Welcome to the seminar

Facing the challenges in the food system

CRV
BETTER COWS > BETTER LIFE

Cobb

Topigs Norsvin
PROGRESS IN PIGS

HENDRIX GENETICS

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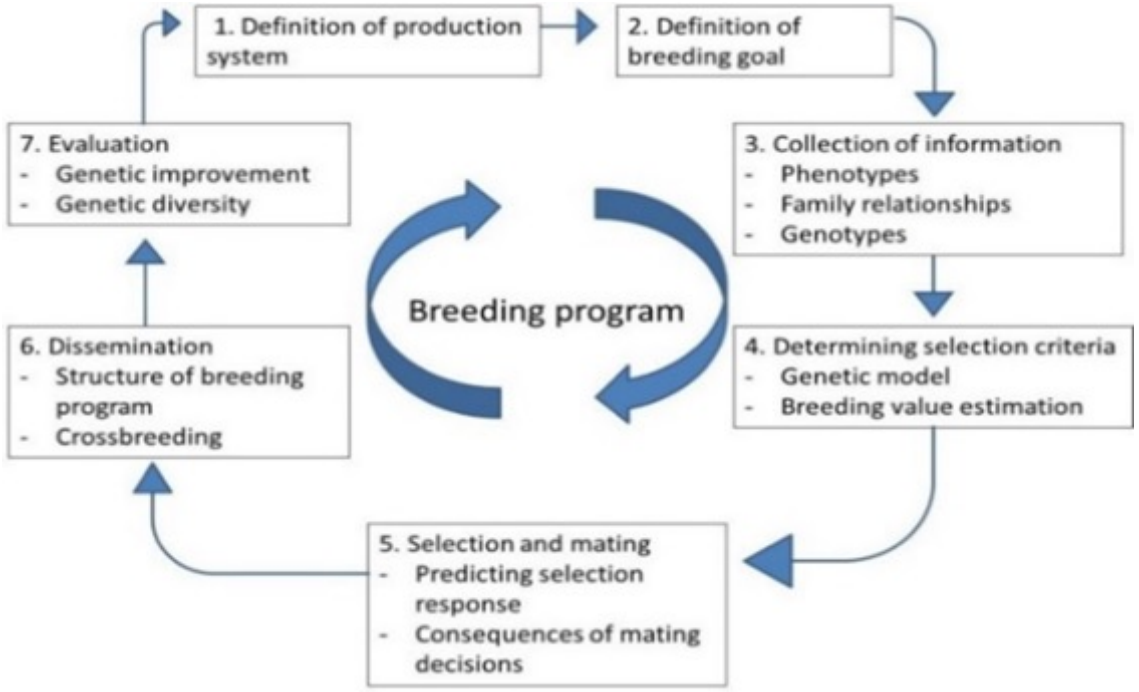
Breed4Food Theme: Precision Phenotyping

Precision phenotyping for animal breeding History, Breed4Food, Future

-

Yvette de Haas

History


1. Definition of production system
2. Definition of breeding goal
3. Collection of information
- Phenotypes
- Family relationships
- Genotypes
4. Determining selection criteria
- Genetic model
- Breeding value estimation
5. Selection and mating
- Predicting selection response
- Consequences of mating decisions
6. Dissemination
- Structure of breeding program
- Crossbreeding
7. Evaluation
- Genetic improvement
- Genetic diversity
Breeding program

Selecting the best animals as parents

countries. They have become widely disseminated in Sweden and Norway, and there are now control associations in Finland, Russia, Germany and Scotland. In most places an attempt is made to carry out the weighing and valuation of the feed, as in Denmark; but, in some parts of Norway, where the cows subsist entirely on grass in the summer and on hay and straw in the winter, it is thought that the estimate of the feed will be too inaccurate, and therefore the work of the control assistant is limited to managing the test milking, testing for butter fat, and keeping a record of the milk and butter yield.

Where there is no record of the consumption of feed, there will be no basis for a fair comparison of the milk and butter yield in the various herds, because the amount of feed will always affect the yield of butter; but, even without a record of the feeding, the "control" will give every farmer valuable information regarding the yield of milk and butter of the individual cows, so that he can positively distinguish the best, the good, and the poor cows; and he gets an opportunity to find those cows that give particularly rich milk, which is of immense importance, if it is, as we believe, that giving rich or poor milk is for each cow a peculiar and inherited quality.

NOTE.—
1 pound, Danish, is the same as 1.12 English.
1 Krone = $.268.
1 Ore = 1/100 Krone = 1/4 cent.

[Presented by the Committee on Cooperation in Animal Breeding.]

Translated from the Danish manuscript.

COW-TESTING ASSOCIATIONS.

COLON C. LILLIE, *Coopersville, Mich.*

A cow-testing association is a cooperative business association among the dairy farmers of a community for the purpose of testing their cows for economical production. Each cow is charged with the food she consumes and given credit for the butter fat she produces for the entire year at market prices. A competent person is employed by the association to go from farm to farm and weigh and compute the ration, weigh and test the milk and keep accurate records of the same.

Journal of Heredity (1911) os-6:295-300

Novel phenotypes

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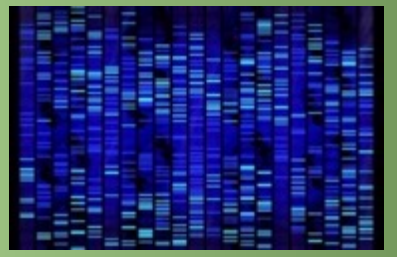
BREED4FOOD

1980's	1990's	2000's	2010's

production

fertility/health



genomic selection

methane/
feed efficiency

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Livestock & Environment
Animal Nutrition

TiFN FOOD & NUTRITION

production

genome

social behaviour

immunity

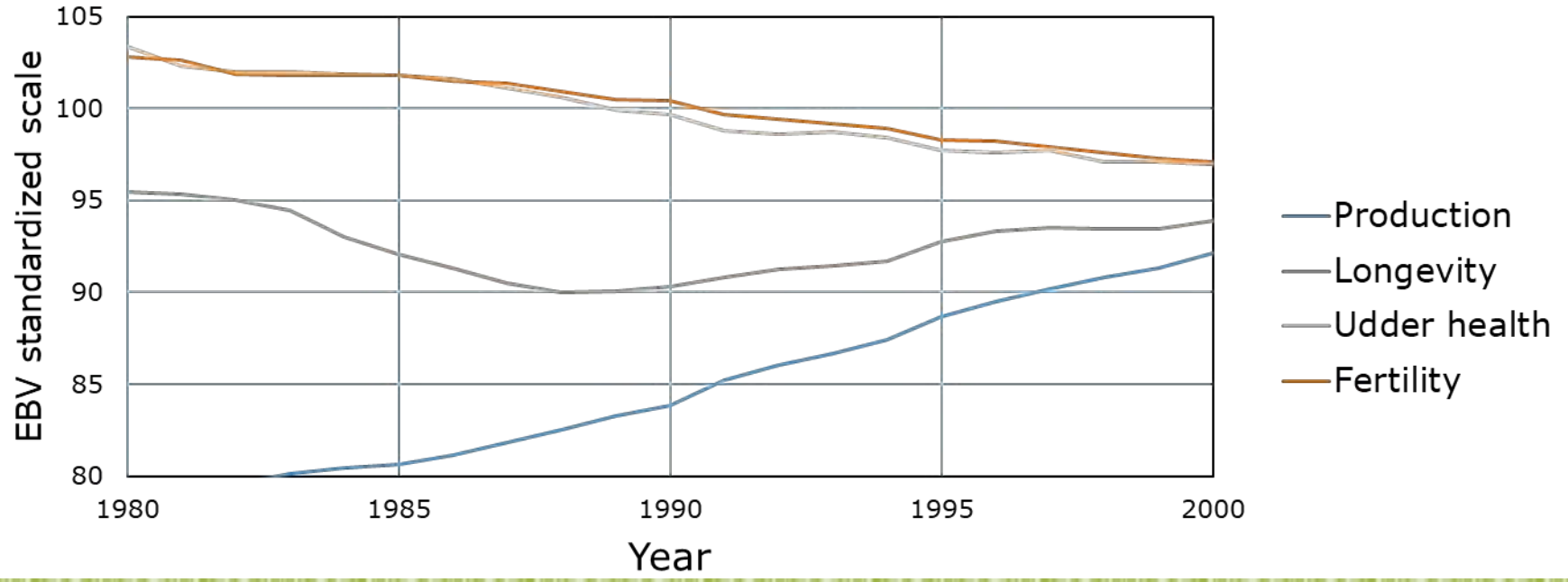
HENDRIX GENETICS

Adaptation Physiology
Behaviour Ecology

STW connecting innovators

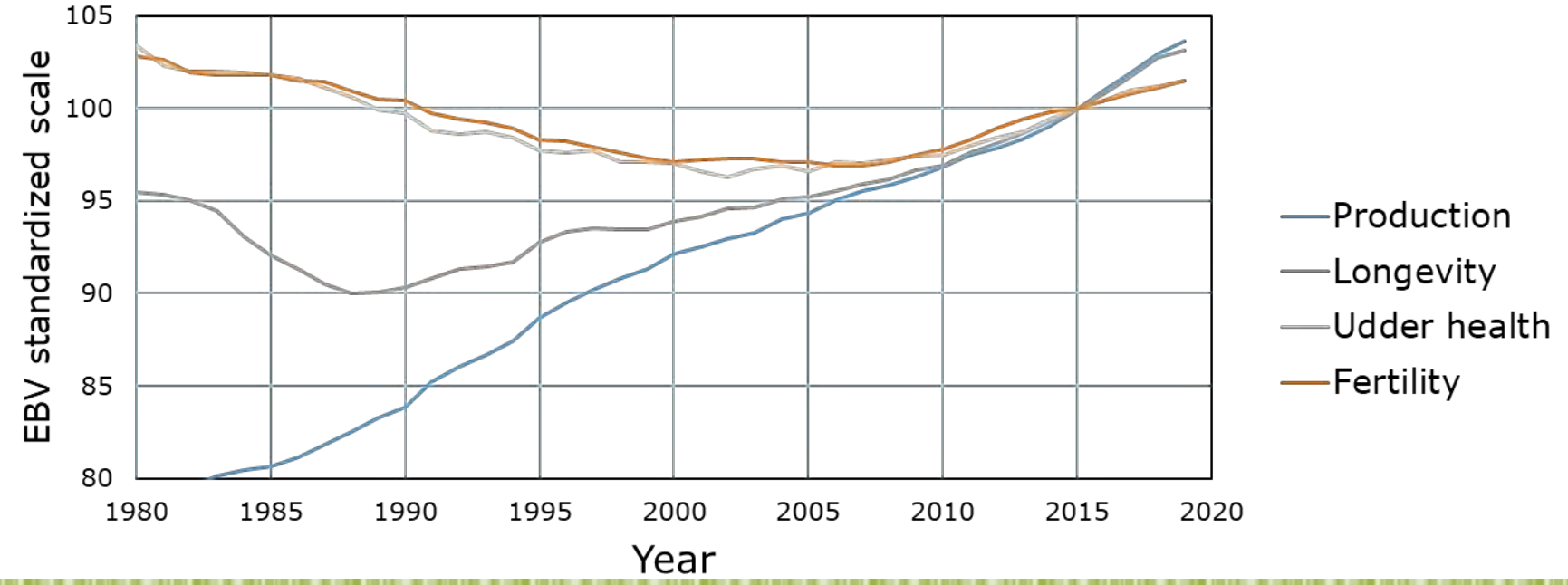
History of breeding dairy cattle

- 1930-1990s: selection for production traits (and conformation traits)



History of breeding dairy cattle

- 1930-1990s: selection for production traits (and conformation traits)
- 1990-...: fertility, SCS, longevity



Breed4Food

Health and resilience

Resource efficiency

Welfare and longevity

Sustainable animal production

Efficient selection

Broad breeding goals

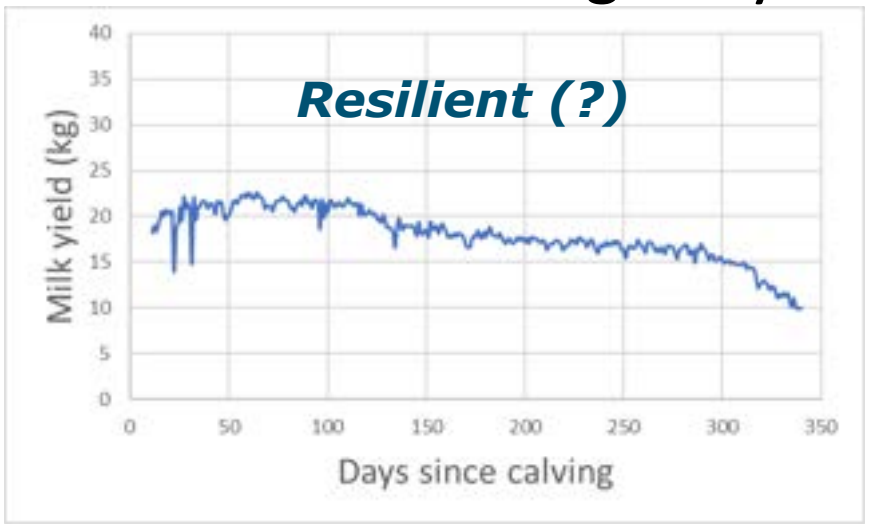
Focus areas for phenotyping

1. Health and resilience
   - Locomotion
   - DNA pooling
   - Microbiome
   - Mortality
   - Resilience
     - Cattle – milk production
     - Turkey – feed intake

Genetic selection for resilience

AIM: To develop resilience indicators for dairy cattle that can assist in genetic selection for improved resilience

...using daily milk yield records



Low variance
&
low autocorrelation

High variance
&
high autocorrelation

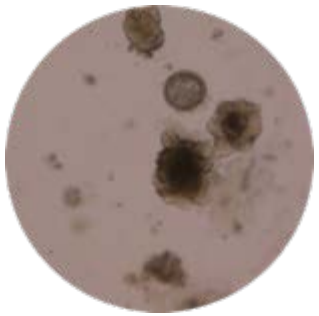
Conclusions resilience indicators

- We can select for resilience in dairy cows using resilience indicators based on daily milk yield records
  - Heritable
  - **Variance** genetically associated with:
    - Health & longevity
    - Strength of response to actual disturbances
  - **Autocorrelation** genetically associated with:
    - Recovery rate after actual disturbances

- Combination of variance & autocorrelation → improve all aspects of resilience

Focus areas for phenotyping

2. Resource efficiency
   - Organoids
   - Digestibility
   - Infrared thermography
   - Protein efficiency

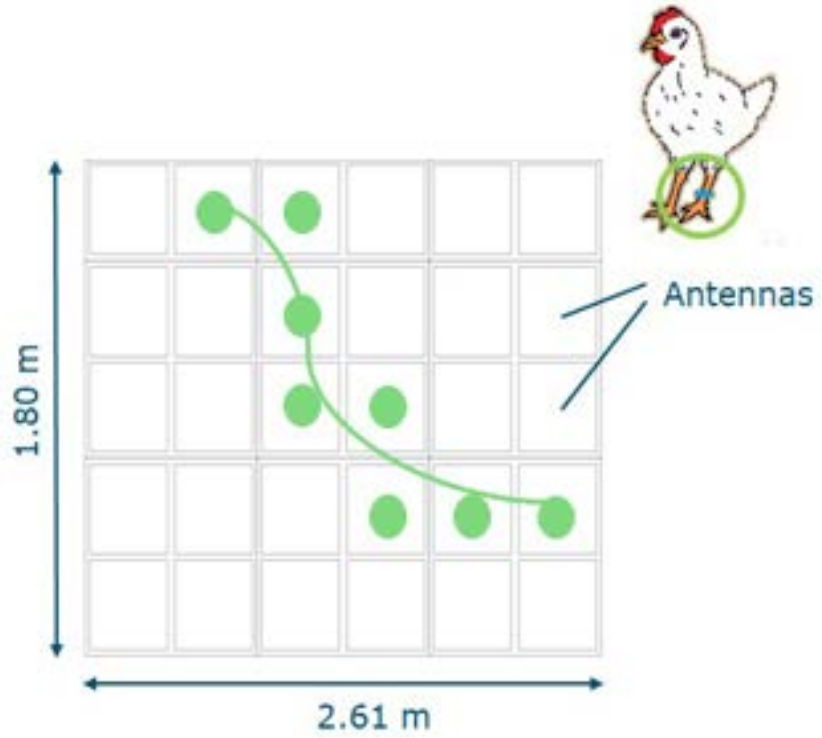


Focus areas for phenotyping

3. Welfare and longevity
   - Tracking and monitoring
     - Broilers
     - Cattle
     - Pigs

Tracking broilers for activity

- RFID tag in leg band
- 30 antennas in a grid underneath floor
- One sample per second
- From hatching onwards



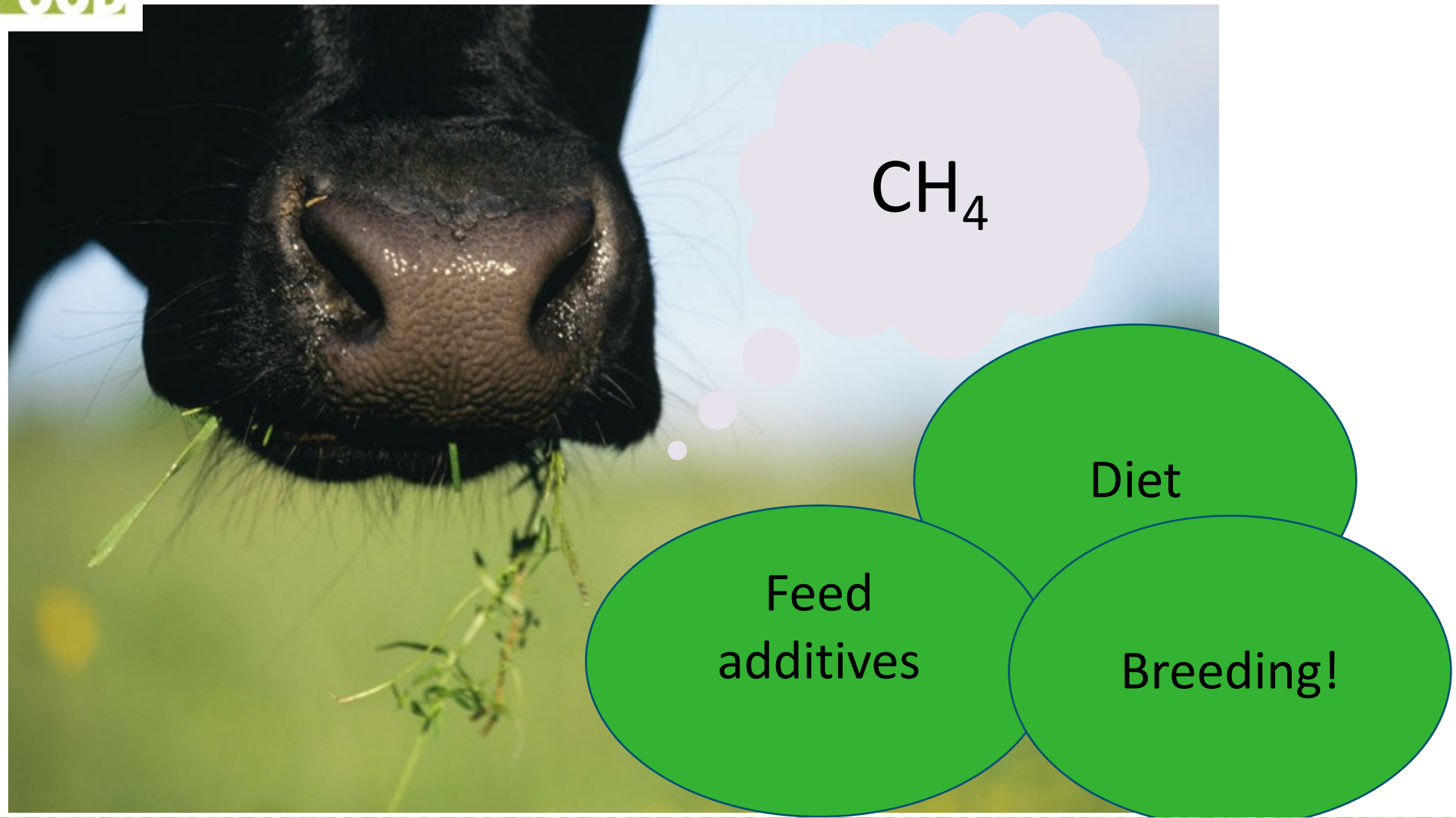
Monitoring activity throughout life

- RFID system is suitable
- Valuable for breeding programmes
- Keep track of individual health, welfare and performance
- Early intervention: detect or even predict problems early on

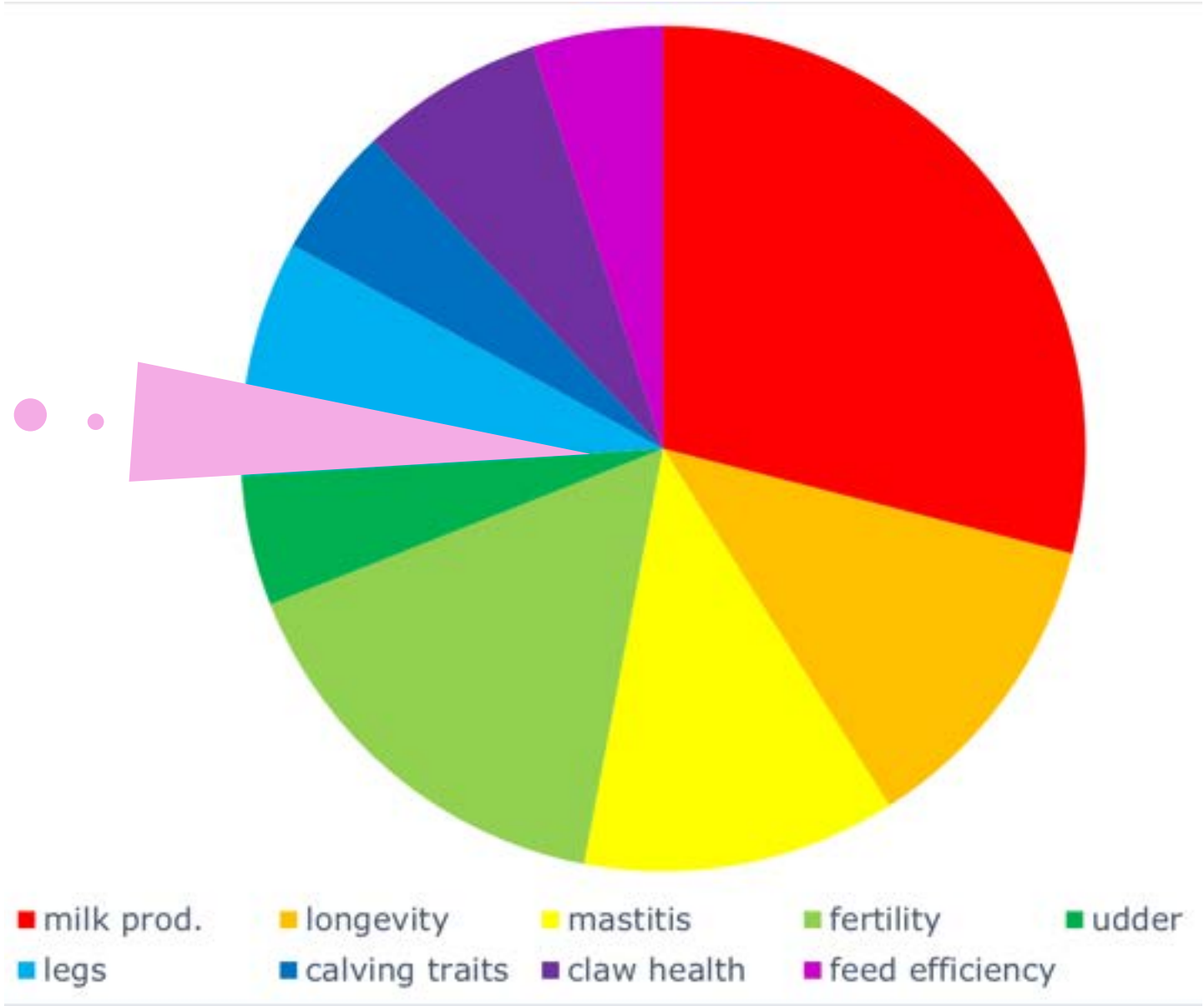
Focus areas for phenotyping

4. Environmental impact
   - Methane emissions
   - N & P efficiency
   - Mineral losses

5. Big data
   - Hackathon machine learning
   - Data lakes
   - Cloud solutions
   - Ploidyscreen


CH_4
Diet
Feed additives
Breeding!

CH_4


milk prod.
longevity
mastitis
fertility
udder
legs
calving traits
claw health
feed efficiency

Measuring enteric methane

- Spot sampling method, installed in feed bin of a milking robot, measures concentration (ppm)

☺High throughput

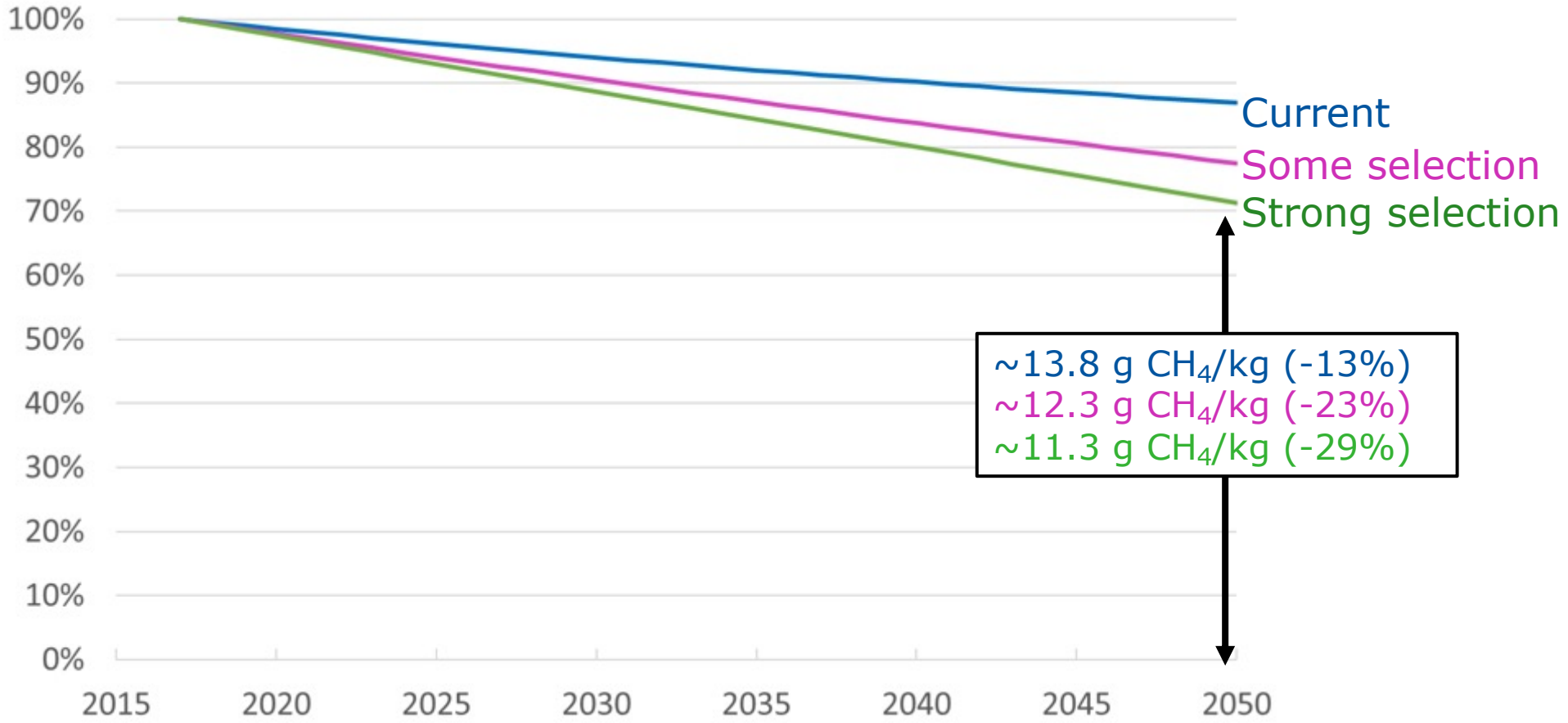
☺Non-invasive

☺Cost-effective

☹ Lower precision

FrieslandCampina

CRV BETTER COWS > BETTER LIFE


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2015
2020
2025
2030
2035
2040
2045
2050
Current
Some selection
Strong selection
~13.8 g CH4/kg (-13%)
~12.3 g CH4/kg (-23%)
~11.3 g CH4/kg (-29%)

Future

To serve animal husbandry & society

Precision phenotyping enables to:

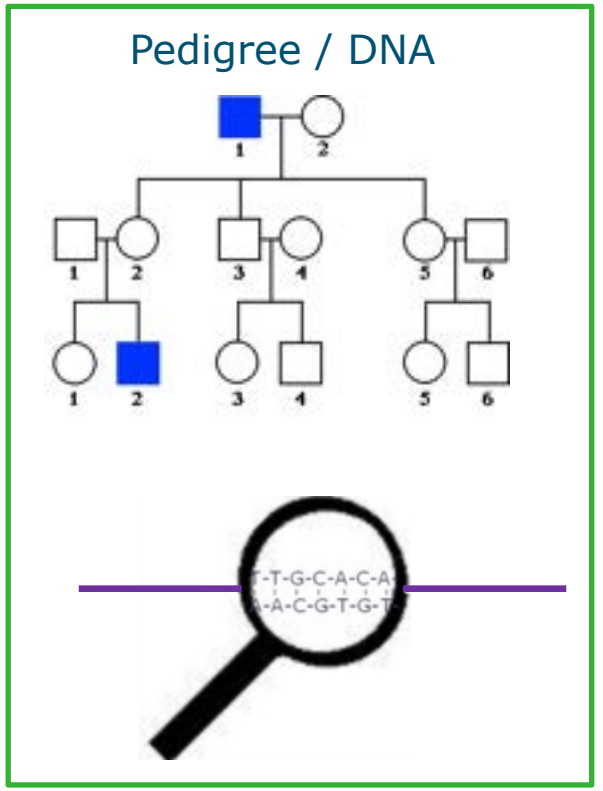
- Record new traits that are important for consumers & society
  - Health, Welfare
  - Environmental impact
- Record information to get a better / deeper understanding of existing traits
  - Efficiency
  - Fertility

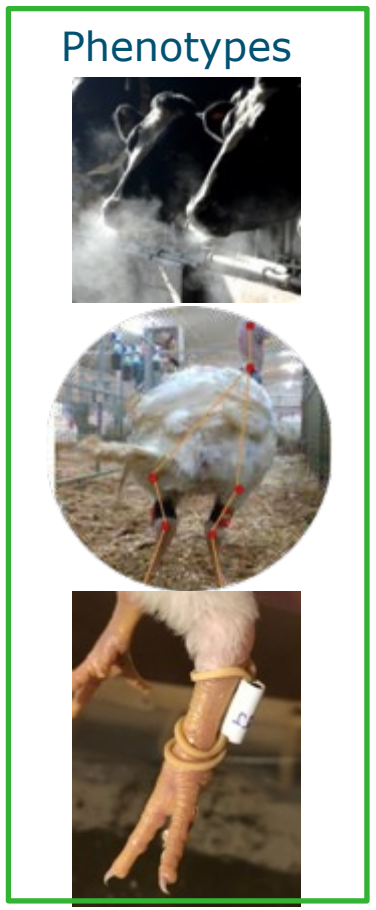
Phenotyping interface

- Handling large-dimensional data
  - Aggregate from automated and (near) real-time data collection
- Link these data with genomic prediction pipeline

Summary

- For genetic progress precision phenotyping remains important
- Only then you know which animals to select





Save the date: 29 September 2022

IMAGEN & Breed4Food Individual Tracking symposium

on **automated phenotyping**

Thursday the 29th of September 2022, full day

Hotel de Nieuwe Wereld, Wageningen

Interesting programme with national and international speakers

More information will follow

Contact: Piter Bijma, Esther Ellen, Malou van der Sluis

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Breed4Food Theme: Precision Phenotyping

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Highlights & Interaction

Highlight 1

DNA pooling related to phenotyping

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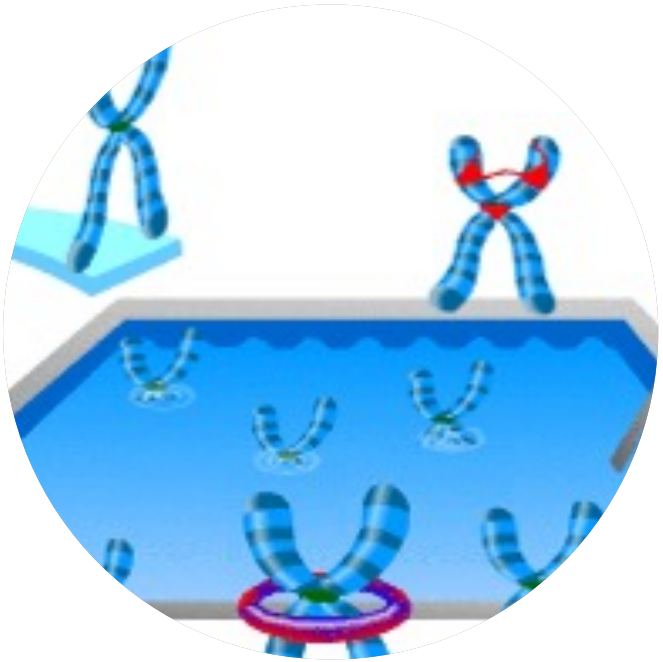
Marco Bink, HG

Michael Aldridge, WUR

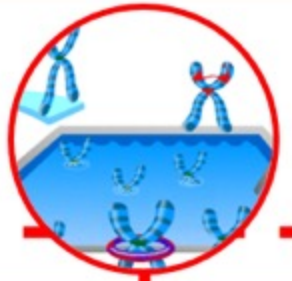
DNA pooling

B4F 07/04/2022 - **Michael Aldridge**, J. Marjanovic, J.M. Henshall, B. de Klerk, K. Peeters, K .de Greef and Y. de Haas



twitter
@mn_aldridge

DNA pooling – a cheap link to the purelines



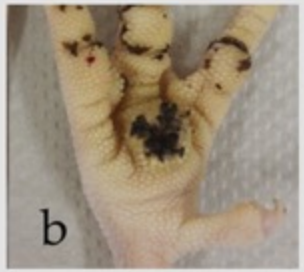
Commercial crossbreds

Good environment

Average environment

Challenging environment

Slaughterhouse



1. Sort tissue samples
2. Extract DNA
3. Amplify DNA
4. Mix DNA samples
5. Genotype pools
6. Estimate SNP effects
7. Select purebreds.

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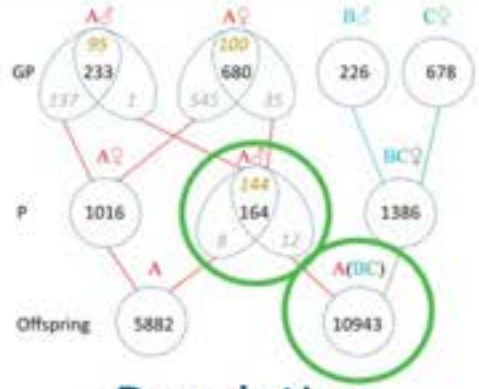
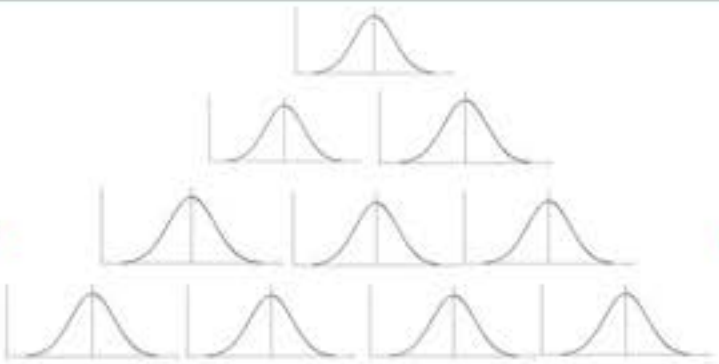
twitter @mn_aldridge

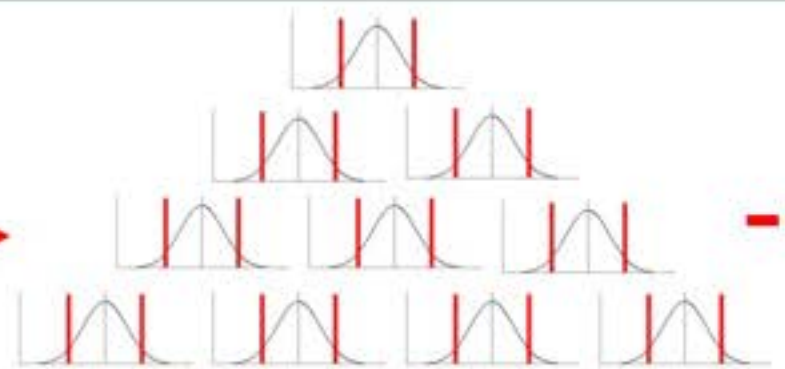
Summary of sampling



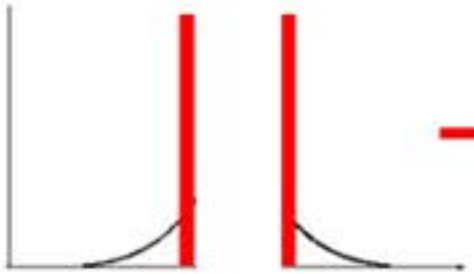
Population



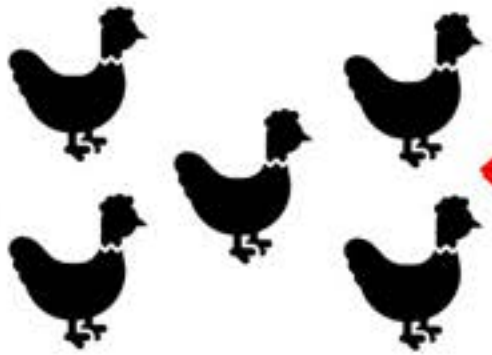
Contemporary groups



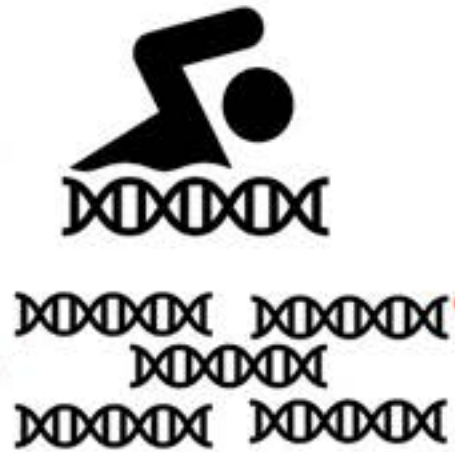
High and low ends



High and low ends



Individuals randomly selected



Create allele frequency pools
or
Individual genotypes

Repeat selection 10 times for each sampling strategy.

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What does this mean practically

Method	Accuracy	Bias	Cost per sample genotyped	Number of samples genotyped	Total cost
890 high/low	0.62	0.98	€28	890 (890)	€24,920
426 high/low	0.42	0.74	€28	426 (426)	€11,928
58 high/low	0.14	0.24	€28	58 (58)	€1,624
Pool size 5 (25%)	0.51	0.87	€29	890 (4,450)	€25,810
Pool size 5 (20%)	0.51	0.87	€29	706 (3,530)	€20,474
Pool size 5 (10%)	0.46	0.79	€29	342 (1,710)	€9,918
Pool size 10	0.49	0.83	€30	426 (4,260)	€12,780
Pool size 50	0.45	0.76	€38	58 (2,900)	€2,204

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Highlight 2
Behaviour analysis in dairy cattle

-

Erik Mullaart, CRV

Ines Adriaens, WUR

Quantification of animal behaviour

For ***breeding***:
- Large scale phenotyping
- Complex traits
- Animal-in-environment

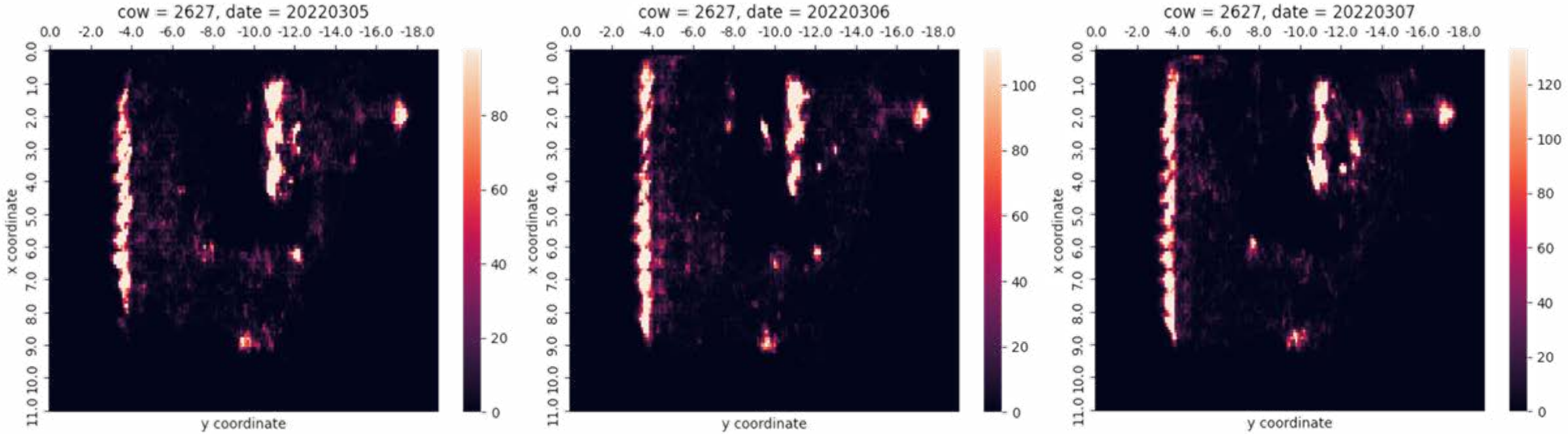
For ***monitoring***:
- (early) disease detection
- Welfare assessment
- Recovery & cure

Lying behaviour – spatial data

Sensor system attached to the neck

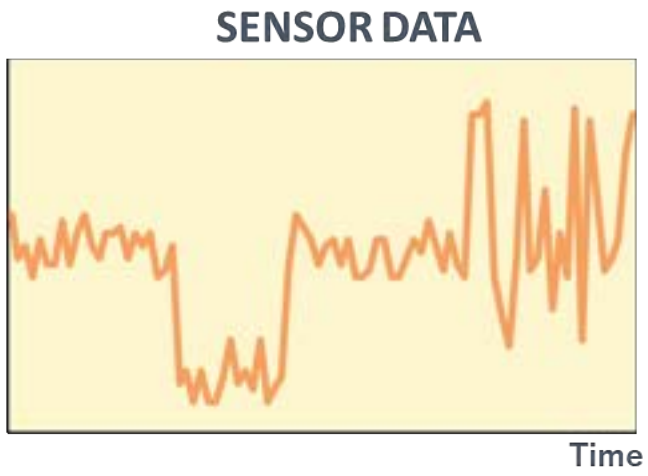
2022-01-18 05:51:00

Lying behaviour – spatial data

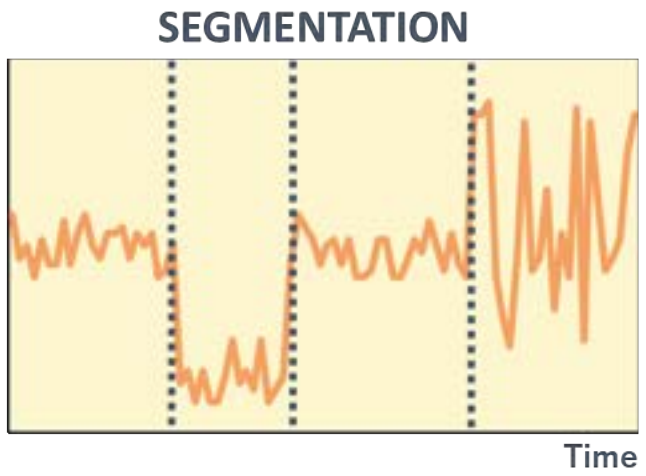


+ time dimension

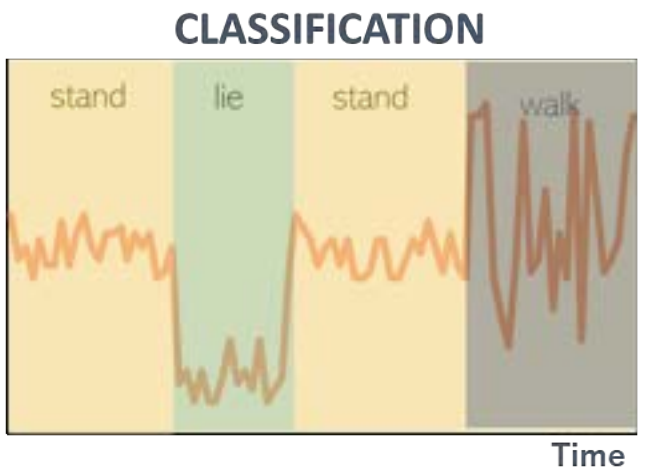
Methodology



Data preparation

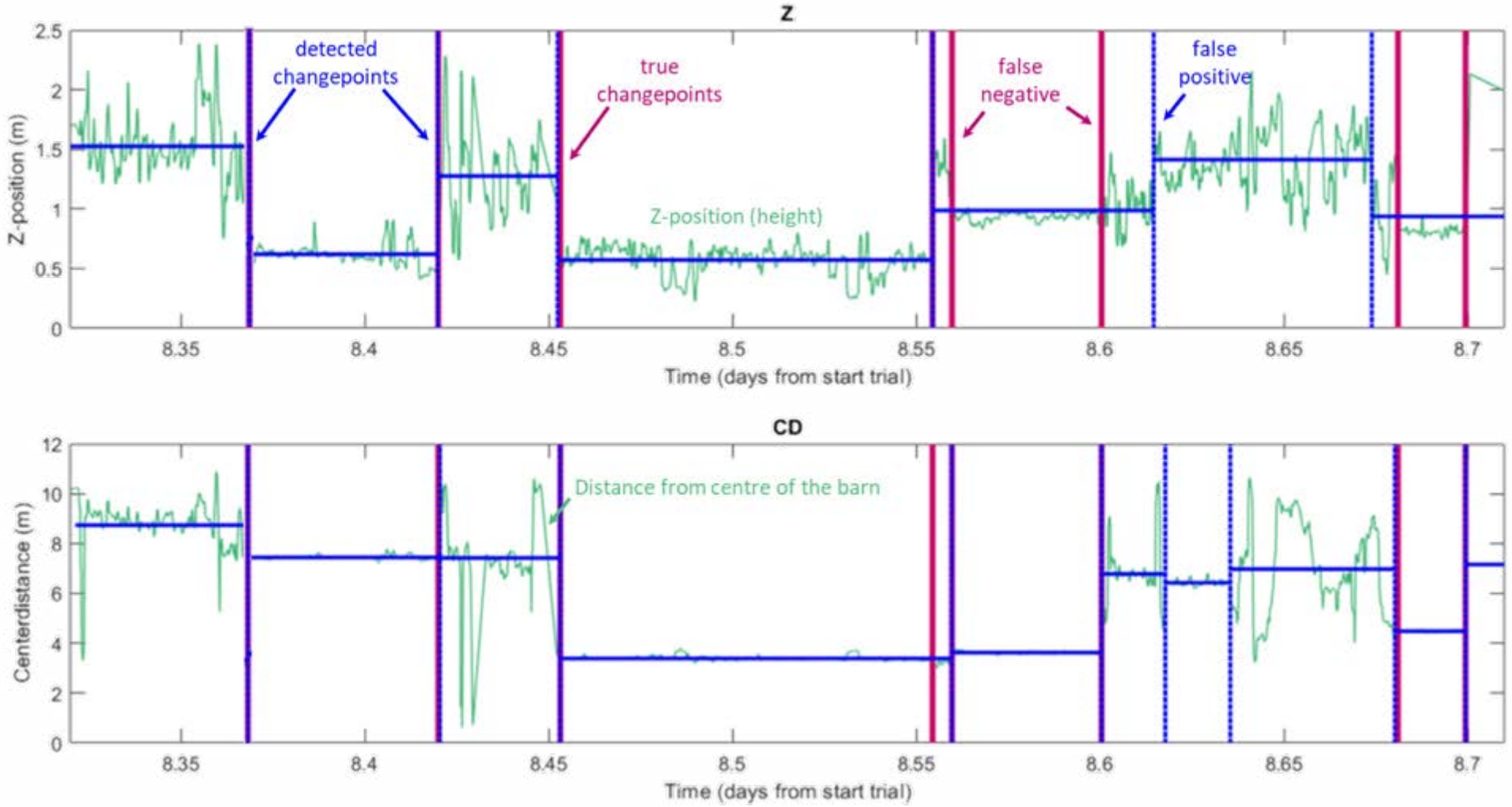


Statistical changepoint analysis

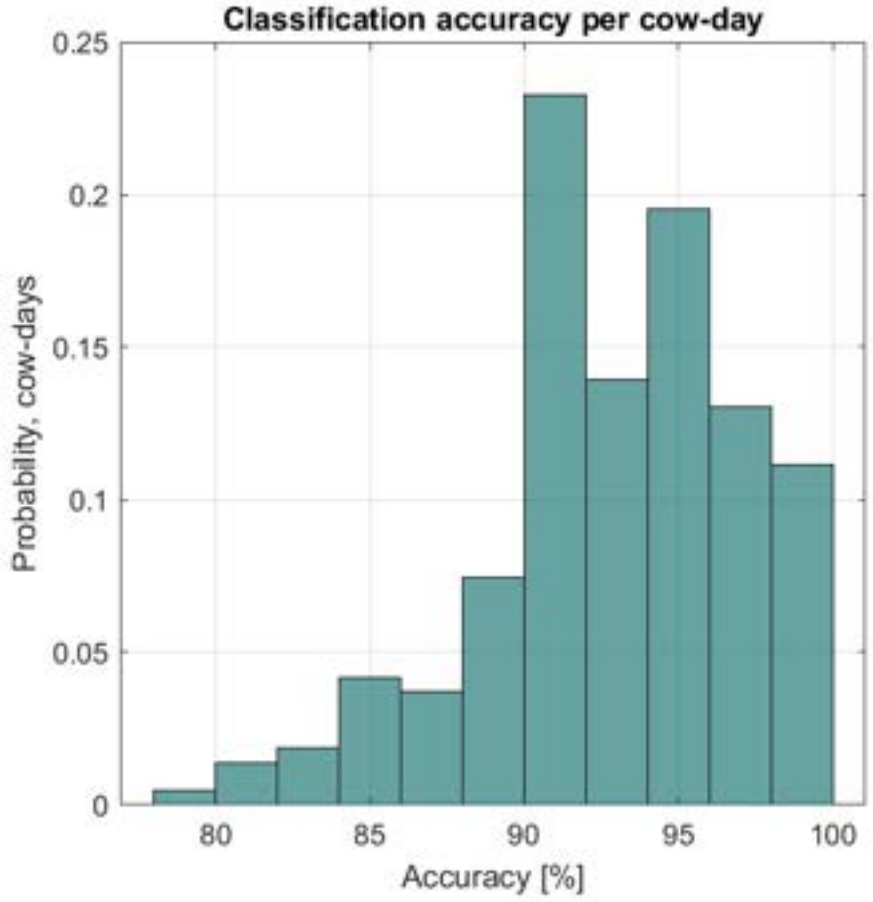


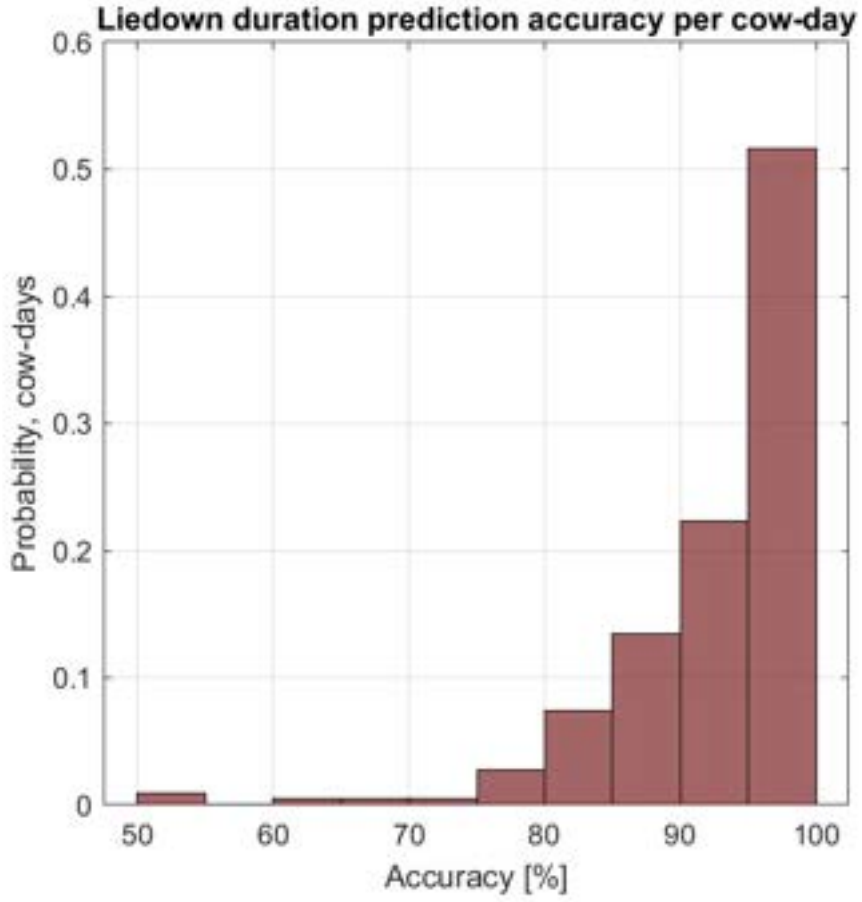
Machine learning – bagged decision trees

Methodology



Accurate prediction with minimal training data





Highlight 3

Finding answers with organoids

-

Lisanne Verschuren, TopigsNorsvin

Esther Ellen / Leo Kruijt / Agnes de Wit / Elianne van der Valk, WUR

Highlight 4

Individual monitoring activity broilers

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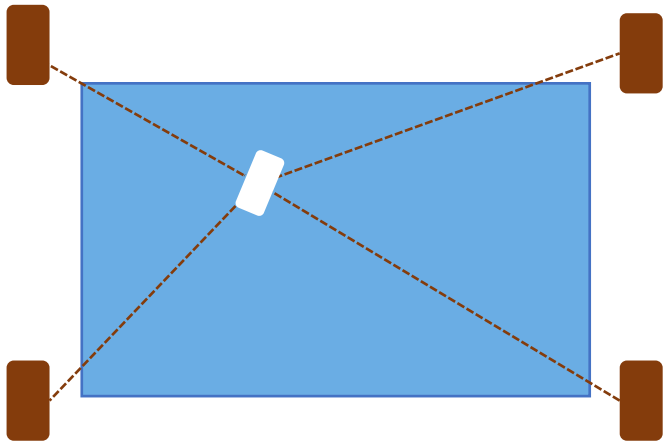
Britt de Klerk, Cobb

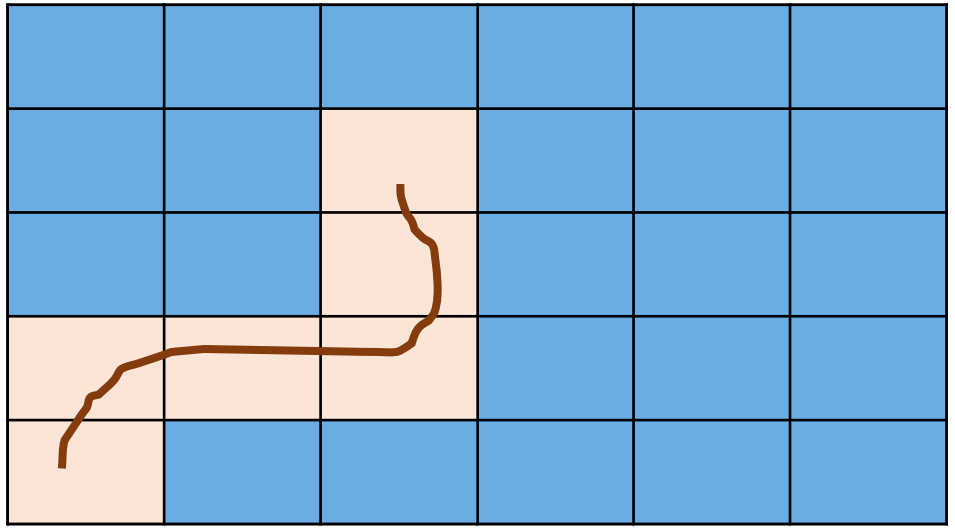
Malou van der Sluis, WUR

Automated recording of activity

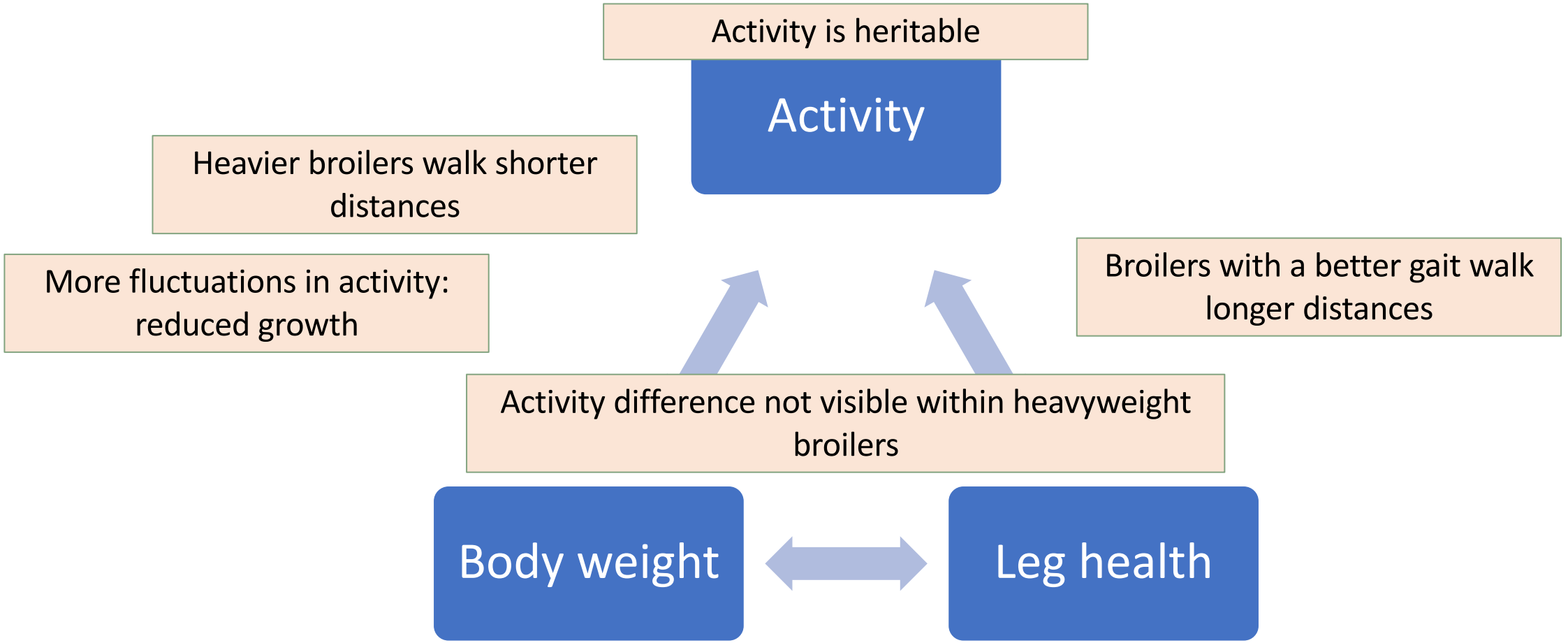
Ultra-wideband tracking



Radio frequency identification



Linking activity to health, welfare and performance



Wrap up with young scientists in the audience

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Martijn Derks

Malou van der Sluis

Marieke Poppe

Thanks for joining us!

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