Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Economic Affairs,
Education and Research EAER

Agroscope

Agroscope's current research projects in digitisation of lifestock and agriculture

Thomas Anken, Agroscope
Tänikon, CH-8356 Ettenhausen

Foto M. Ruttimann

www.agroscope.ch

Agroscope in a nutshell

- **Research institute** within the Swiss Federal Office for Agriculture

- **Research** across most agricultural production systems

- **Enforcement tasks, Knowledge transfer** to agricultural practice, extension, industry, science, teaching and the public

- **1000 collaborators** in 10 locations in Switzerland

- **Agritec:** Group Digital production, Tänikon
  → digitisation can be found everywhere!

www.feedbase.ch a collection of feed data

Patrick Schlegel patrick.schlegel@agroscope.admin.ch

Pocket Feed Lab (Innosuisse project)

Michael Simmler michael.simmler@agroscope.admin.ch

Rapid on-site analysis of the nutritional composition of poultry feed and feed ingredients

Mobile app

Cloud backend
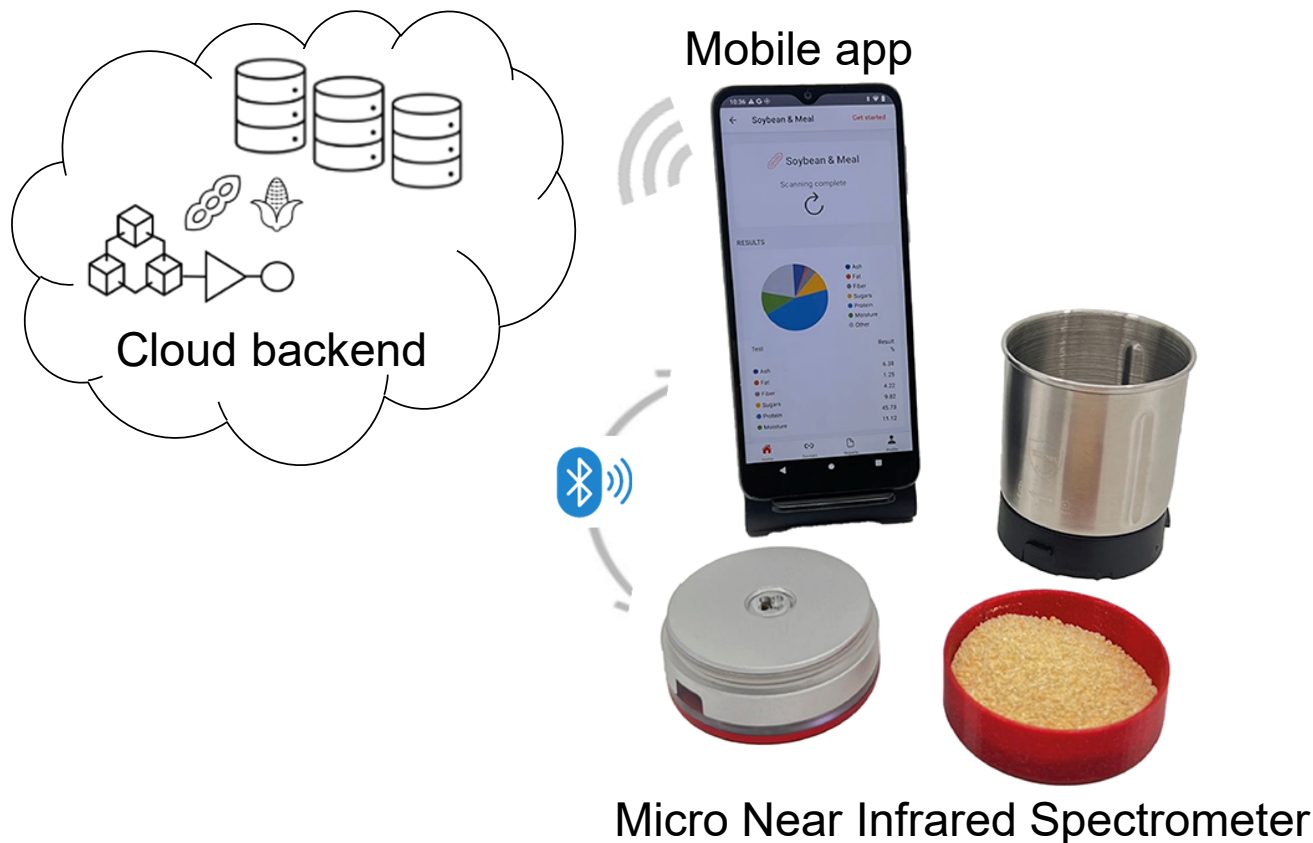
aikemy

Hardware
Software
Business case

Agata Sroka
agata@aikemy.com

Agroscope

Chemometrics
Maschine learning

Micro Near Infrared Spectrometer

Pocket Feed Lab (Innosuisse project)

Rapid on-site analysis of the nutritional composition of poultry feed and feed ingredients

Sample collection to result in < 10 min
(with sample preparation)

Pocket NIR

Pocket NIR

Models for…

protein
fat
fiber   in
sugars
ash
moisture

poultry feed
corn
wheat
soja
Distiller's Dried Grain with
Solubles

aikemy.com developed a highly portable feed- testing solution for livestock (poultry)

The NIRS sensor-app-cloud system determines feed quality
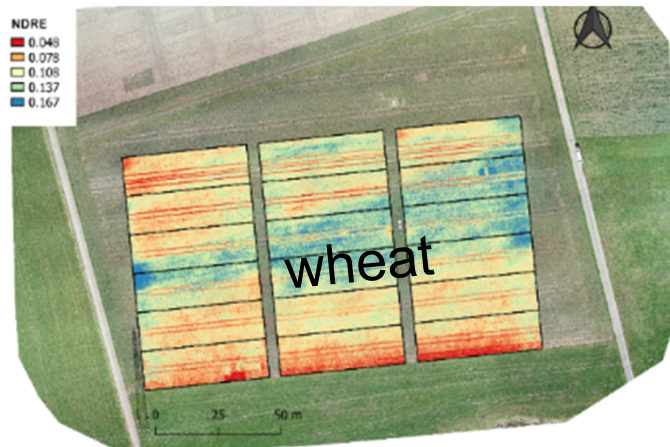
→ Agroscope contributed the data analytics

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How to split different protein levels at harvest?

Thomas Anken thomas.anken@agroscope.admin.ch

Site specific farming allows much better insight on quality levels on fields

Satellites are measuring the status of the plants

wheat

Application map for fertilization is generated in the cloud

fertilizer spreader knows where to put more or less fertilizer

→ Mapping of protein levels becomes possible, NIR-tools on combines…
→ We know where good and where poor qualities are, but fields are harvested uniformly
→ How interesting would it be to split different protein levels: A combine with two bunkers….

RumiWatch for health monitoring of cows

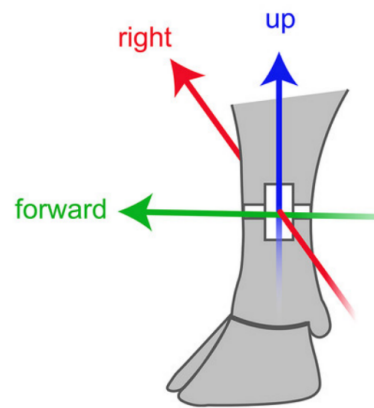Markus Keller markus.keller@agroscope.admin.ch

data logger

battery

pressure hose

pression sensor
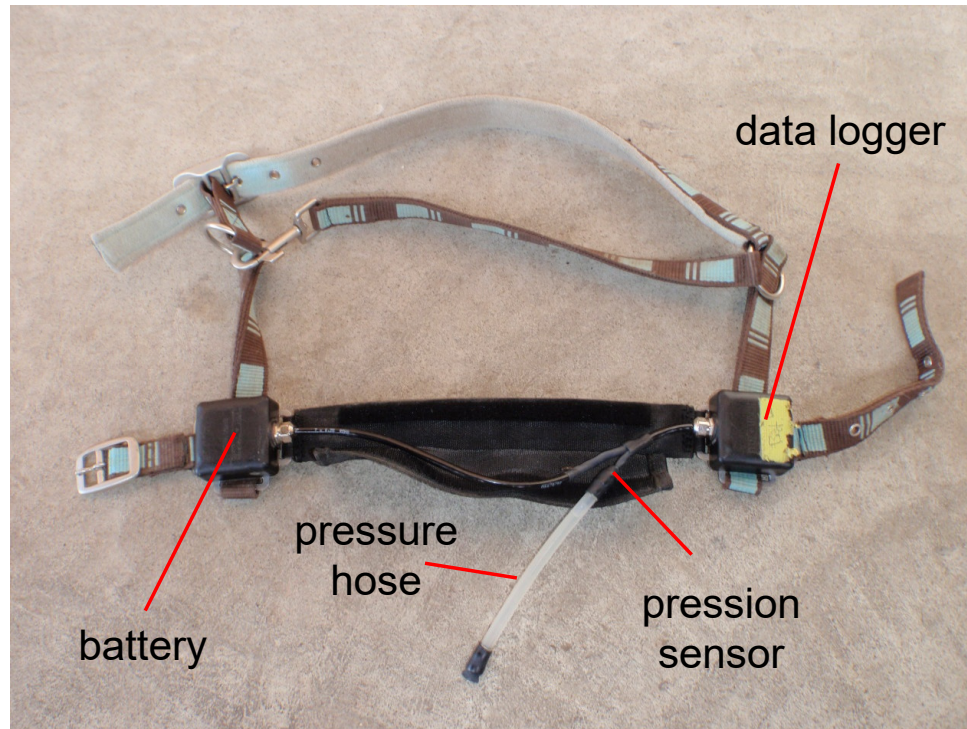
Monitoring of the chewing frequencies as indicator for feed intake commercialised by Itin & Hoch www.rumiwatch.ch

Analyzing the lying behavior of cows by accelerometers

Michael Simmler michael.simmler@agroscope.admin.ch

3D accelerometer on hind leg of cow

- total lying duration,
- number of lying bouts,
- mean duration of lying bouts
- level of physical activity

Lying duration of cows
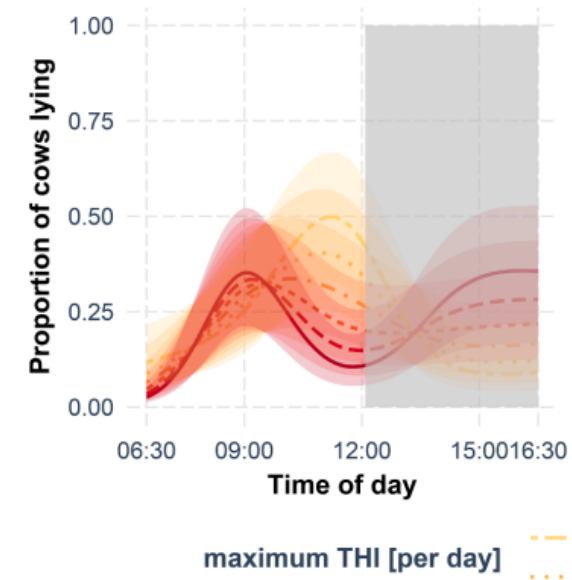
Holinger et al., 2024

Open Source R-package available:
Code Repository: https://github.com/agroscope-ch/triact/
PeerJ 12:e17036 https://doi.org/10.7717/peerj.17036

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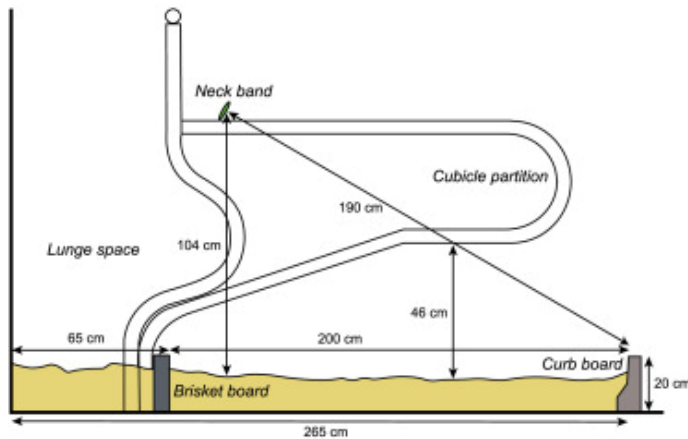# Objectifying welfare evaluation of cow housing installations with sensors and machine learning

Pascal Savary pascal.savary@blv.admin.ch

3D accelerometers
on legs and head

ML models for **detection of atypical behaviours*** during lying down and standing up

*e.g., sideways or hesitant head lunge, pawing, extensive inspection…

Accuracy not yet satisfactory for welfare evaluation of new housing installations…

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DigiRhythm – rhythmicity computation

Hassan-Roland Nasser, hassan-roland.nasser@agroscope.admin.ch

→ **Goal:** Characterising behavioural data, finding abnormalities
→ Can be applied to a wide range of sensors
→ An open source software (R package) that facilitates animal rhythmicity research by providing ready-to-use tools for visualization and rhythmicity assessment using the Degree of Functional Coupling (DFC).

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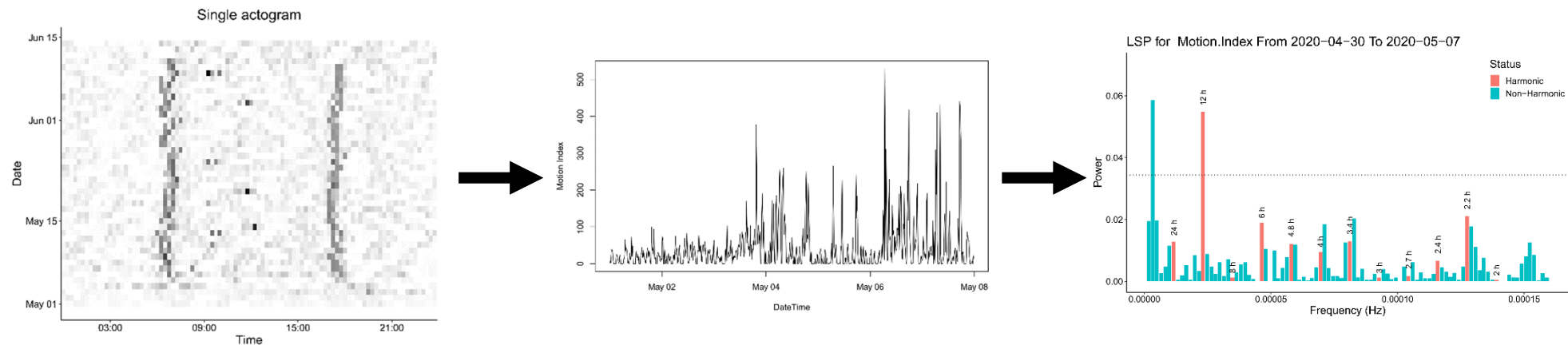
Assessing pig behavior from video surveillance

Claudia Kasper claudia.kasper@agroscope.admin.ch & Hassan Nasser

Goal

Tail biting is heritable – how to select animals for breeding?

Methods for detecting behaviours of *individual* pigs?

- 2 pens with 12 castrated male pigs each
- 100 – 140 kg live weight
- 5 surveillance cameras

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Automated analysis of images

- Software *CVAT*

  Label images with relevant information to be used in training models

  - Posture of pig (*standing/sitting/lying*)
  - Bounding boxes (BB) around pig, head, tail → 286 frames
  - Segmentation + BB head & tail → 516 frames

  1 camera –
  	800 frames
  	15'645 objects

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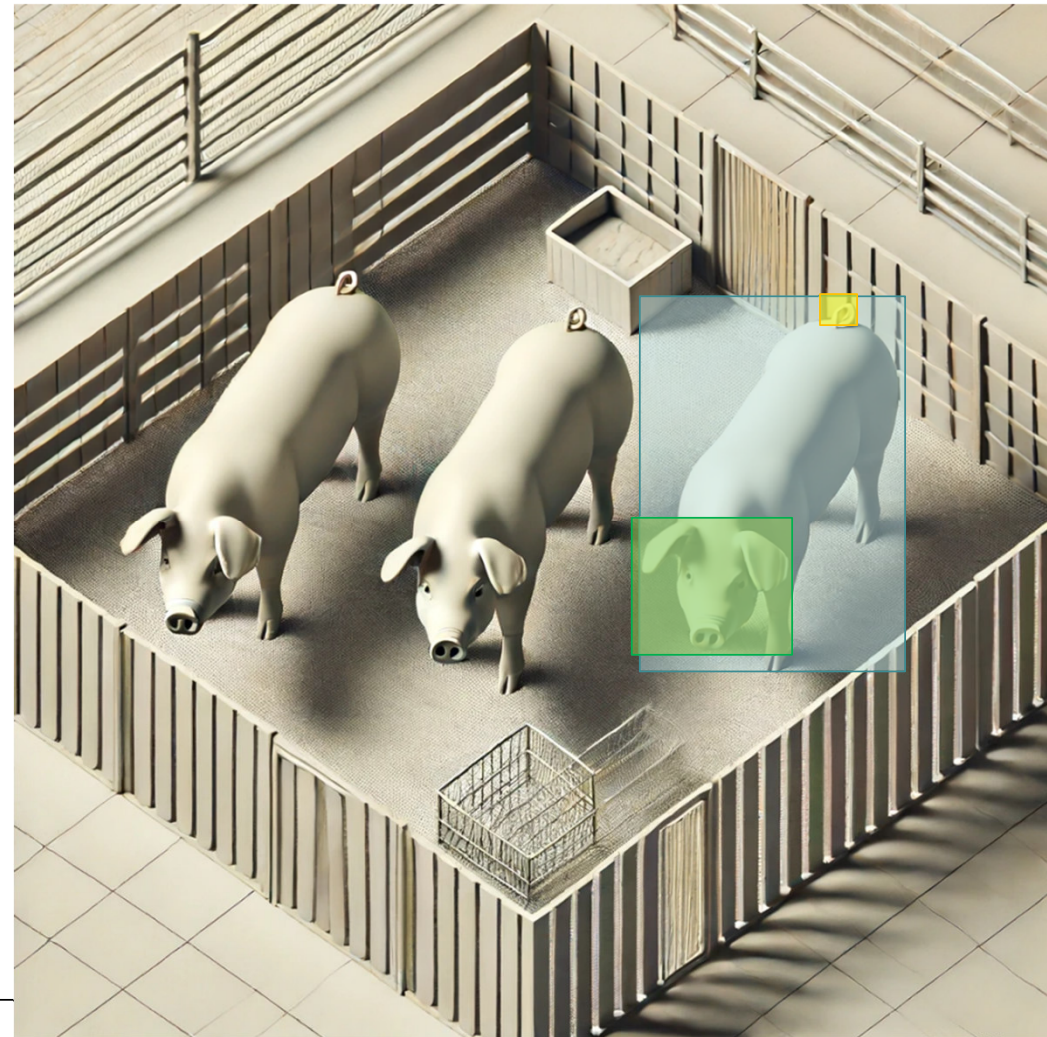
Annotating the images

Recognition of individual pigs, head, tail

→ When the head is approaching a tail, biting is probable.

Model creation (neuronal network)


- So far: obtained results are ok, with just 286 frames
- Training on the full set of available annotated frames promising
- Future work:
  - Infer behaviours using specialized software and define rules
  - Compare the three methods (object detection – key points – action recognition)

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Nitrogen use efficiency of cows

Claudia Kasper claudia.kasper@agroscope.admin.ch
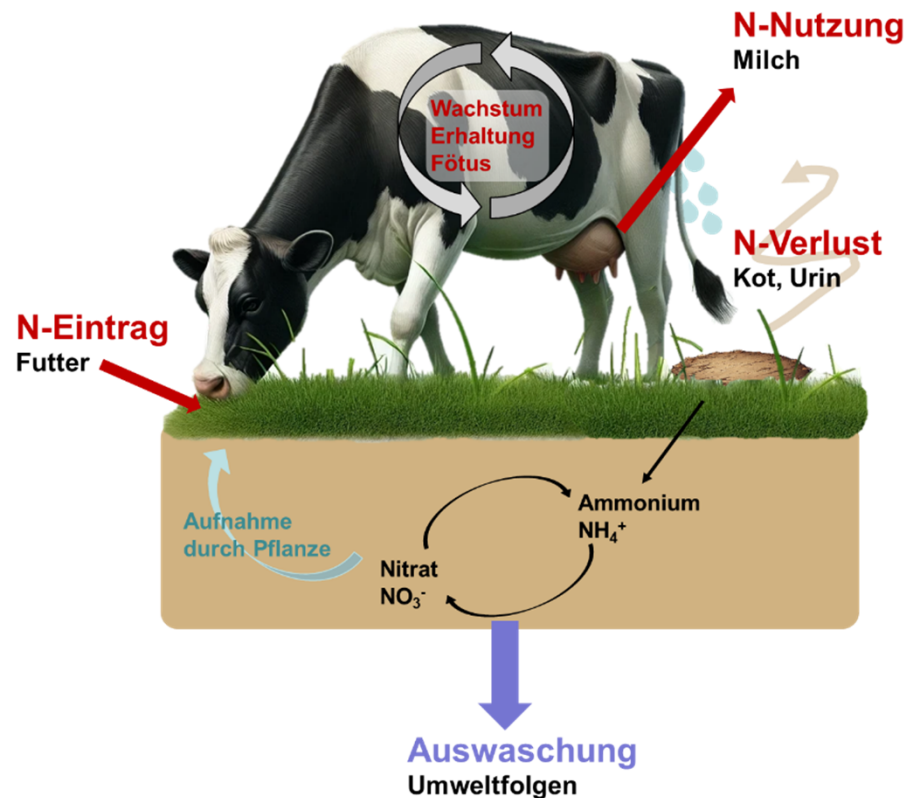

- N is a fundamental nutrient for cows
- Environmental issues (NO_3, NH_4, N_2O)
- Productivity loss (milk protein)

How to optimize?
- Optimized feeding
- Genetic selection

- **Efficiency differences between cows** on the same feed
  - Trait **inherited**?
  - → enabling selection

Genotyping of 2300 cows – easier than phenotyping…

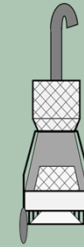DNA extraction from hair roots (genetical characteristics of animals)
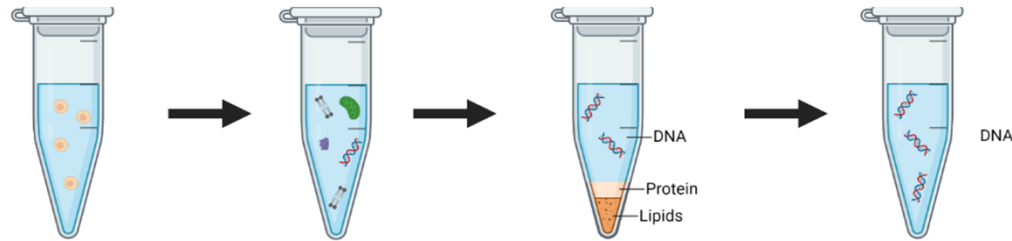
Phenotyping (traditional agronomy):
Measuring Nitrogen use efficiency
→ performance of the animals

Weighing the ration, chemical analysis of milk, feed, feces…

Methane emissions
via GreenFeed®

Mid-infrared (MIR) and near-infrared (NIR)

Milk control (each cow is checked monthly)

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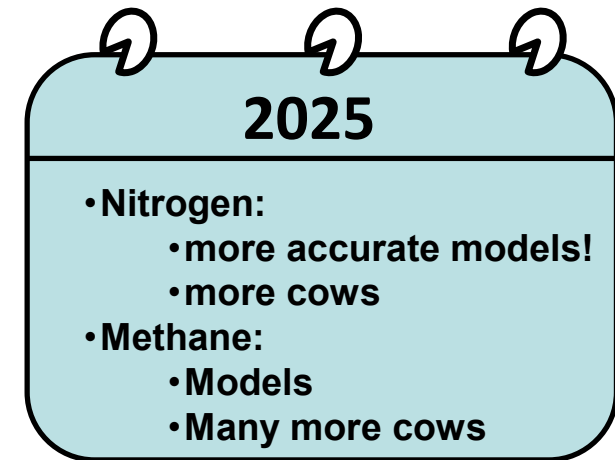
Current status

- Methane production clearly heritable, consistent estimates
  - *Breeding potential?*
- Nitrogen utilization efficiency still unclear

In progress:
- What role does feeding play?
- Record more reference data
- Improvement of the infrared models

2025
- Nitrogen:
  - more accurate models!
  - more cows
- Methane:
  - Models
  - Many more cows

Breeding pigs with higher protein efficiency

Claudia Kasper claudia.kasper@agroscope.admin.ch

Phenoptyping
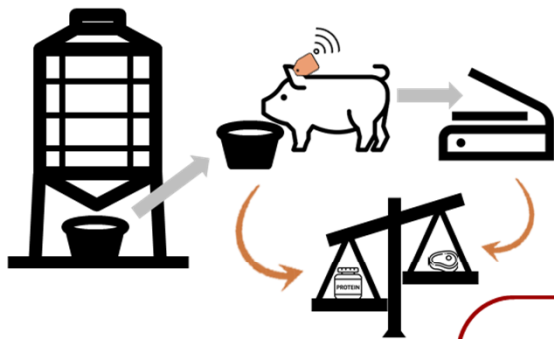
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Genotyping

1000 pigs
HD-genotyping, low-pass
1 sequence

fondation
sur la croix

Projekte Landwirtschaft

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Phenotyping by Dual Energy X-ray Absorptiometry (DXA)

Patrick Schlegel patrick.schlegel@agroscope.admin.ch
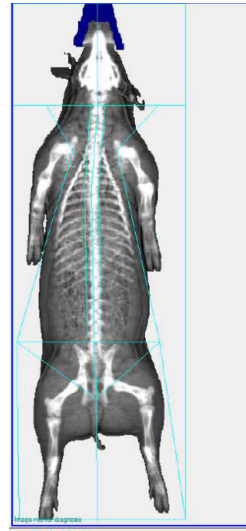
Main Data:
- Lean tissue weight
- Fat tissue weight
- Bone mineral weight
- Bone mineral density

→ Very accurate technology (throughput: 4-5 carcasses/h)

→ Agroscope is running research on several topics: mainly about nutrient efficiency and resilience of the animal; update of nutrient requirement.

→ Potential use on field: grading reference for carcasses; genetic selection

Interim conclusion regarding protein efficiency of pigs

- **Protein efficiency is highly heritable** (pedigree heritability = 0.54 ± 0.10)
- **Complex phenotyping:** difficult to achieve the necessary sample size
- **Genomic variants on chromosome 2 and 9** promising
- Most heritability "recovered" in genomic data
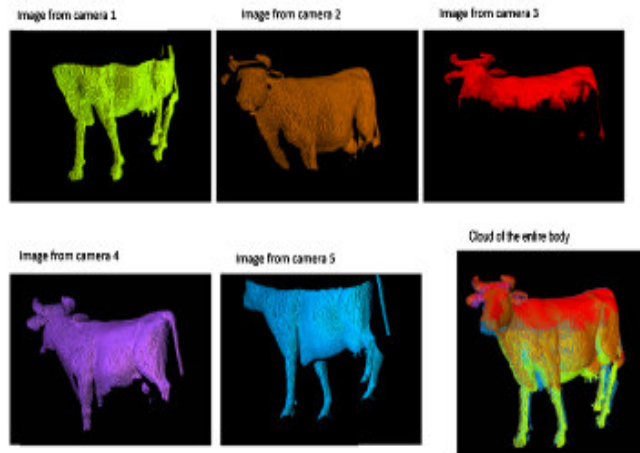- **Genomic selection seems possible**

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The Morpho 3D Scanner

Sylvain Lerch sylvain.lerch@agroscope.admin.ch

Measurement of complex morphological properties:
Distance, circumference, surface area, volume, angle...

Purchase of 5 sets
for 2D imaging

5 camera pairs / laser
80 images / second / camera

Reconstruction
of the 3D shape
«mesh»

developped by   l'institut Agro   INRAE   INSTITUT DE L'ELEVAGE idele   3D Ouest   for dairy cows
agriculture · alimentation · environnement   (Le Cozler et al., 2019, Comp. Electr. Agri. 157, 447-53)

The CompoMeat 3D project

Sylvain Lerch sylvain.lerch@agroscope.admin.ch

Estimating the body composition of growing cattle using imaging techniques:

i)   3D of the external body structure of the living animal

ii) Dual X-ray absorptiometry (DXA) of carcasses

" Gold standard "	" Proxy "

Post-mortem dissection, grinding and chemical analysis

3D-Scans and DXA analysis

Link?

Empty body, carcass hot weight, body mass can be well expressed by the Proxy
Chemical components are less precise (Xavier et al. 2024, Animal 18)

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Virtual fences – promising first results!

Manuel Schneider manuel.schneider@agroscope.admin.ch

www.nofence.no

→ Virtual fence: Animal is kept in defined zones by audio & electrical signals

→ Agroscope is testing and further developing the virtual fencing systems

→ System is not yet authorised in Switzerland (animal protection)

→ https://www.youtube.com/watch?v=FZcEx1C1sbs

Virtual fencing

- Three experiments carried out 2021 – 2023
- Results from experiment 2021 and 2022 published in Journal of Animal Science

Stress indicators in dairy cows adapting to virtual fencing

Patricia Fuchs[†,‡,1,] Joanna Stachowicz,[‖] Manuel K. Schneider,[§] Massimiliano Probo,[‡]
Rupert M. Bruckmaier,[¶] and Christina Umstätter[‖]

➢ Given proper application, no impact on animal welfare detected.
- A lot of interest of media and framers

The future is data driven

To decrease complexity, data should be managed by few systems which need to be connected

FMIS (Farm Managment Information System) (industrial twin: SAP)

→ barto, myjohndeere, agraroffice, geofolia, eFeldkalender... are promising approaches

→ smartphone is a powerful and well-accepted interface

→ interoperability with manufacturer of milking and housing technologies is a big issue

→ farmers need time to adapt

365farmnet.com

farmworks

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25
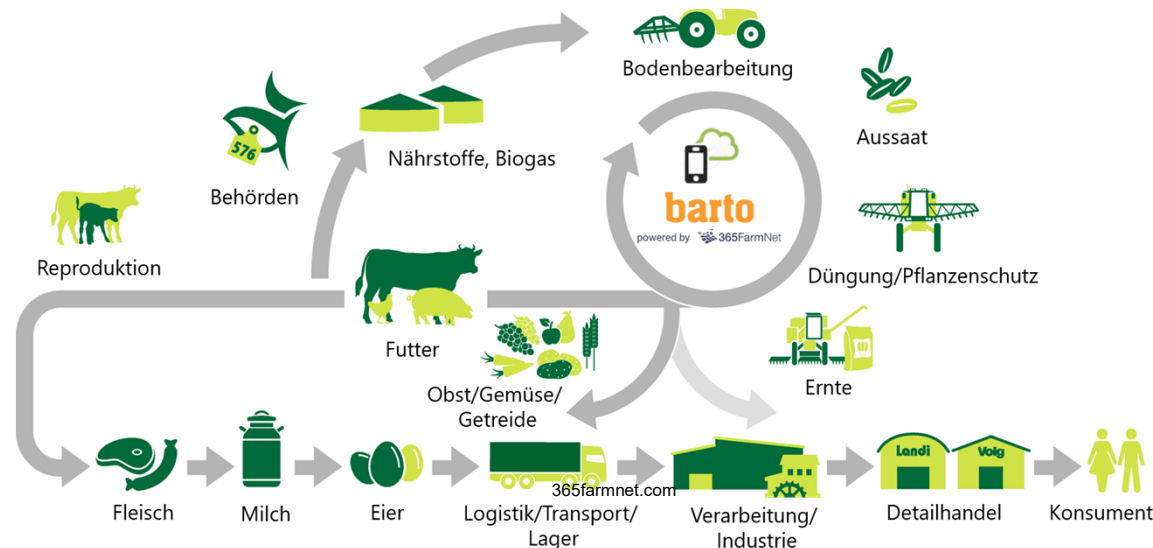
Monitoring the Agri-Environmental System by FMIS

Anina Gilgen anina.gilgen@agroscope.admin.ch

www.agroscope.ch/maus

A new tool "MAUS" has been established which is available in barto

- N-, P-Balances
- Energy balances
- Soil cover
- Use of plant protection products and risk of aquatic ecotoxicity

→ FMIS deliver already most of the relevant data

Data are key

- There is still a significant lack of sensors (e.g. for animal welfare and acidosis).
- In terms of data transmission, 5G and LoRa-WAN represent significant progress.
- AI enables the better interpretation of complex data, representing a clear step forward.
- FMIS: a lot needs to be done.
- The question of whether agriculture will go digital or not is obsolete.

→ The potential of digitization is by far not exploited!

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Thank you!
www.agroscope.ch

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