WG functional traits

Which new traits are expected to be available in the near future?

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Overview

- **Introduction**
- **Circumstances and new developments**
- Impact on trait complexes – new traits?
- Challenges and important steps for the future
- Conclusions

Use of data

- **Farm management**
  - Primary motivation to register traits!
  - Challenge to balance high milk yield and reproduction, health,...
  - Need for appropriate and timely available information
  - Easy handling; simple access to data
- **Genetics / breeding**
  - Complex breeding goals - EBVs for 1-43 functional traits in 23 countries (Stock et al, 2012); expected increase in 22 of 26 countries;
  - wide spread of health initiatives; future main research activities reproduction, metabolism and efficiency,..;
  - Central availability
- **Others – multidisciplinary use**
  - Public (parameters for monitoring (food safety, surveillance, welfare,..)
  - Animal health, supply chain,..

Consumer demands

- **Food safety**
  - Consumer acceptance and confidence
  - Increasing concerns about risks connected to the use of antibiotics – resistances in humans (One Health: Healthy animals=Healthy people)
- **Nutritional value**
- **Well-being of animals (welfare)**

  Scientific report on the effects of farming systems on dairy cow welfare and disease (EFSA-Q-2006-113, 2009):
  - Leg disorders, mastitis and reproductive disorders considered major components of poor welfare in dairy cows.
  - Genetic selection of dairy cattle over many years considered to be a major factor leading to poor welfare in dairy cows.

  COM has called for animal welfare indicator (Pavon, 2013)

Legal circumstances

EU: e.g. Animal Health Law in elaboration (presently about 40 Directives and Regulations) Pavon (2013)

- Disease prevention (awareness, registration, traceability,..)
- Disease control and eradication
- Intra-EU-movements and entry into EU of animals and animal products
- New element: Union intervention on antimicrobial resistant pathogens

Regulations on national level ..

Documentation requirements could be used!

Environmental circumstances

- World human population is expected to reach 9,6 billion people in 2050 (UN, 2013)
- Expected increase in demand for animal products and pressure on resources (land, water, energy,..)
- Reduction of environmental footprint of cattle; reduction of emissions
- Economic interest in efficienct use of resources
  - expected increase in prices for concentrates, energy,..

Traits related to „**efficiency**“
increase in importance!

Technological advances

Trait and biology

- Recent technological developments enable more knowledge about the genetic background of traits (genomics, proteomics, metabolomics..)
- New traits are coming up – e.g. genetic defects
- **Genomics offer new perspectives for registration** – establishing reference population with „deep“ phenotypes – population wide recording with indicator traits

Better description of phenotype – closer to genotype -
new possibilites and higher efficiency!

Technological advances
Exploiting existing tools e.g. MIR

- Milk fine components – cow status
  - (e. g., mid-infrared MIR spectra)
  - to generate additional information – e.g. fatty acids, indicator traits for fertility, mastitis, energy balance, ...

- MIR under research (RobustMilk, OptiMIR, PhenoFinlait,..)

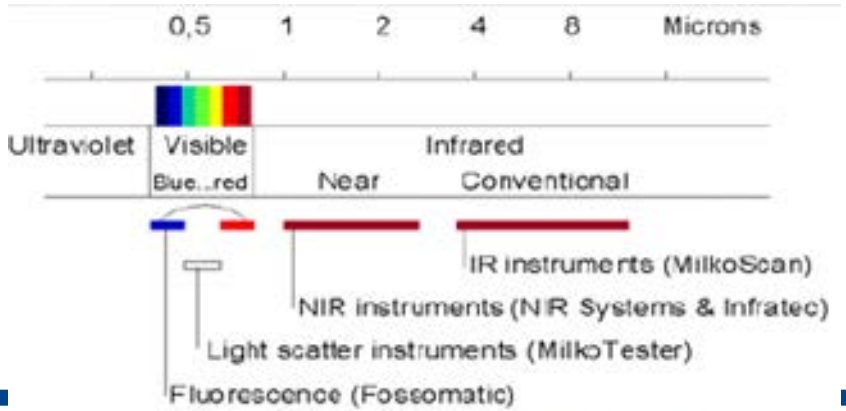


Figure 1 : Electromagnetic spectra (Foss, 2012)

Technological advances

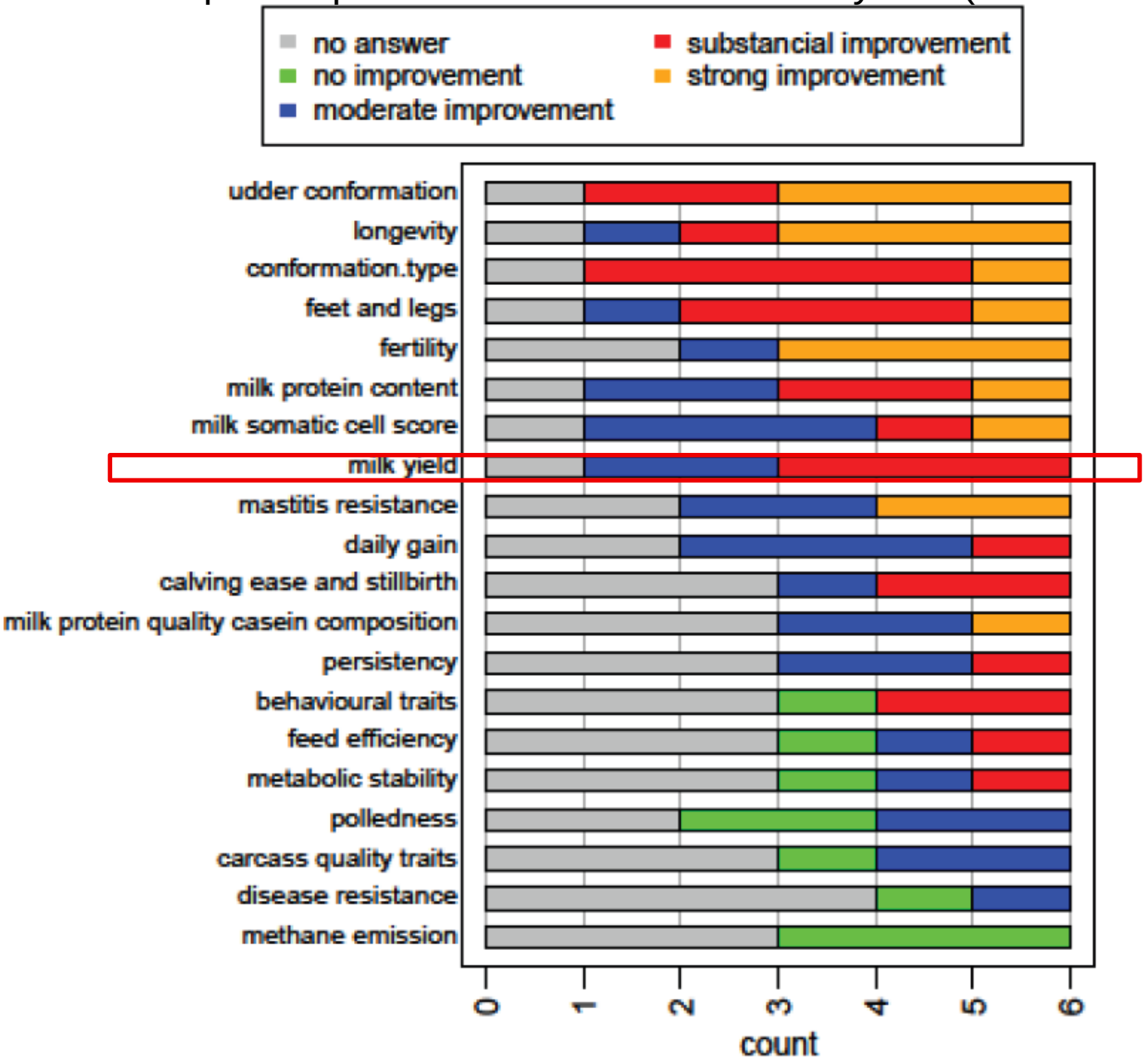
Automation on farm

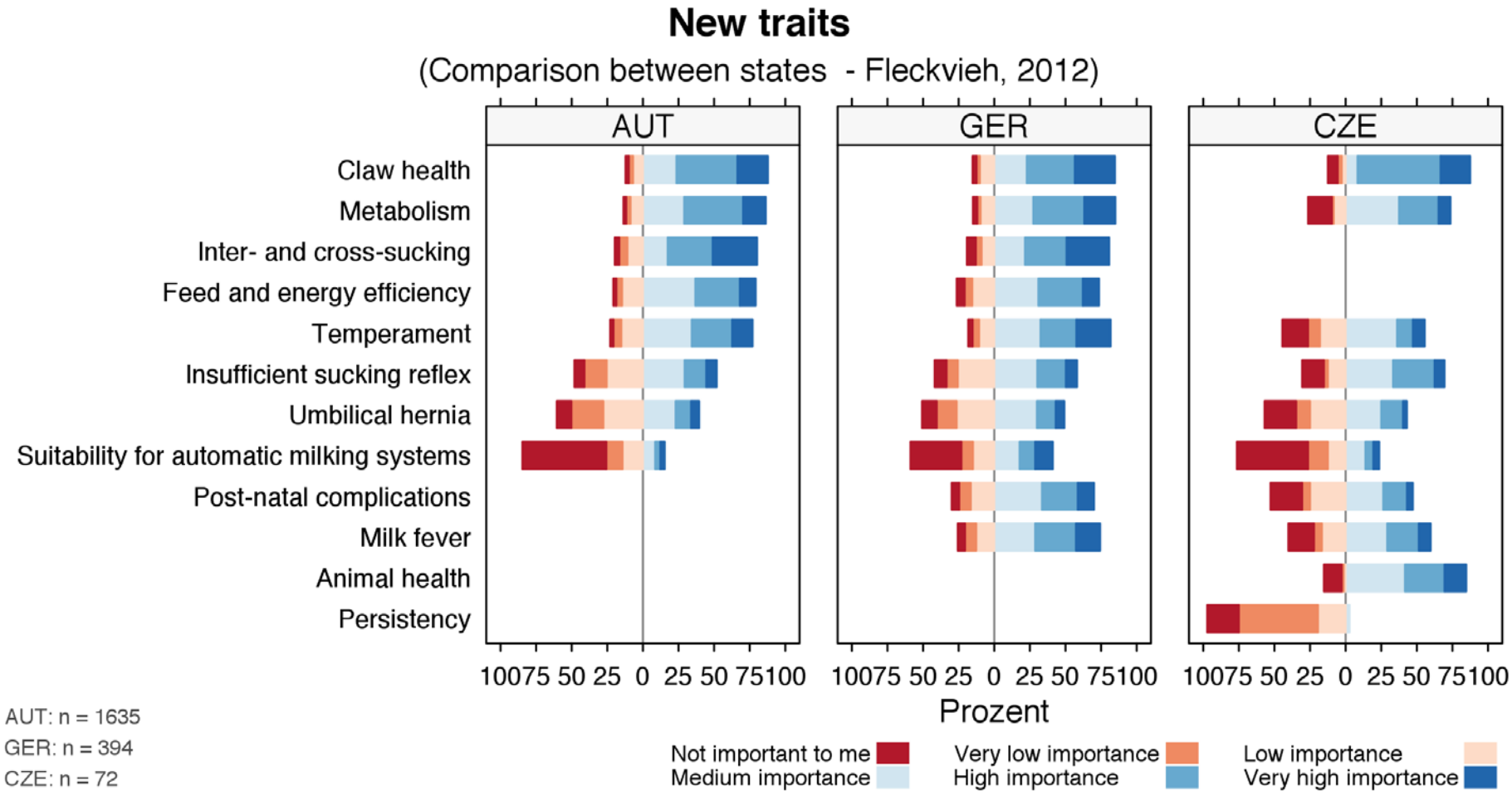
- High investment in developments of farm technology
- High expectations to generate indicator traits for health and fitness automatically without additional labour, repeatability,..

Needs of farmers

- Essential for further developments and motivation to record traits
- Surveys in different countries (Rössler et al. 2013; Gene2Farm (2013), Steininger et al. 2013, Amer et al. 2013,..)

Traits for which breeders of dairy and dual purpose breeds represented by the SME within Gene2Farm expect improvement within the next 10 years (Gene2Farm, 2013)





Steininger et al. 2013

Easy care, healthy, “invisible” cow with good production

Complex breeding goals require complex data recording!

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Direct health data

- Direct health traits – more effective in breeding (Heringstad et al. 2007; Egger-Danner et al. 2012)
- Routine genetic evaluation of direct health traits beside Nordic countries in DEA (2010), France (2012) and Canada (Dec 2013)
- Systems for recording of diagnoses are presently being established in other countries,..

Direct health traits will be more frequently available in the future (either veterinarian diagnoses or producer recorded data)

Standardisation of direct health data
(ICAR-guideline)

	Comprehensive key of diagnoses	Reduced key of diagnoses	Simple key of diagnoses
Nr. of diag.	> 600	60-100	10-15
Source	veterinarian	veterinarian	producer
Recording	electronic submission (vet)	vet, perform-ance record., producer	producer
Example	ICAR-guideline: mastitis catarrhalis acute and subacuta, mastitis parenchymatosa acuta and subacuta, ...	E.g. AUT: acute mastitis chronical mastitis;	mastitis

Coding of diagnoses precondition of use!
International cooperation (IDF, ICAR,..) for comparability of results across countries!

New traits

- **Udder health**
  - Improved SCC – definitions (e.g. prolonged elevated SCC)
  - Diagnoses (clinical mastitis (CM), ..)
  - Indicator traits (electrical conductivty, MIR,.)
  - Pathogen information
    - Important for effective programs on prevention and prudent use of antimicrobials
    - Potential for use in genetics (Sorensen et al. 2009; De Vliegher et al. 2012, Haugaard et al. 2012)
    - Limitations and challenges:
      - standardization across laboratories – limited comparability of results
      - preselected animals
      - availability in central database

New traits

- **Reproduction**
  - Fertility related diagnoses (metritis, cystic ovaries, retained placenta,..)
  - Milk composition based indicator traits (based on MIR,…)
  - Other indicator traits (activity, BCS...)
  - Hormonal status (oestrogen, pregnancy rate,..)

- **Feet and legs**
  - Veterinarian diagnoses
  - Hoof trimming data
  - Indicator traits (lamness, data from automation - activity,..)
  - ....

New traits

- **Metabolism**
  - Diagnoses (ketoses, milkfever,..)
  - Body condition score (BCS)
  - Lab data (BHB,..)
  - On-farm testing (ketosis)
  - Milk composition based indicator traits (fat:protein ratio, based on MIR,..)
  - Other indicator traits (rumen activity, body weight change,..)

subclinical cases

Efficiency traits

- **What is efficiency?**
  - Output per input unit on farm level
  - Efficiency of individual animals
  - ...
- **Common traits**:
  - Feed efficiency – e.g. residual feed intake (difference between actual and predicted dry matter intake (DMI)– availability limited to research stations
  - Need for indicator traits (Fogh et al. 2013)
  - Correlations with other traits need to be understood (e.g. RFI and fertility may be unfavourably correlated) (Pryce et al. 2013)
  - Selection for RFI should be through a multi-trait selection index

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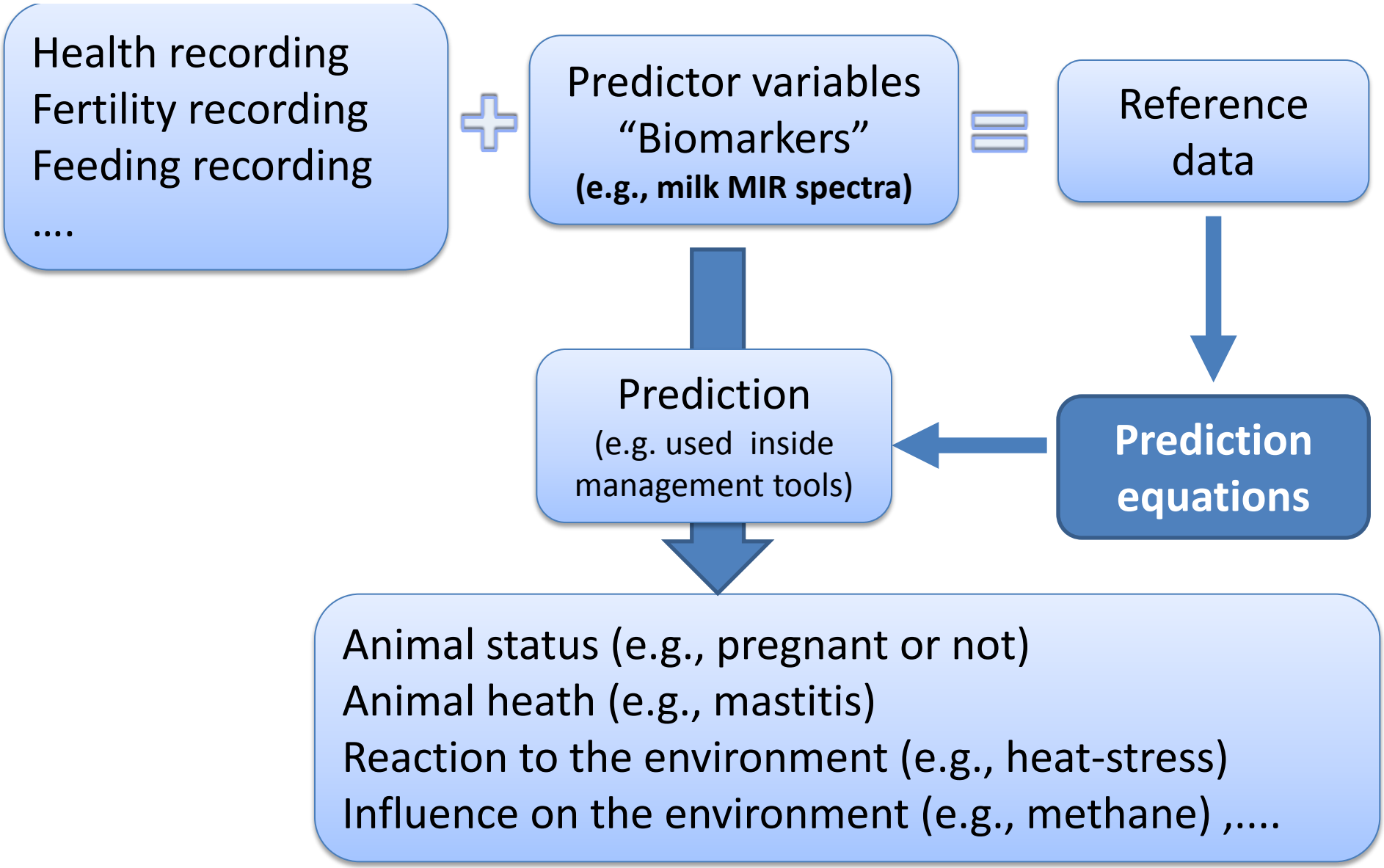
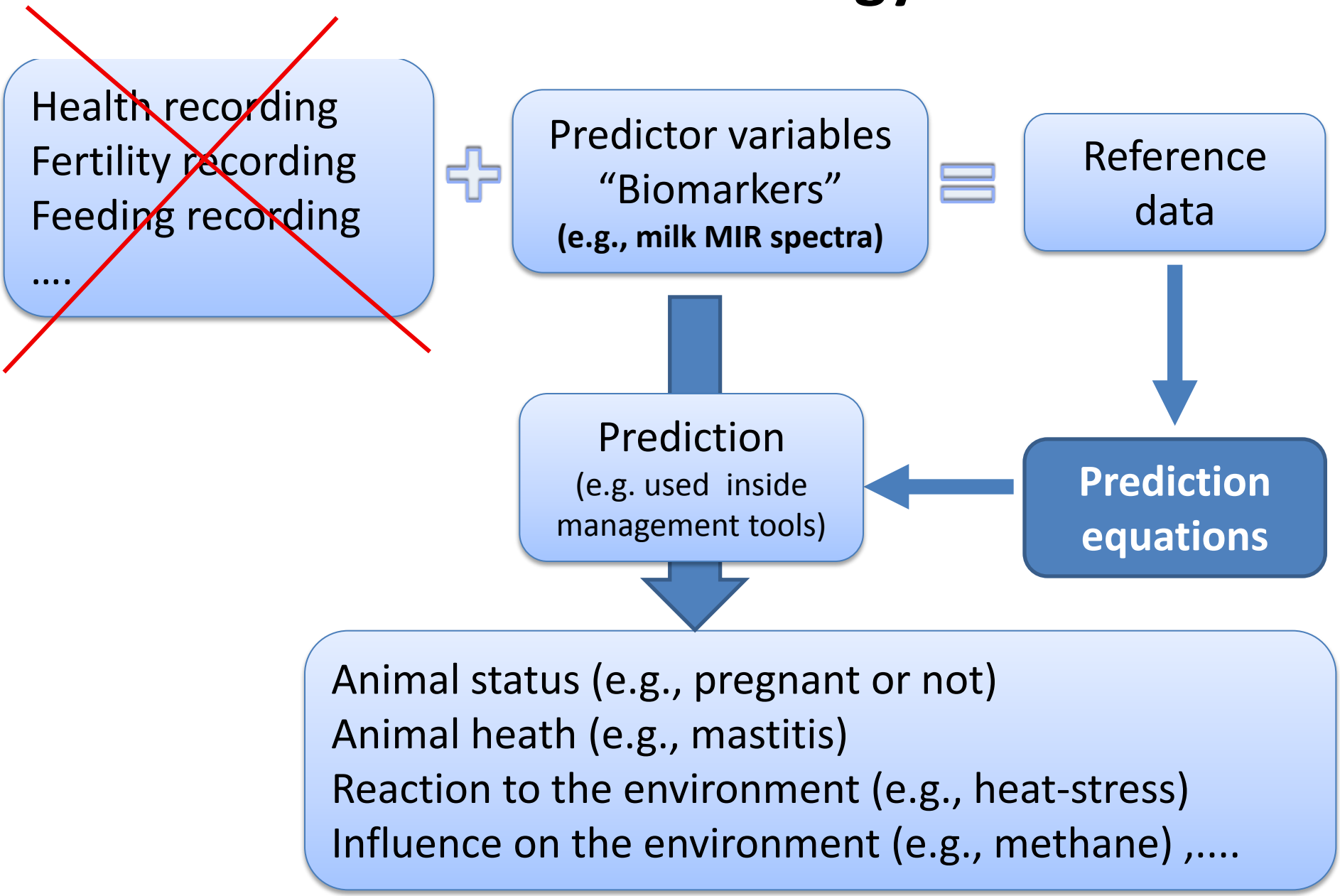
Challenges

- Predictive biology
- Standardization
- Integration of relevant data sources
  - On-farm – central database
  - Between databases
- Simplicitiy of use for farmer
- Closing the phenomic gap

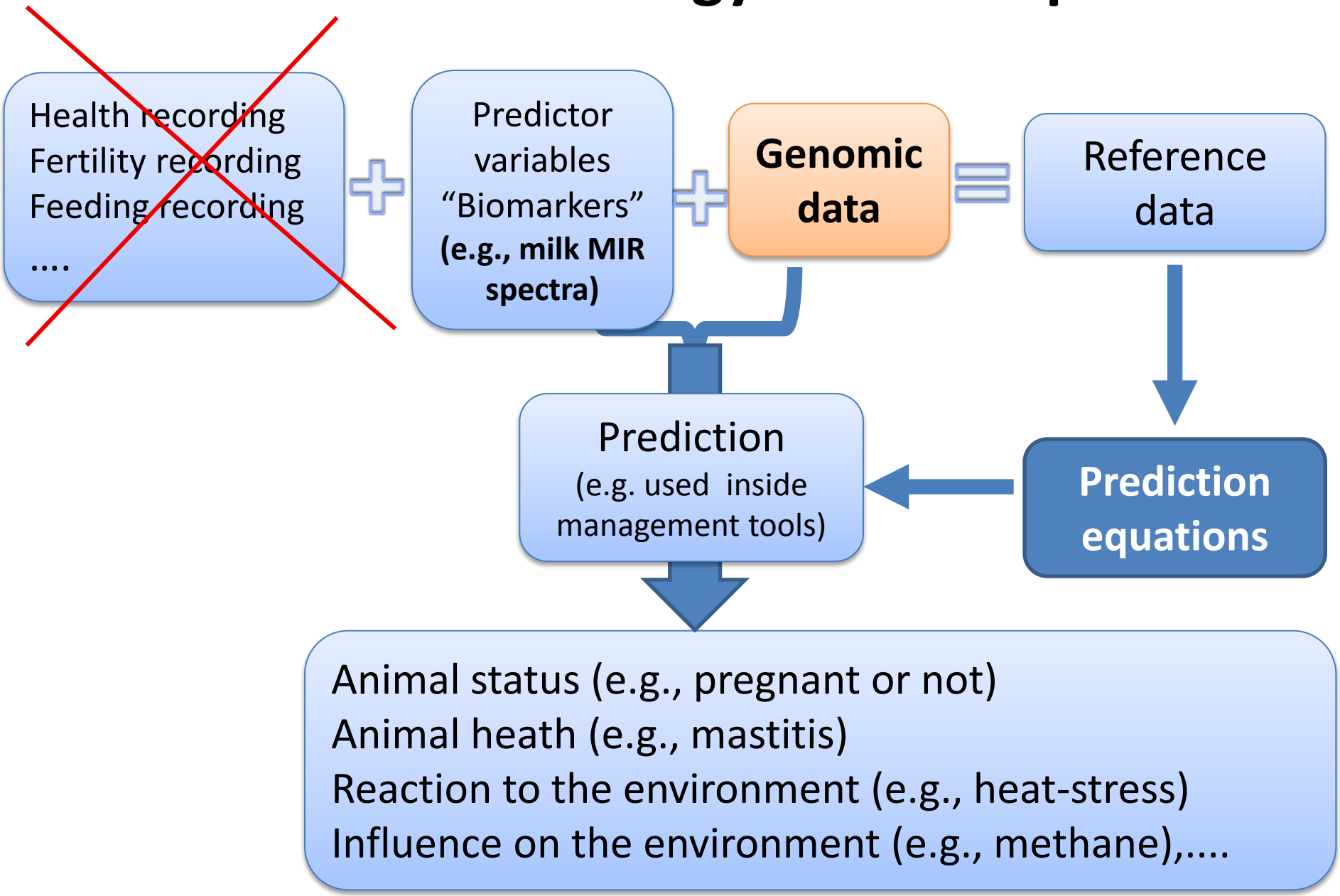
Predictive biology



Predictive biology



Predictive biology – next step



Challenges e.g. MIR

- **Reference spectra for detection of disease e.g. mastitis**
  - Reliable pool of „healthy“ and „sick animals“
  - Low heritability of trait e.g. 0.05 – limited reliability - repeatability
  - Account for different production circumstances
- Comparability of spectra from different brand (Foss, Bentley,.), machines inside brands – stability over time
- Repeatability of results across different breeds, production circumstances,..
- Logistic challenges:
  - Extracting from spectrometers and storing of MIR spectra
  - Standardizing spectra, complex computation of indicators
  - All implemented in routine into milk recording work flow

Automation

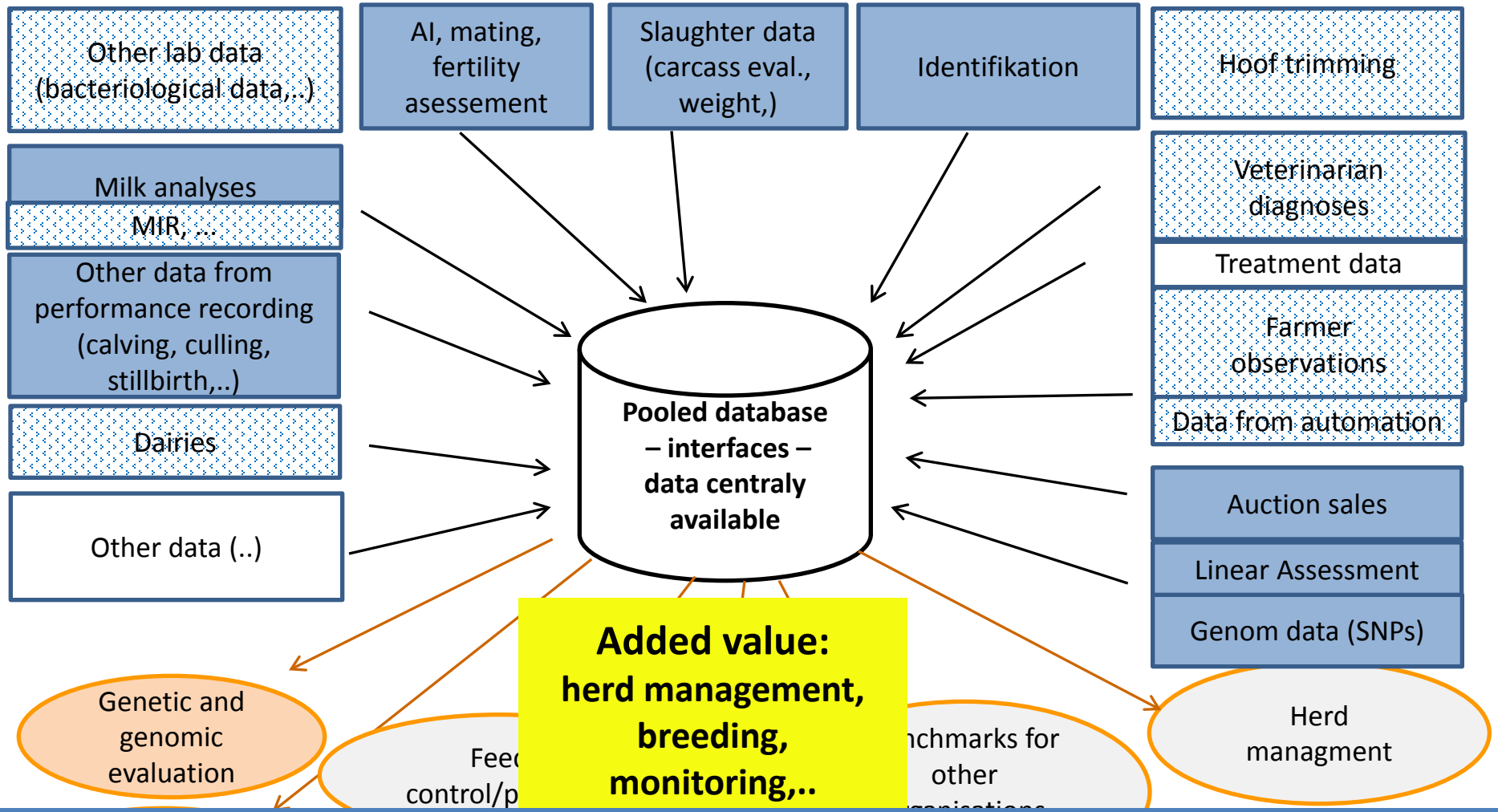
Standardisation and communication

Challenges:

- Rutten et al. (2013) - Review about sensors: still research needed; nearly no integration of already existing data,..
- Carry over (that a milk sample from cow B also contains some milk from cow A that was milked just before B (Lovendahl et el. 2013))
- Calibration of reference
- Standardization of traits accross techniques
- Communication on-farm between different technologies
- Communication between on-farm and central data base
- ..




Pooled Database – potential data sources und use



Need for standardization, integration and communication between data sources!

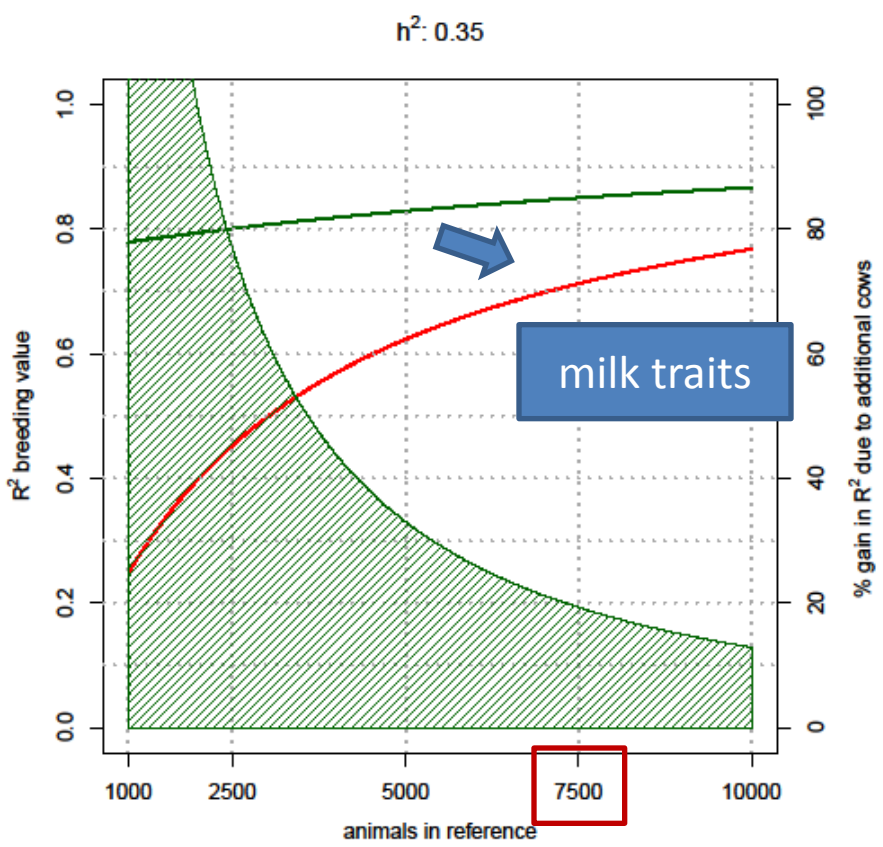
Closing the phenomic gap

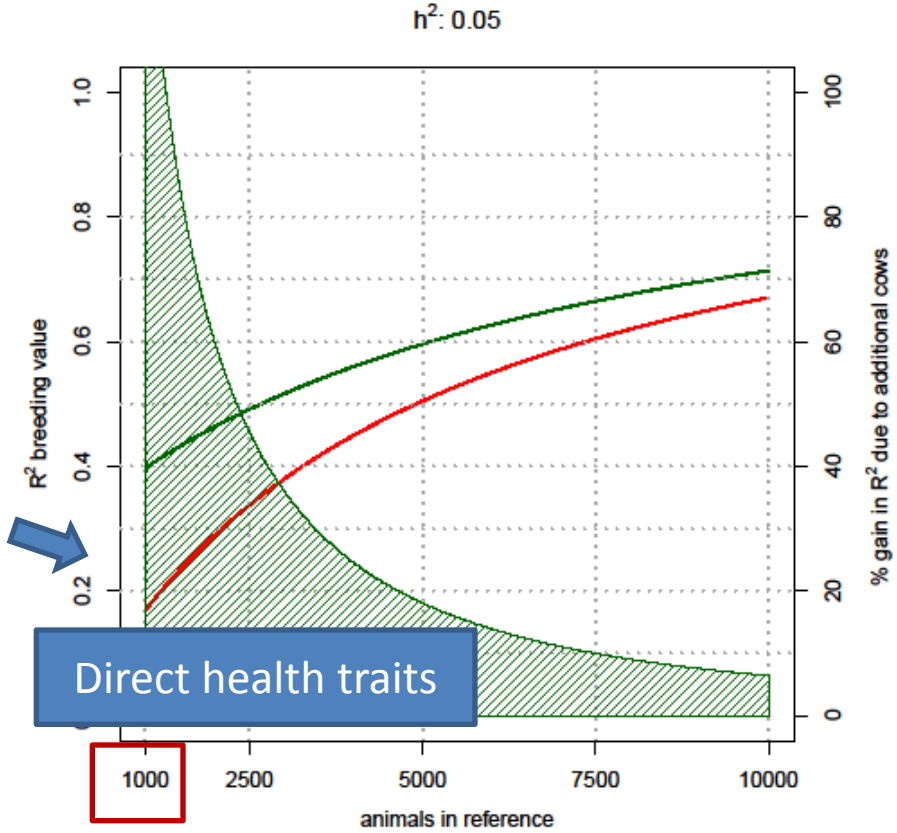
Genomic selection and novel traits

- Close gap between traditional traits and novel traits – a challenge!
- Large amounts of data needed for traits with low heritabilities – reliable phenotypes and genotypes! (reference population of 3,000 bulls comparable with 21,000 cows at heritability of 0.1 (de Roos, 2011)).
- Important to record complete herds!

Genotyping of cows

Impact of genotyping 25,000 cows additionally to bulls on reliability (R^2) for different traits (h^2=0.35; h^2=0.05)





red line – only bulls / **green line** - cows addtional to bulls

(Daetwyler et al. 2010; Schwarzenbacher, 2012)

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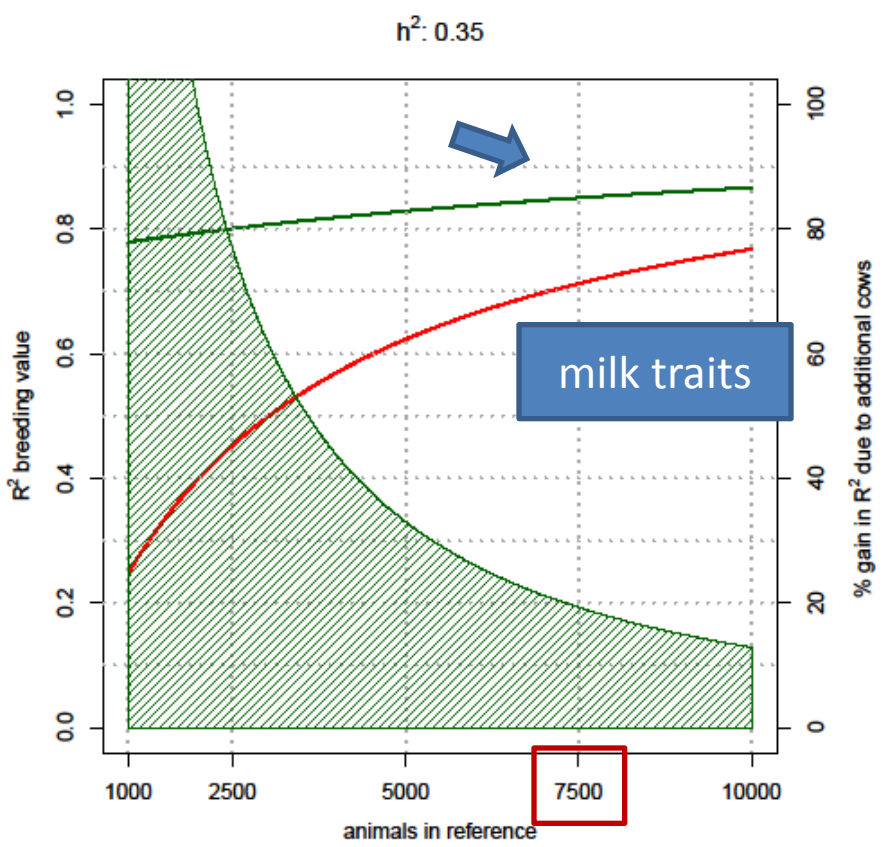

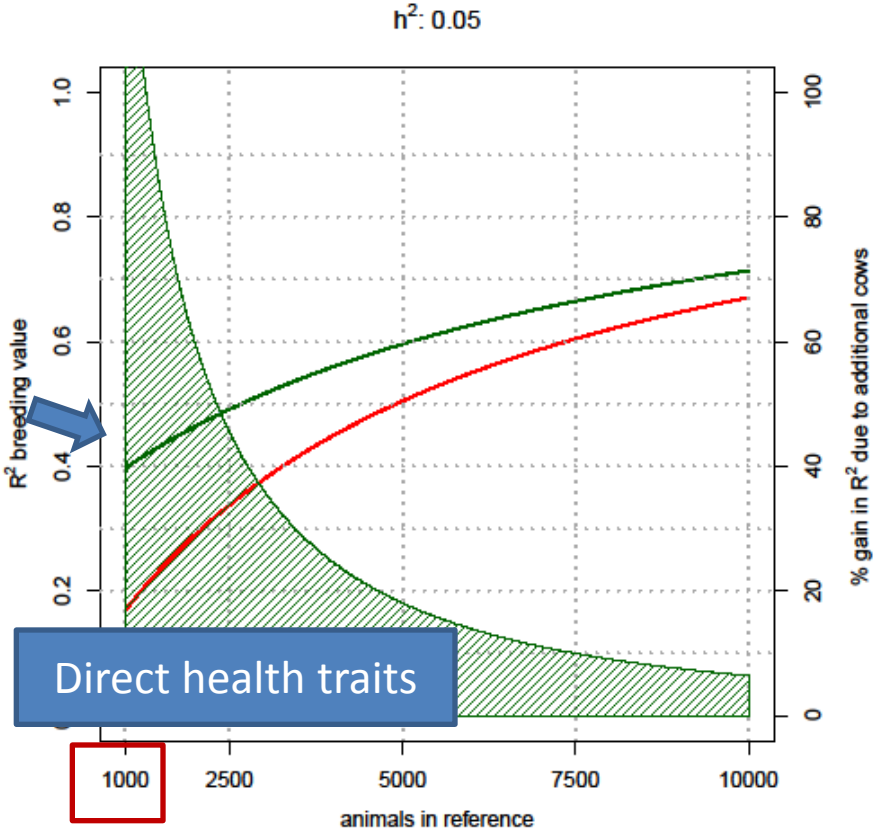

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(Daetwyler et al. 2010; Schwarzenbacher, 2012)

Conclusions

- Circumstances of production will require emphasis on new traits like health, welfare, efficiency,..
- Advances in technology enable “better” trait definitions
- Automation offers possiblities for indicator traits
- Standardization of traits and communication between data sources – a challenge!
- Reliable phenotypes for new traits needed for reference populations,..
- International cooperation needed in many fields!
- We can do better when we work together (multidisciplinary, multi-country approaches)!

Acknowledgement

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Further information on direct health traits are found under ICAR 2013 Health Data Conference – www.icar.org.

Thank you for your attention!