding objectives
- Trait recording
- Genomic selection

Artificial evolution

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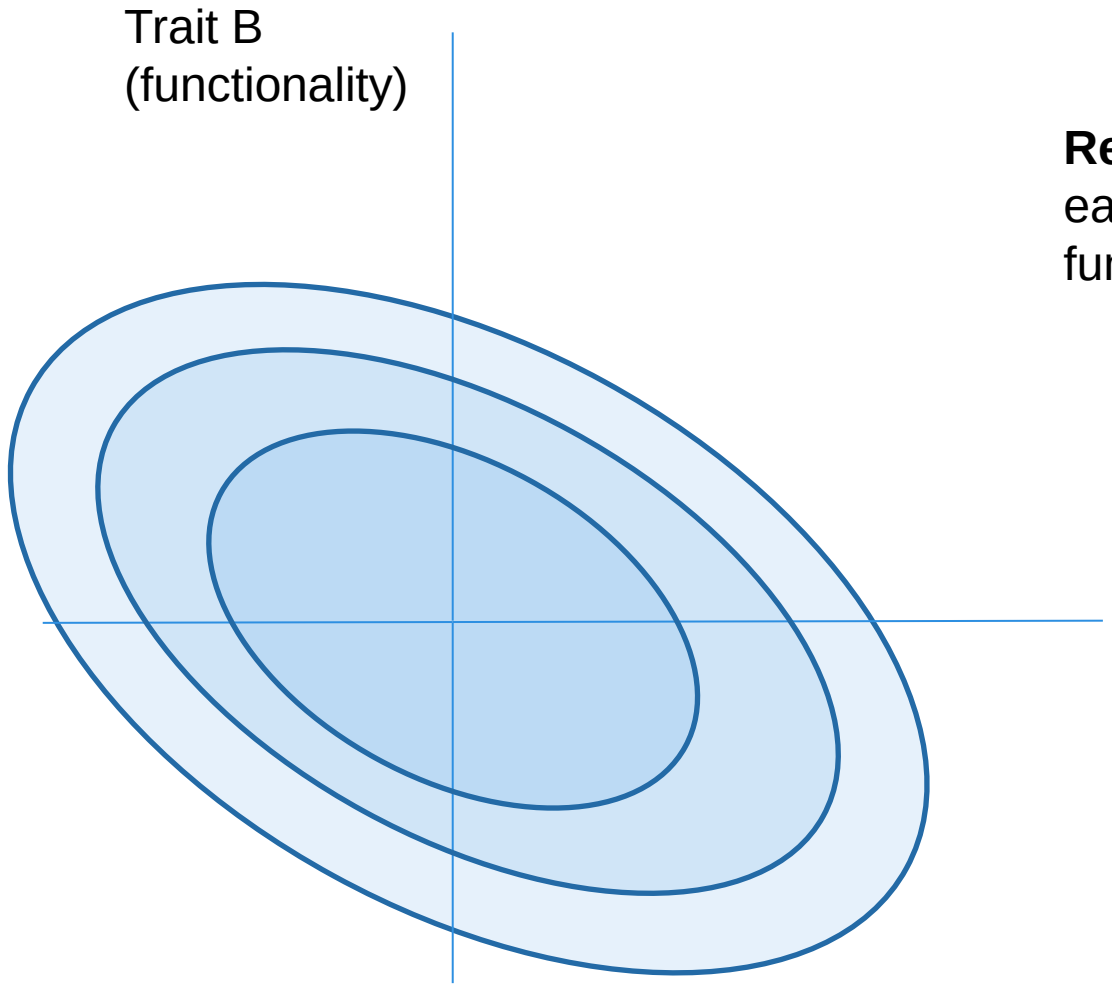

Response elipse – milk easier to improve than functionality

Artificial evolution

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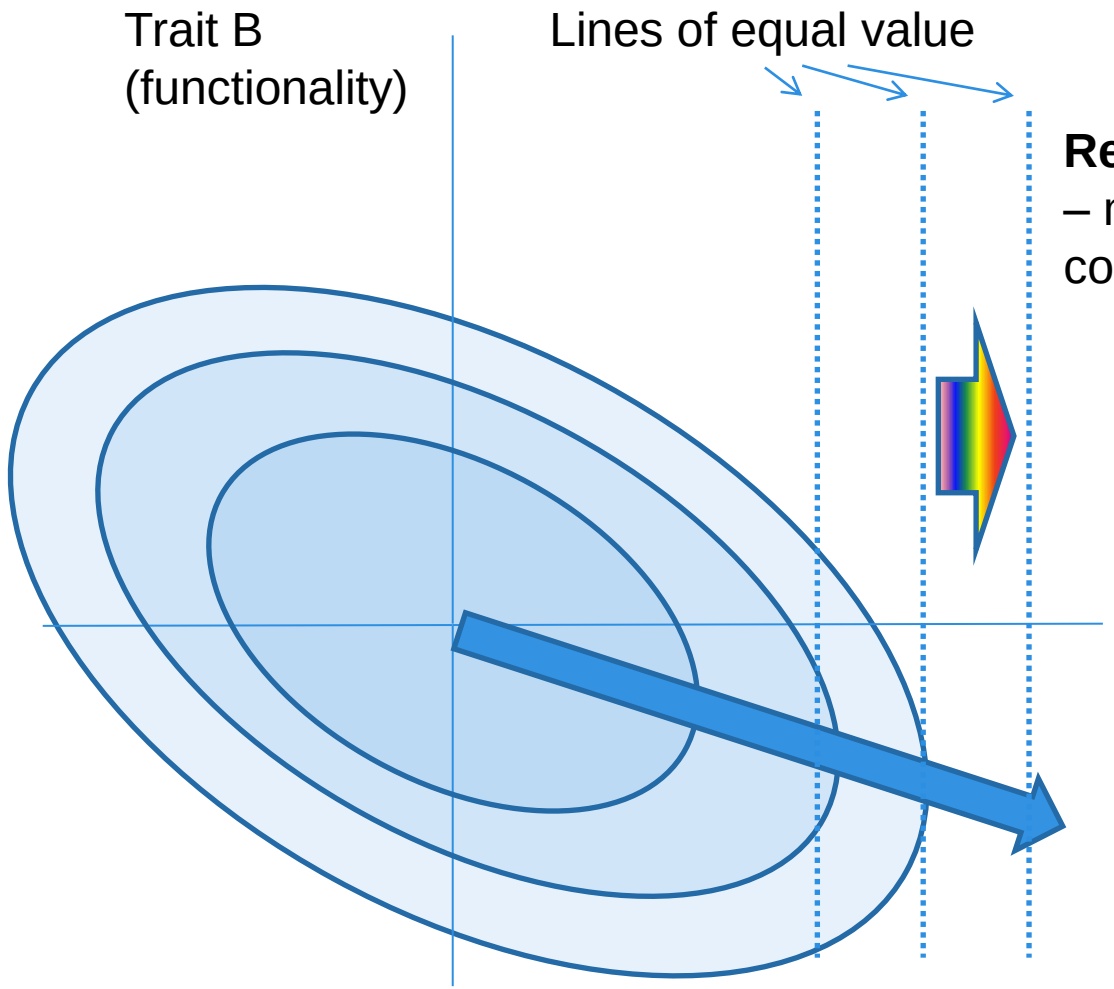

Response elipse
– maximising milk response compromises functionality

Artificial evolution

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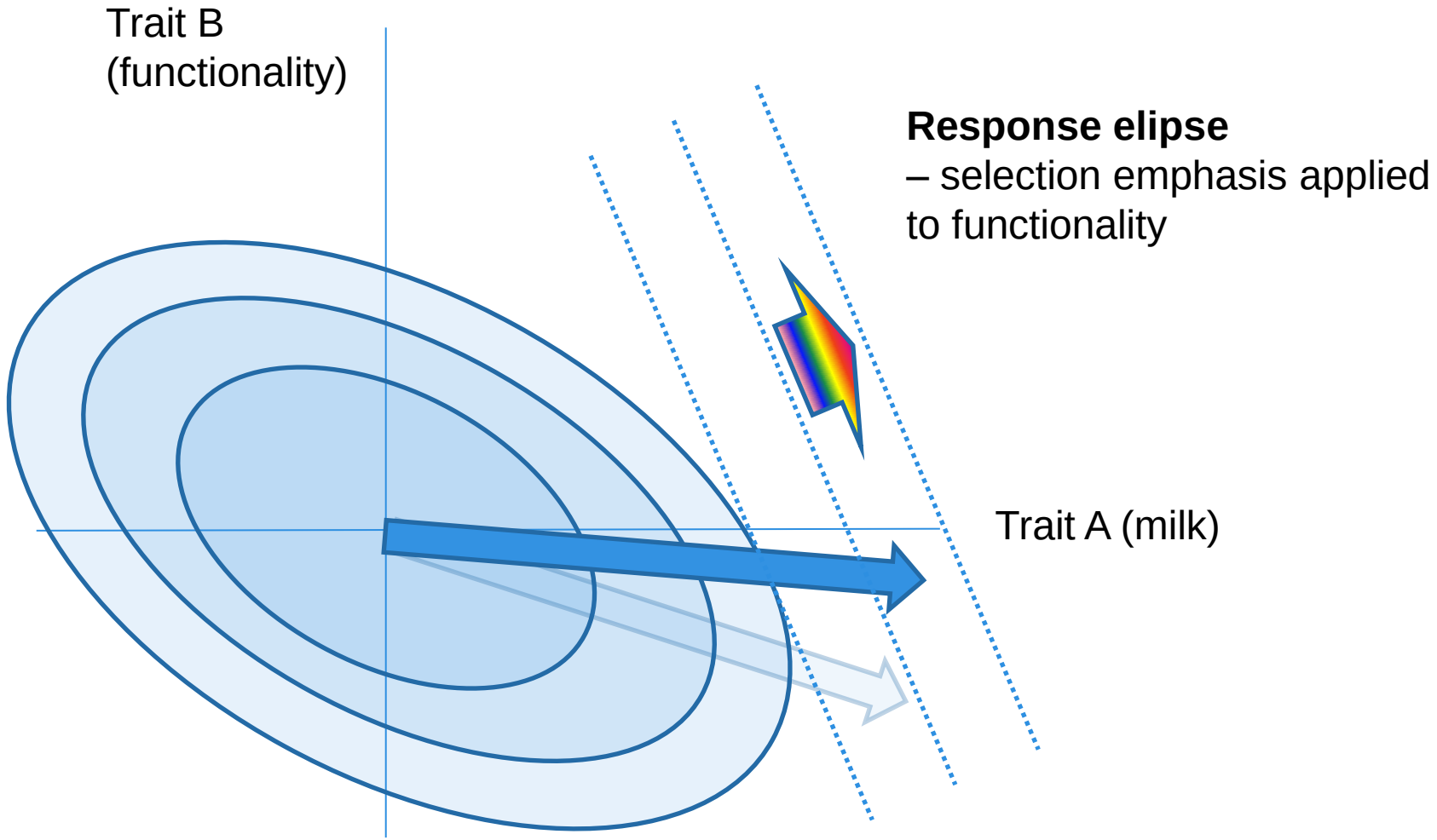

Artificial evolution

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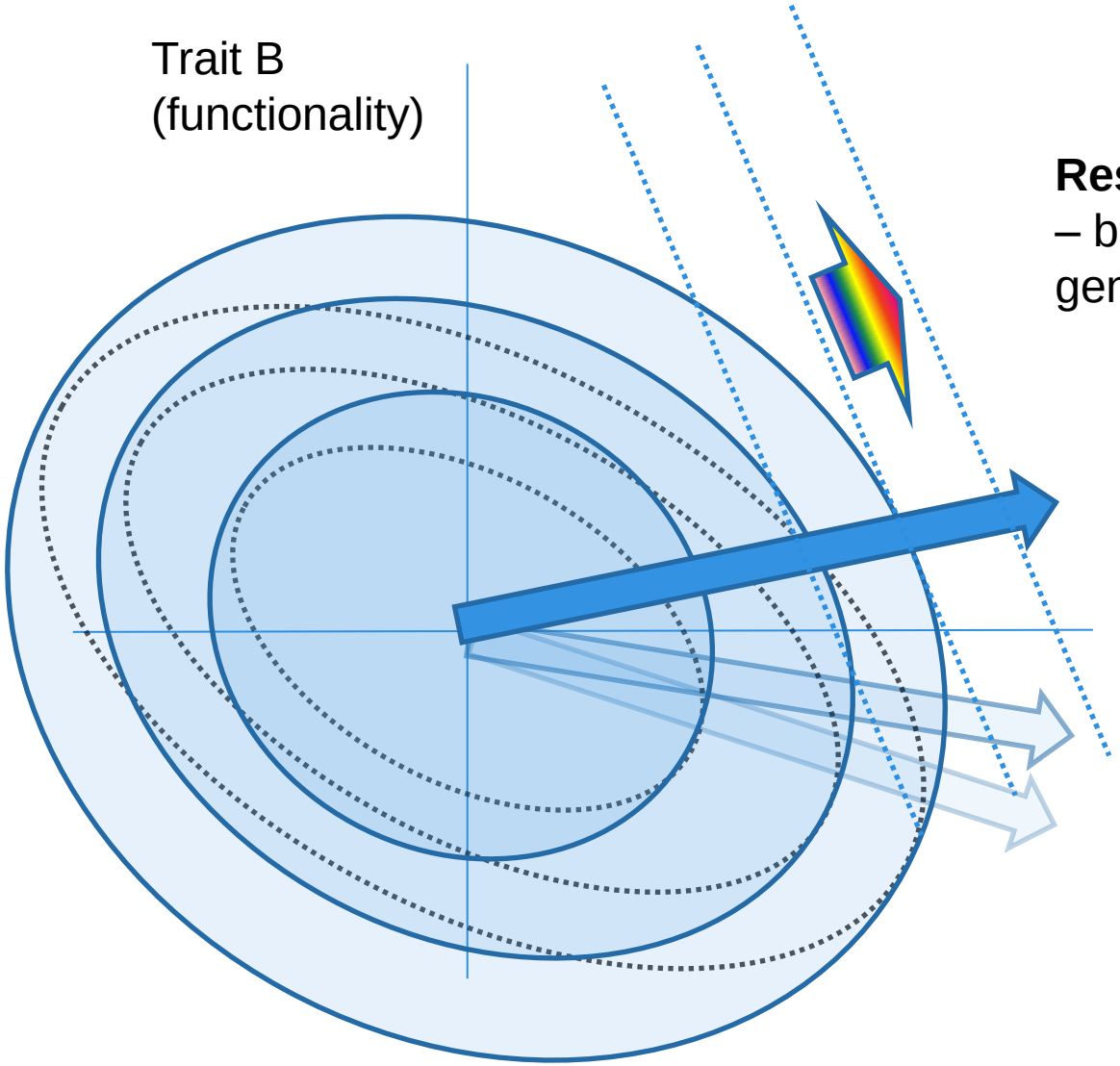

Response elipse
– better identification of genetic merit for functionality

Artificial evolution

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Wanting to improve robustness is only the beginning,

being able to do it is an even greater challenge!

Artificial evolution

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Theor Appl Genet (1989) 78:87–92

Selection strategies and artificial evolution

J. P. Gibson

Centre for Genetic Improvement of Livestock, Department of Animal and Poultry Science, University of Guelph, Guelph, Ontario, N1G 2W1, Canada

..... where economic weights are uncertain, choice between alternative selection strategies might take into account the different types of animal or plant resulting.

Artificial evolution

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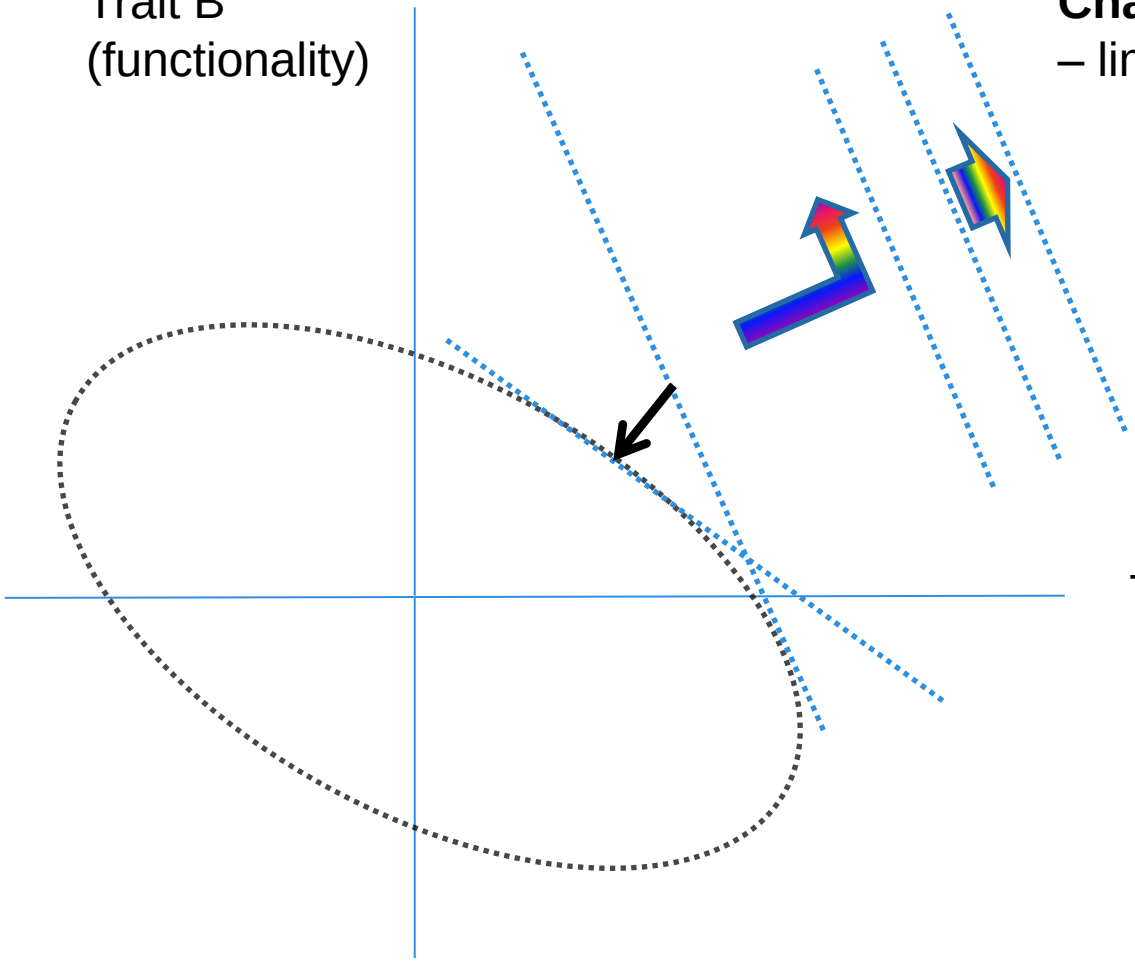

Change direction
– limited opportunity

Artificial evolution

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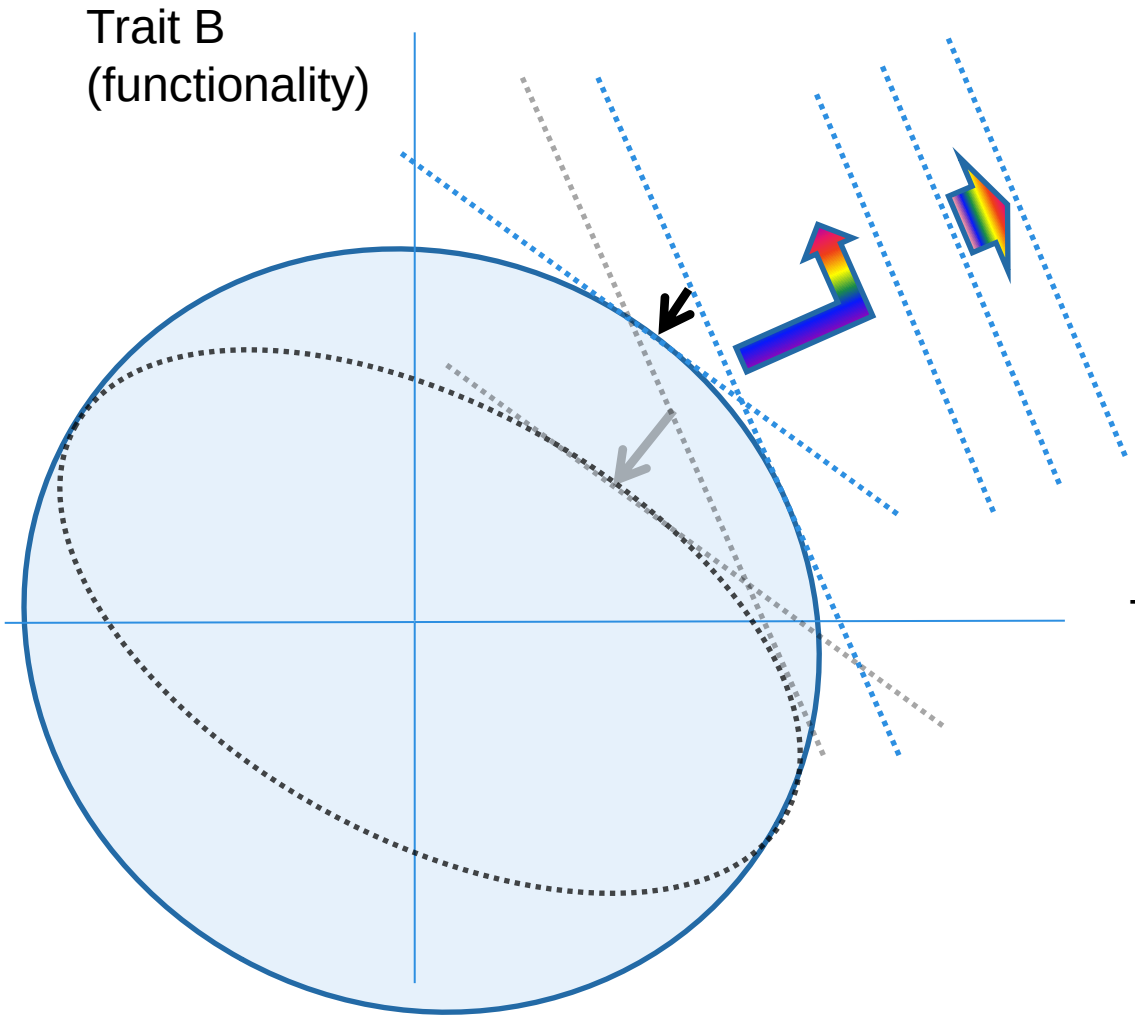

Change direction
– more scope to improve functionality

Artificial evolution

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- The overall economic response to selection is more robust when manipulated towards traits that are easier to improve

Breeding objectives

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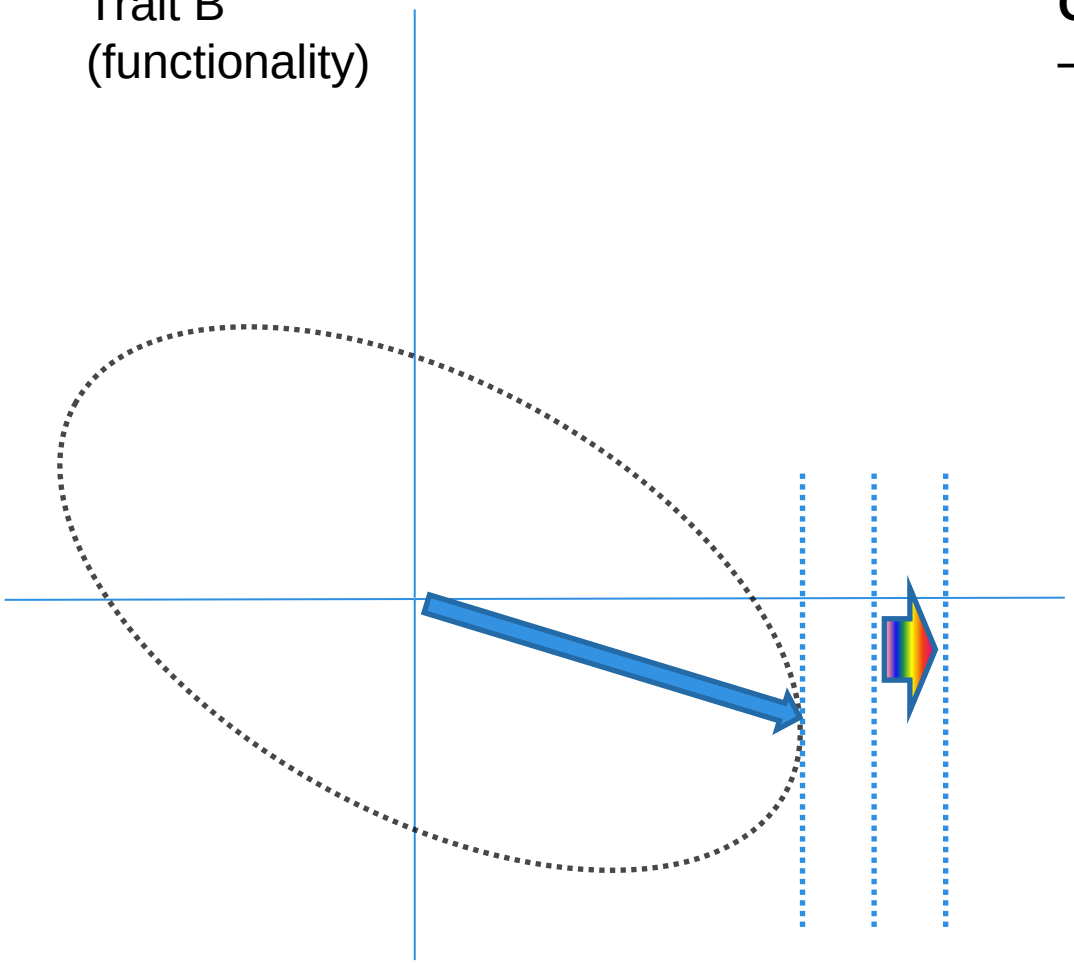

Change direction
– limited opportunity

Breeding objectives

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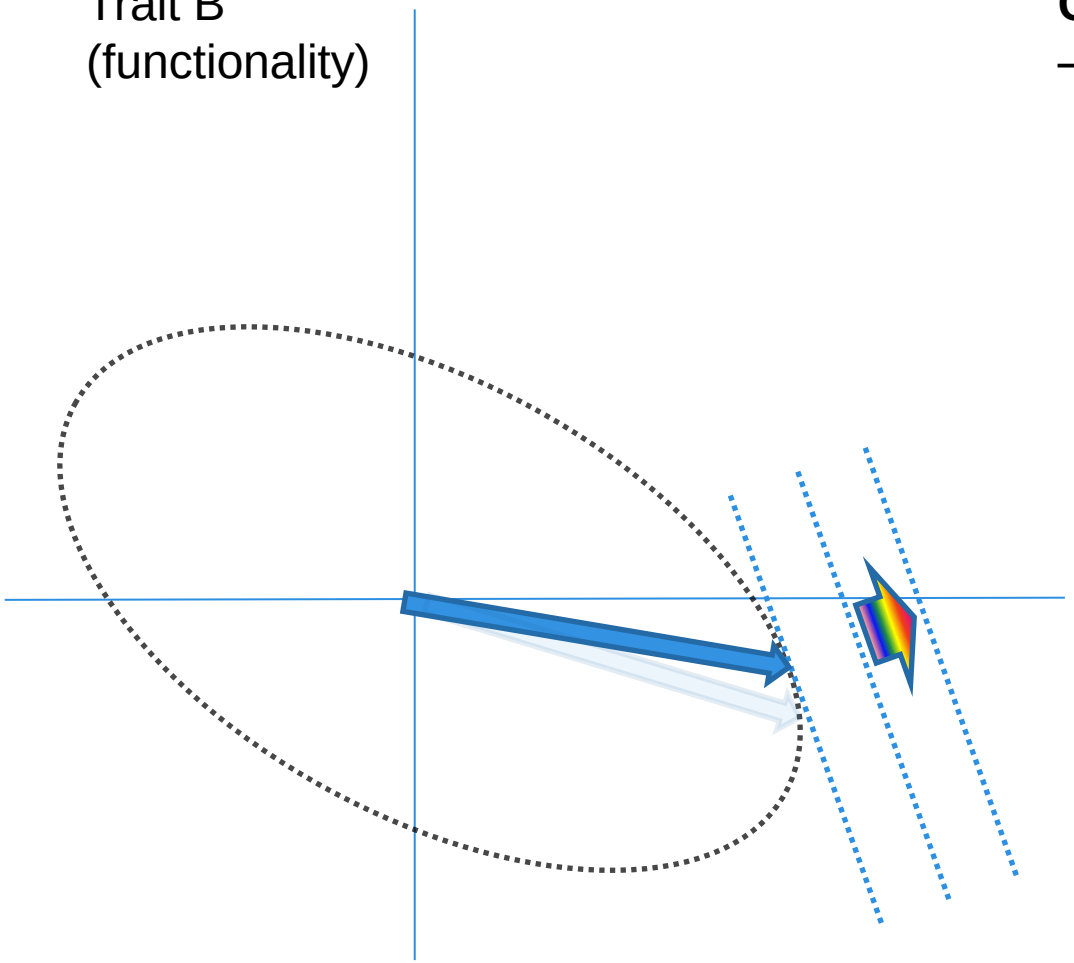

Change direction
– limited opportunity

Breeding objectives

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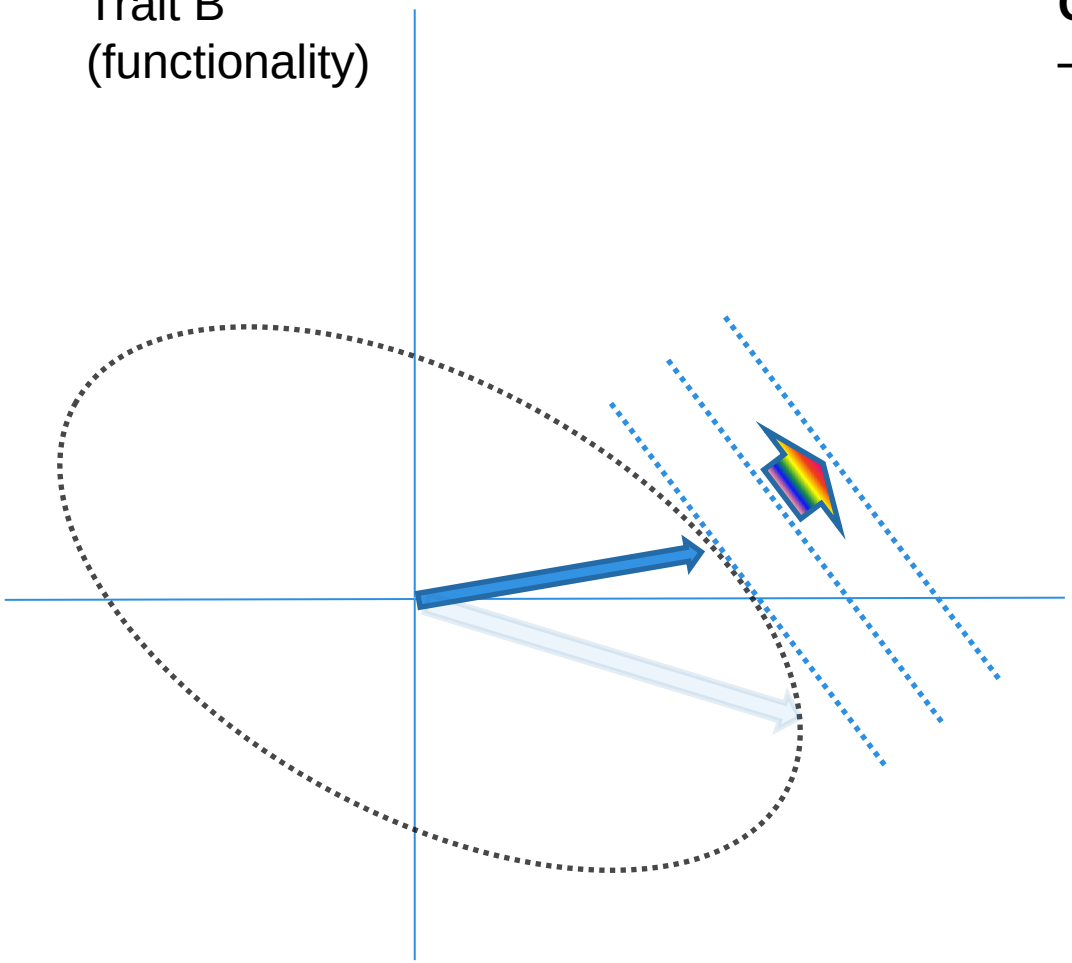

Change direction
– limited opportunity

Breeding objectives

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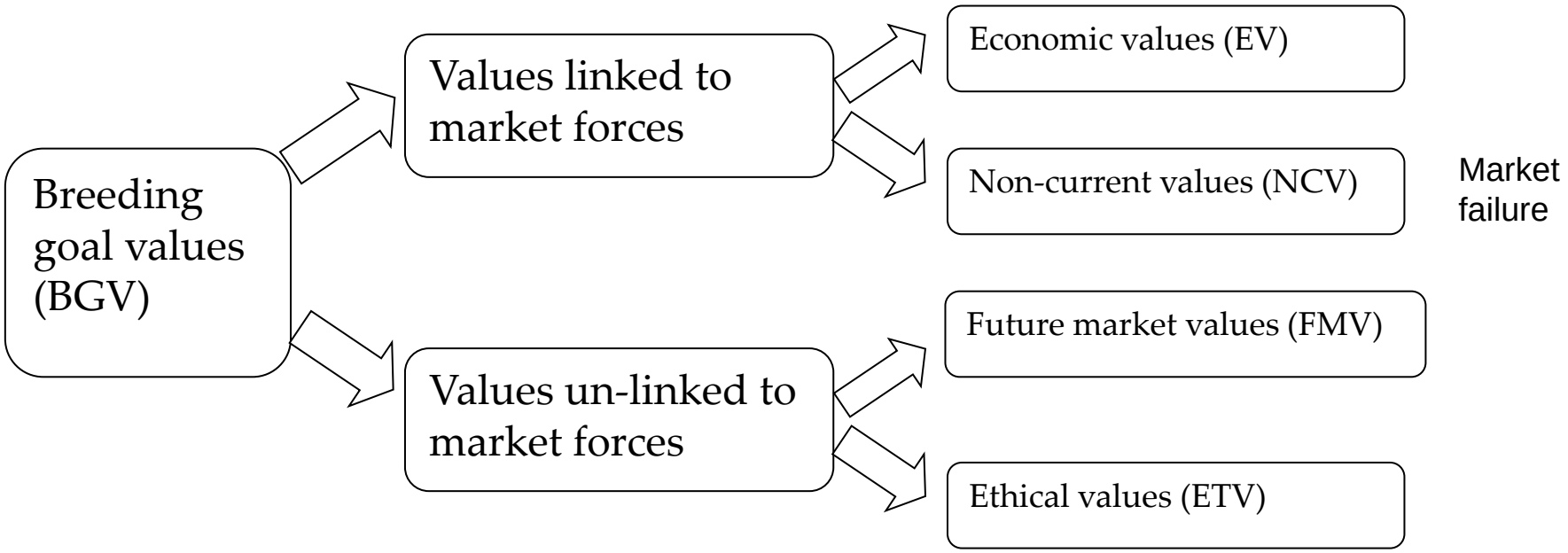
H.M. Nielsen EAAP 2008



Breeding objectives

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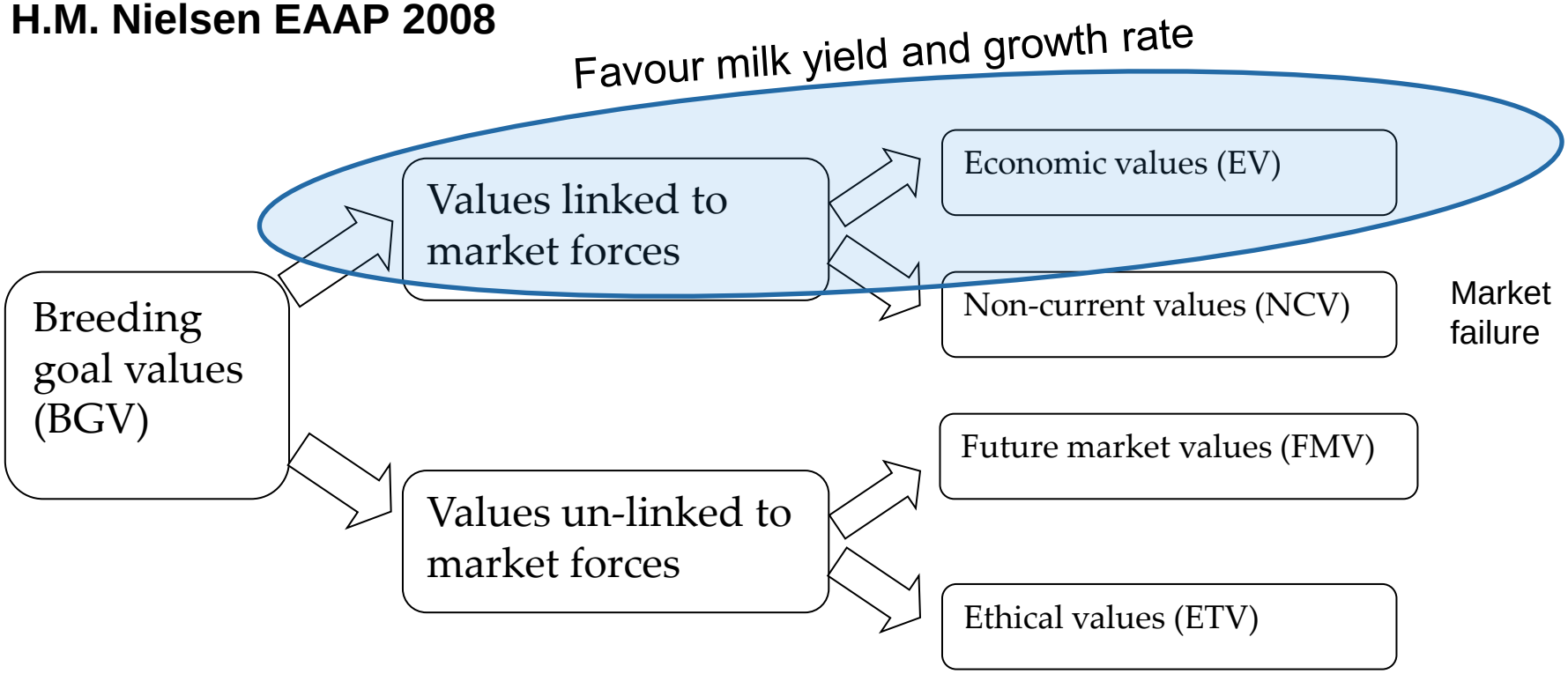

Breeding objectives

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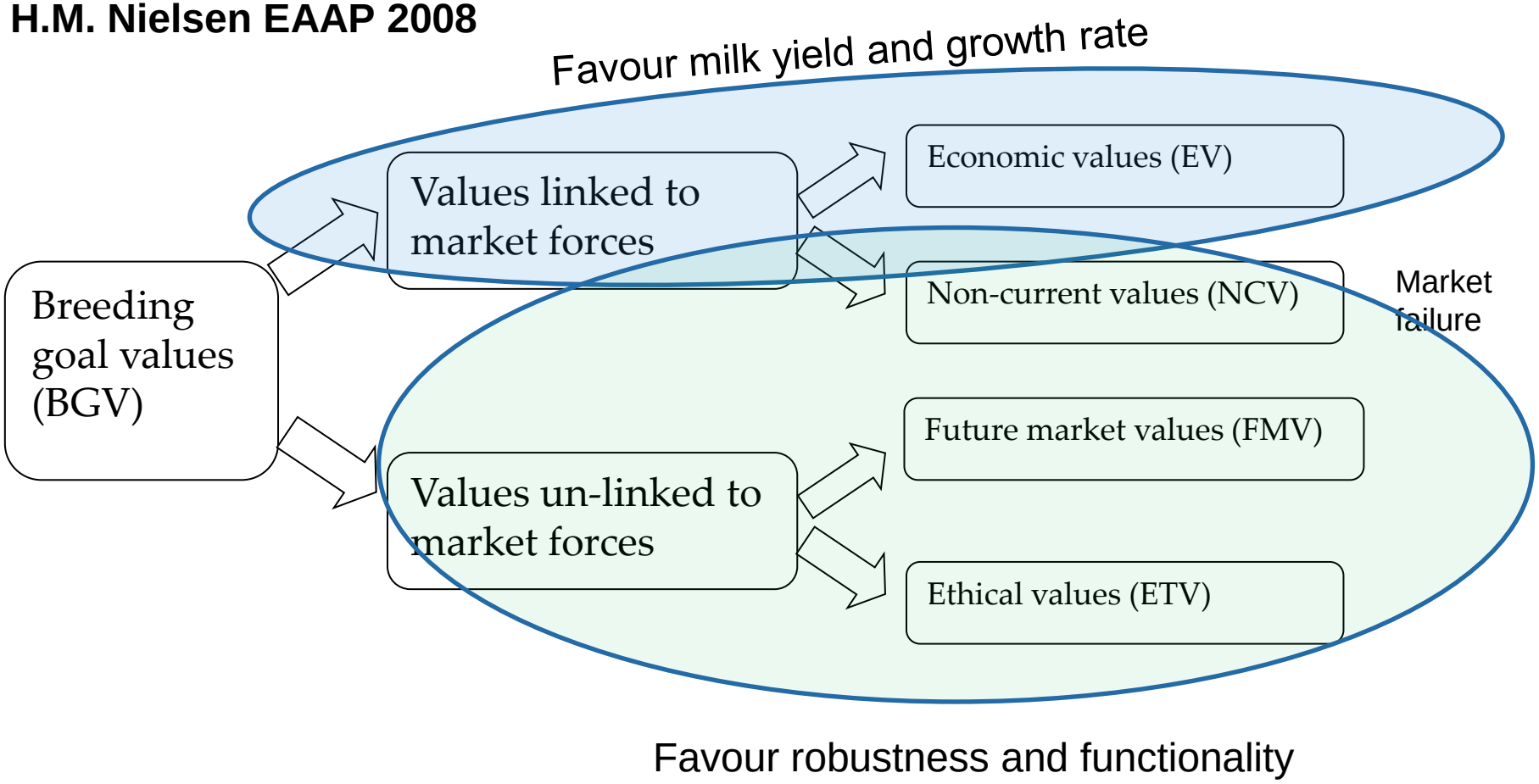

Breeding objectives

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- National breeding objectives taking account of interests of all members of society favour robustness more than current market economic values
- Trying to manipulate the direction of genetic change towards hard to improve traits alienates farmers and therefore competitive breeding programs

Trait recording

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- Beef cattle
  - Young male selection candidates
  - Very accurate merit predictions for growth traits
  - Predictions of carcase traits from ultrasonics
  - Calving and maternal traits often poorly predicted

Trait recording

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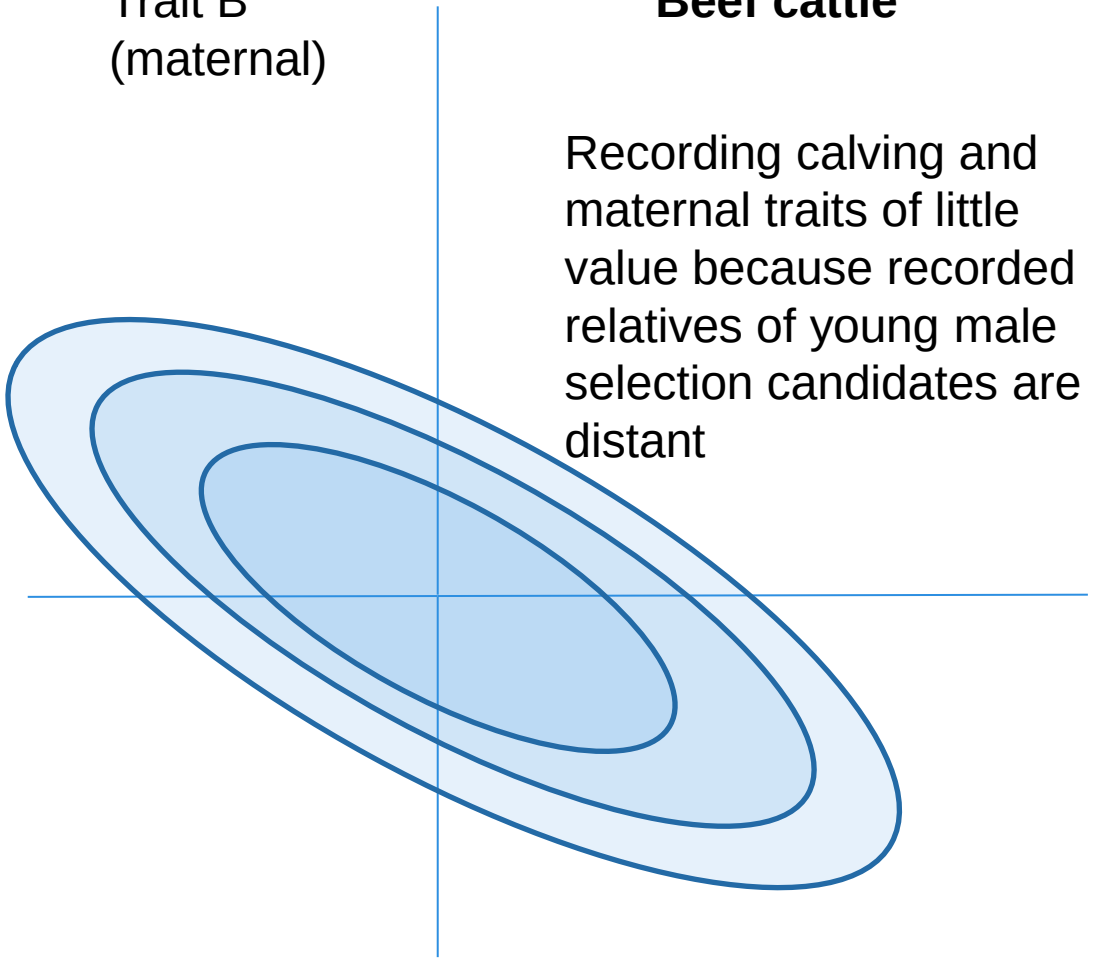
Trait B (maternal)



Beef cattle

Recording calving and maternal traits of little value because recorded relatives of young male selection candidates are distant

Trait A (growth and carcase)

Trait recording

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- Dairy cattle
  - Selection candidates are progeny tested males
  - Milk production information strongest and earliest
  - Targeted/nucleus herds with specialist recording?
  - Trait definition issues and environmental factors obscure heritability for robustness and functionality

Trait recording

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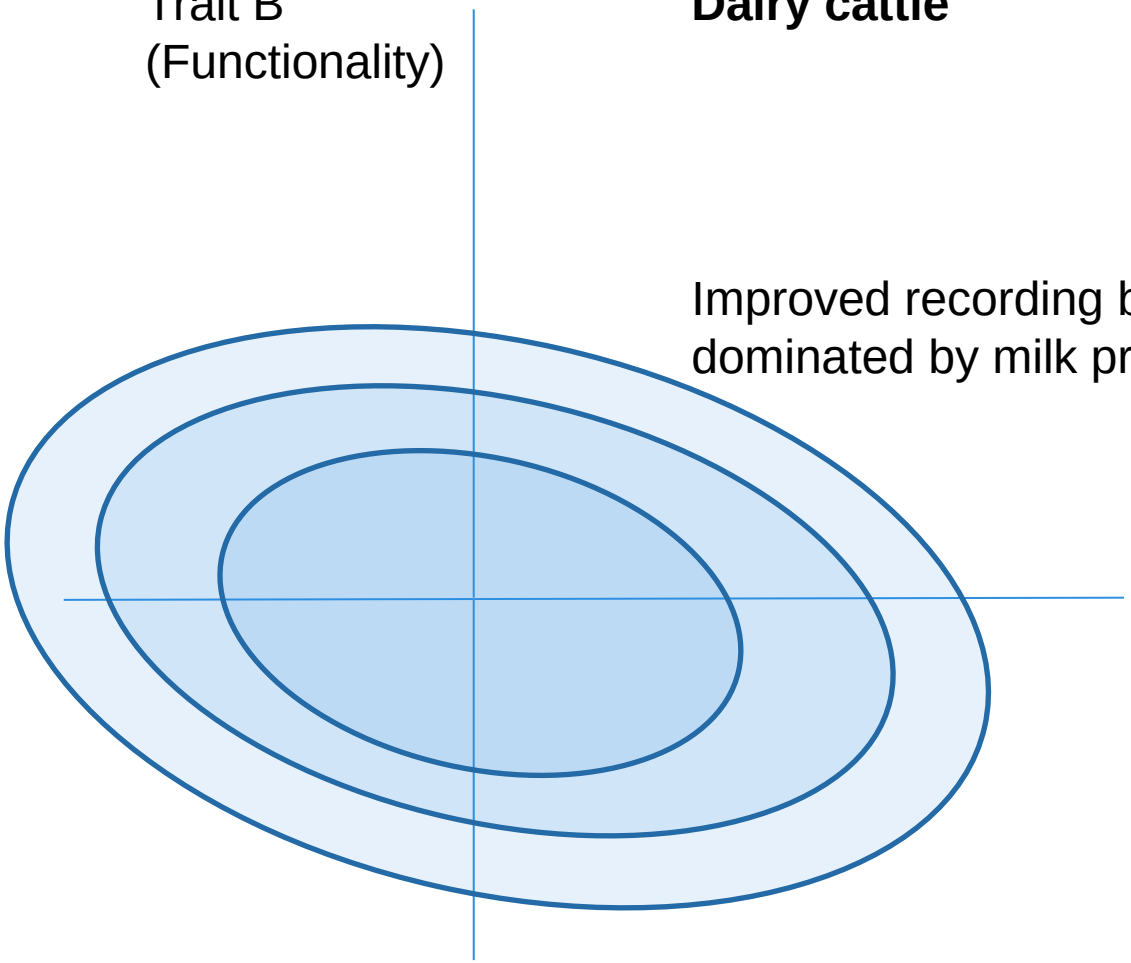
Trait B
(Functionality)



Trait A (milk production)

Dairy cattle

Improved recording but breeding indexes still dominated by milk production traits

Trait recording

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- New opportunities from additional recording limited with conventional genetic evaluation
- Beef cattle – traits other than growth and carcase impractical
- Dairy cattle – functional traits dominated by milk yield

Genomic selection

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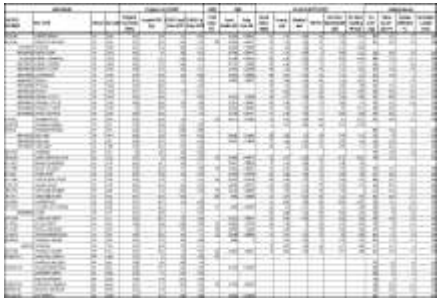
SNP markers

Many markers
per chromosome

Marker chips

Analysis and
prediction

Data



Lab processing

Genomic selection

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- **Earlier and more accurate** predictions of genetic merit
- Accuracy approaching progeny test for young dairy bulls at birth – **restructuring of AI** industries globally
- Higher accuracy for a **broader range** of traits !??
- Young dairy bulls “progeny tested” for milk traits within **first few weeks** of daughters calving
- **Potential** for lifetime maternal traits to have a more meaningful impact in beef selection

Genomic selection

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BUT!

- **Huge** numbers of dependent variables (getting worse)
- Research comparing different statistical methods
- Results so far.....
  - Need **lots of** genotyped **animals** with good phenotypes
  - **Over prediction** of genetic merit common -> severe
  - Lower heritability traits showing **many problems**
  - **Limited** ability to predict **beyond close relatives**
  - **Limited** ability to predict **across breeds**

Outline

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- Robustness?
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- Trait recording
- Genomic selection
- **Implications**

Implications

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- Breed substitution and crossing are **powerful** tools to achieve robustness (but often **neglected**)
- Importation of gene stocks has a **history** of a net **negative** effect on robustness but this can and must change
- Breeding objectives research has
  - created awareness
  - slowed but not reversed the decline

Implications

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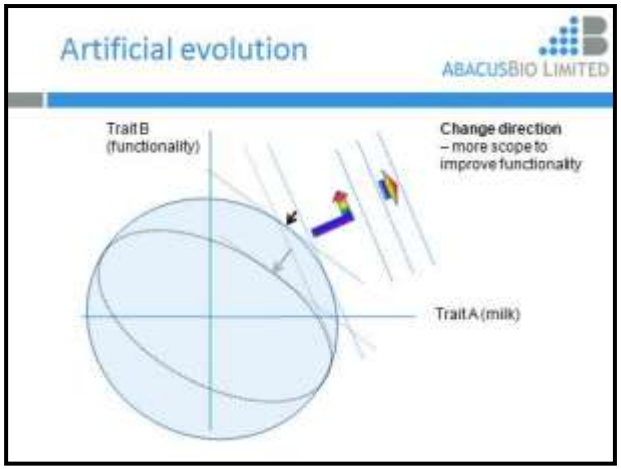
- Gibson's concept of artificial evolution points us now to the "supply side" of genetic improvement



- How do we make it easier for breeding programs to improve robustness traits?

Implications

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- Robustness phenotypes on more animals
- Better phenotypes (more accurate, better analysis, accurate pedigrees)
- "*Deep*" phenotypes will have to be scalable to tens of thousands of animals

Implications

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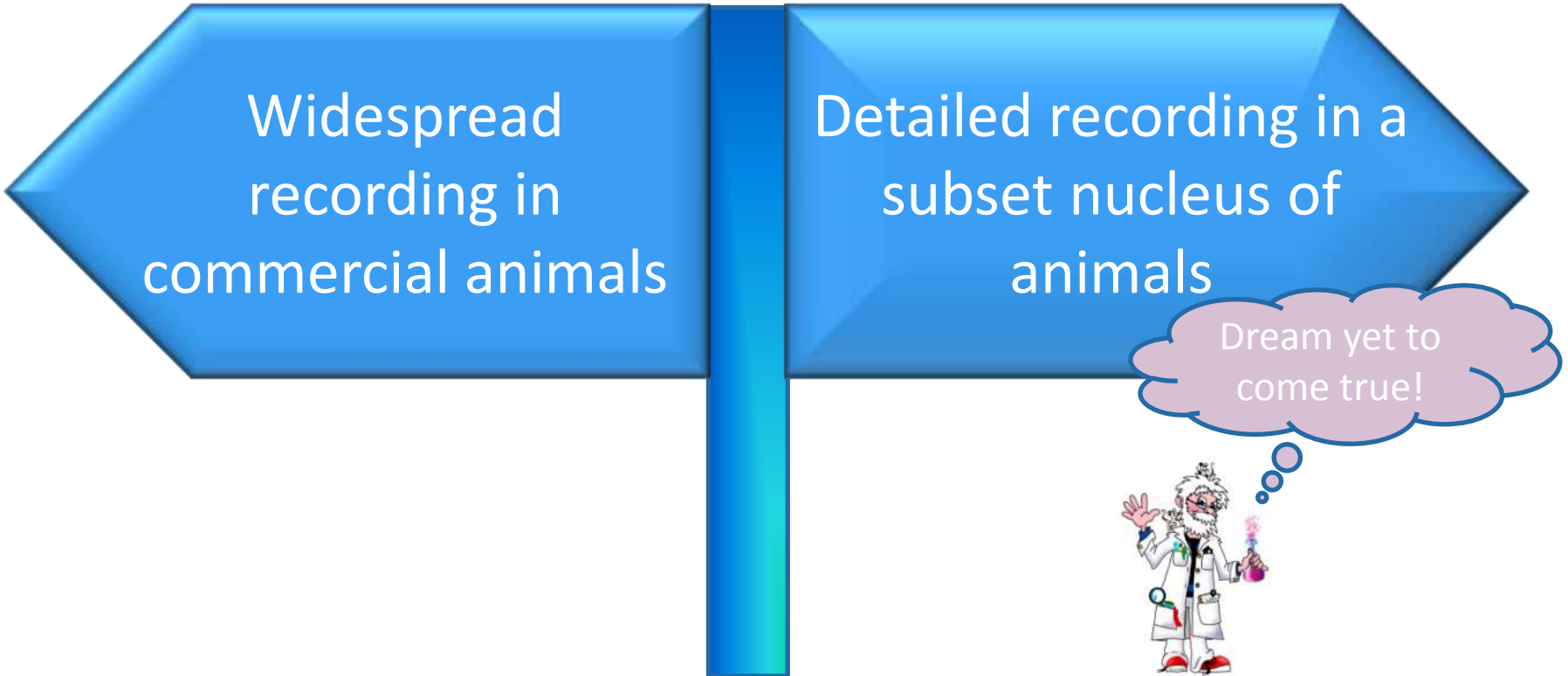
- Genomic selection holds huge promise for robustness but it is at a cross roads



Implications

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- Widespread recording in commercial animals is desperately needed because!

1. Opportunity to test claims of commercial companies
2. Less prediction to distant relatives required
3. Better for integrated across breed predictions
4. Other uses of phenotypic data
   - Farm decision making
   - Traceability
   - Benchmarking
   - Research

Implications

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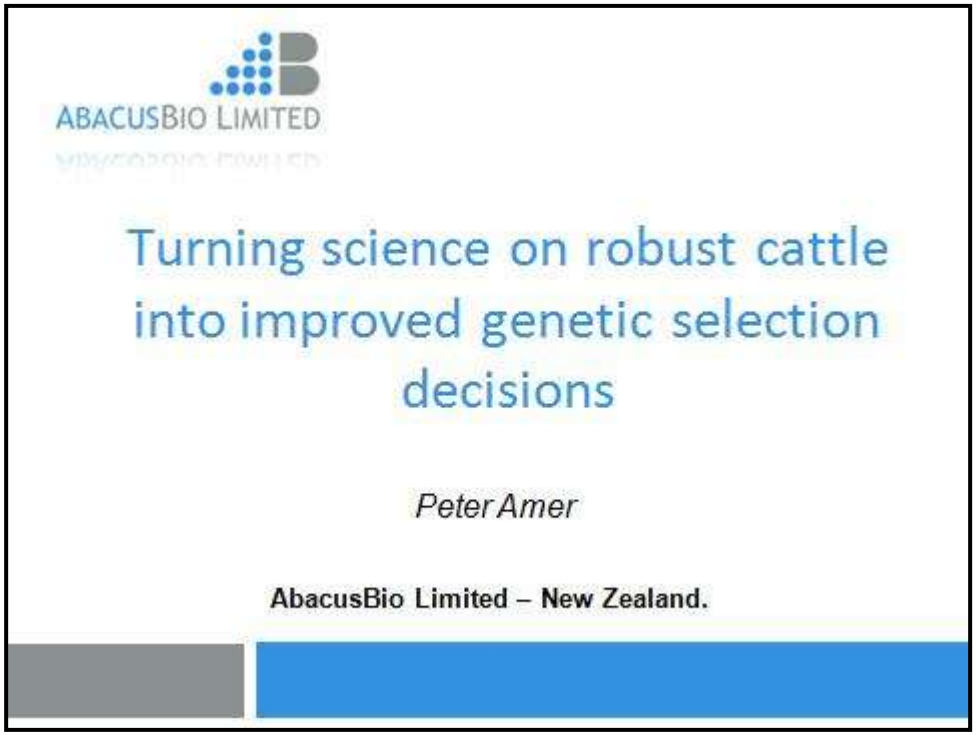

- A renewed focus on low cost practical recording methodologies for farmers and incentivisation of their use is critical!


Questions?