How precise are tools measuring animal-based welfare indicators in dairy cattle?

A.H. **Stygar** [1], Y. **Gómez** [2], G.V. **Berteselli** [3], E. **Dalla Costa** [3], E. **Canali** [3], J.K. **Niemi** [1], P. **Llonch** [2], M. **Pastell** [1]

[1] Natural Resources Institute Finland (Luke),

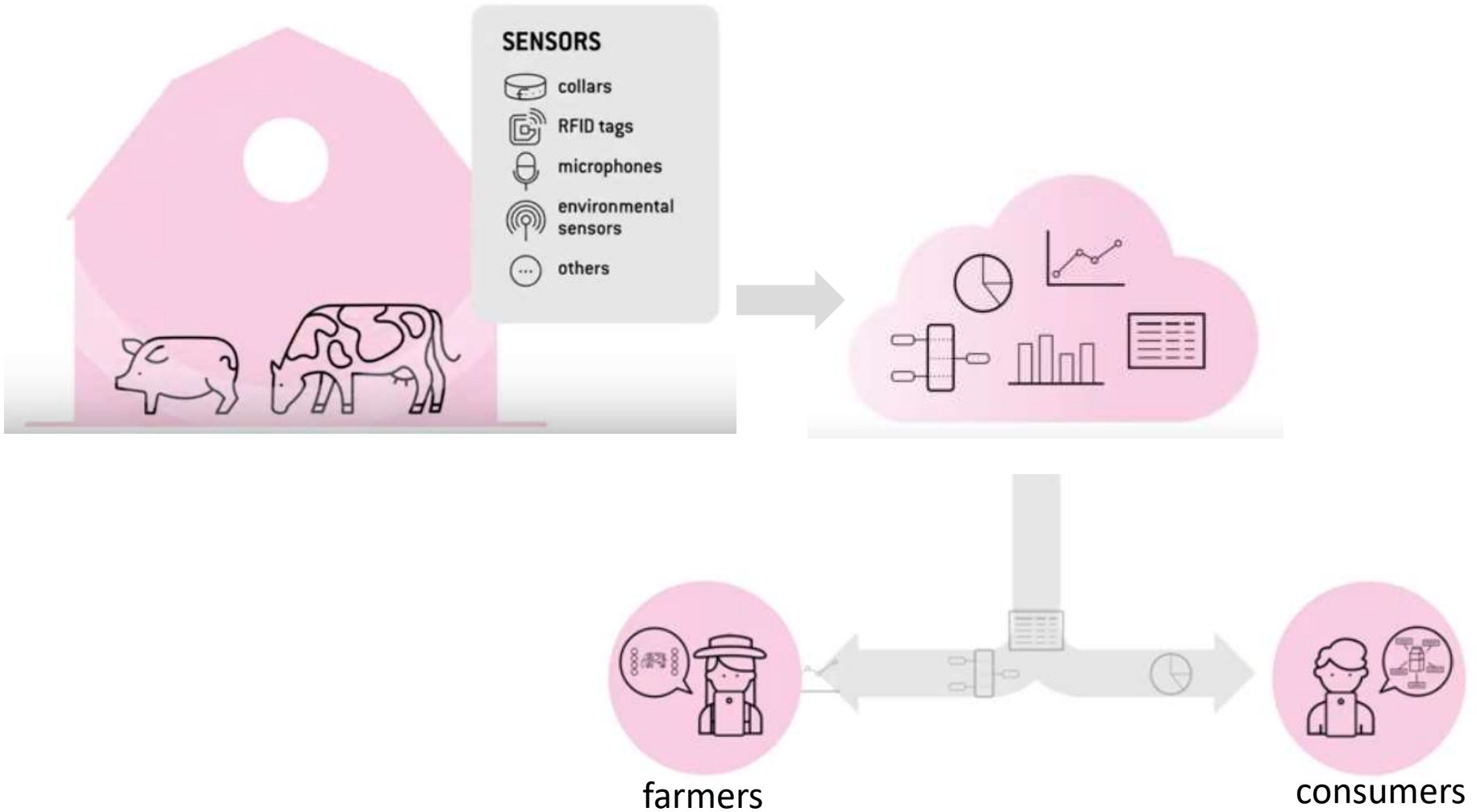[2] Universitat Autònoma de Barcelona,

[3] Università degli Studi di Milano

Outline

1. Introduction – ClearFarm Project and our aim
2. Material and methods
3. Results :
   a. Market search
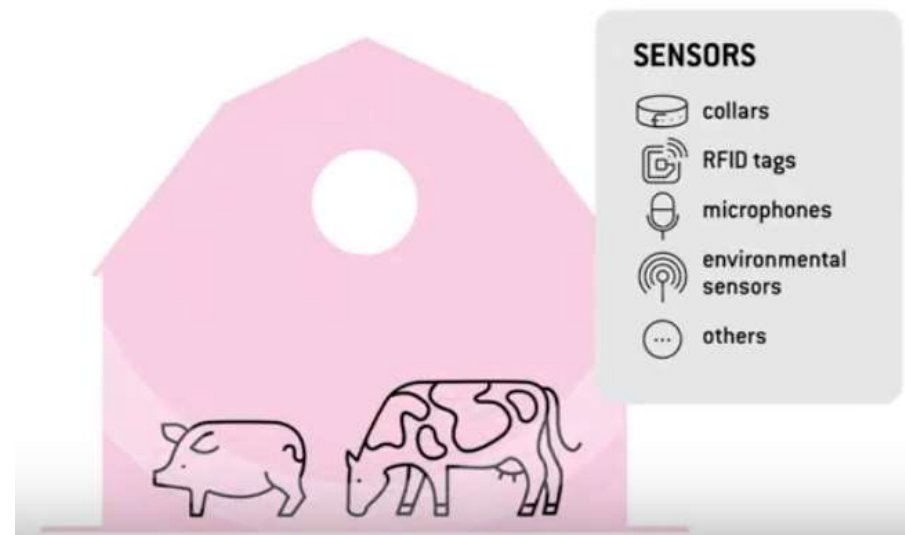   b. Literature search
   c. Welfare relevance
4. Conclusions

INTRODUCTION

ClearFarm project

SENSORS
- collars
- RFID tags
- microphones
- environmental sensors
- others

farmers

consumers

Aim of the study

To assess which welfare **aspects of cows', heifers' and** calves' husbandry can be addressed by available (and validated) technologies.
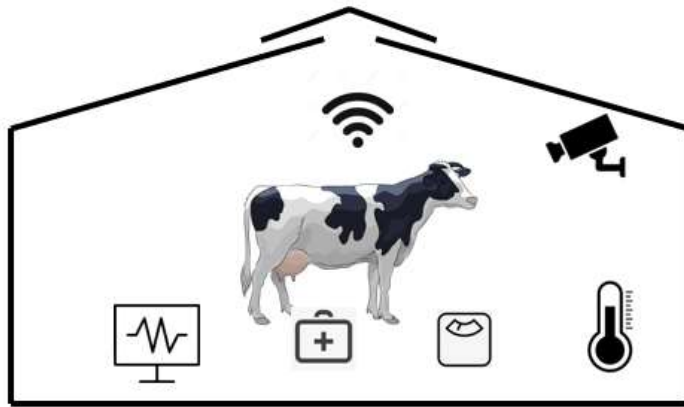
Material and methods

Material and methods

ClearFarm

Market Availability Search
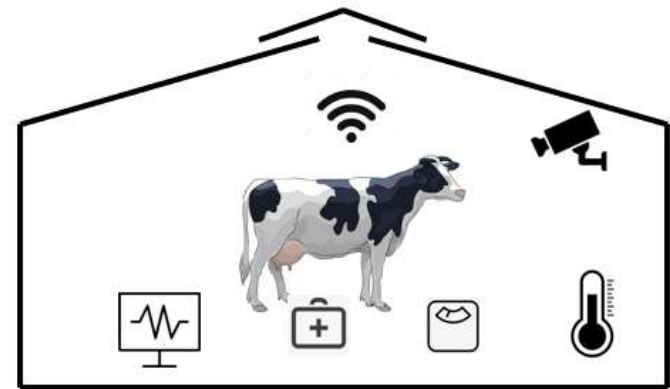(web Google search)

Literature Search
Preferred Reporting Items for Systematic
Reviews and Meta-Analyses (PRISMA)

Material and methods

Farm 1
system building and
Initial testing
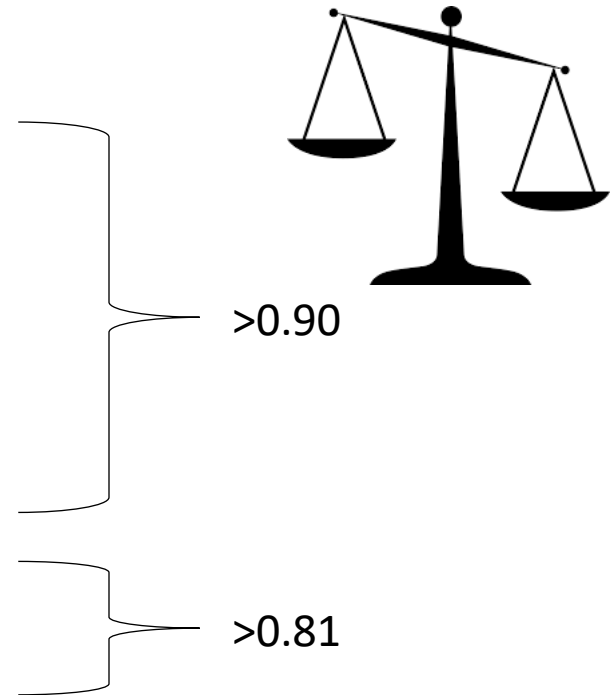
Farm 2
system validation

Material and methods

Performance indicators (for high performance):

Pearson correlation coefficient (r),
Spearman's rank correlation coefficient (rs),
concordance correlation (CCC),
Sensitivity,
Specificity,
Area under the receiver operating characteristics curve (AUC)

>0.90

Coefficient of determination
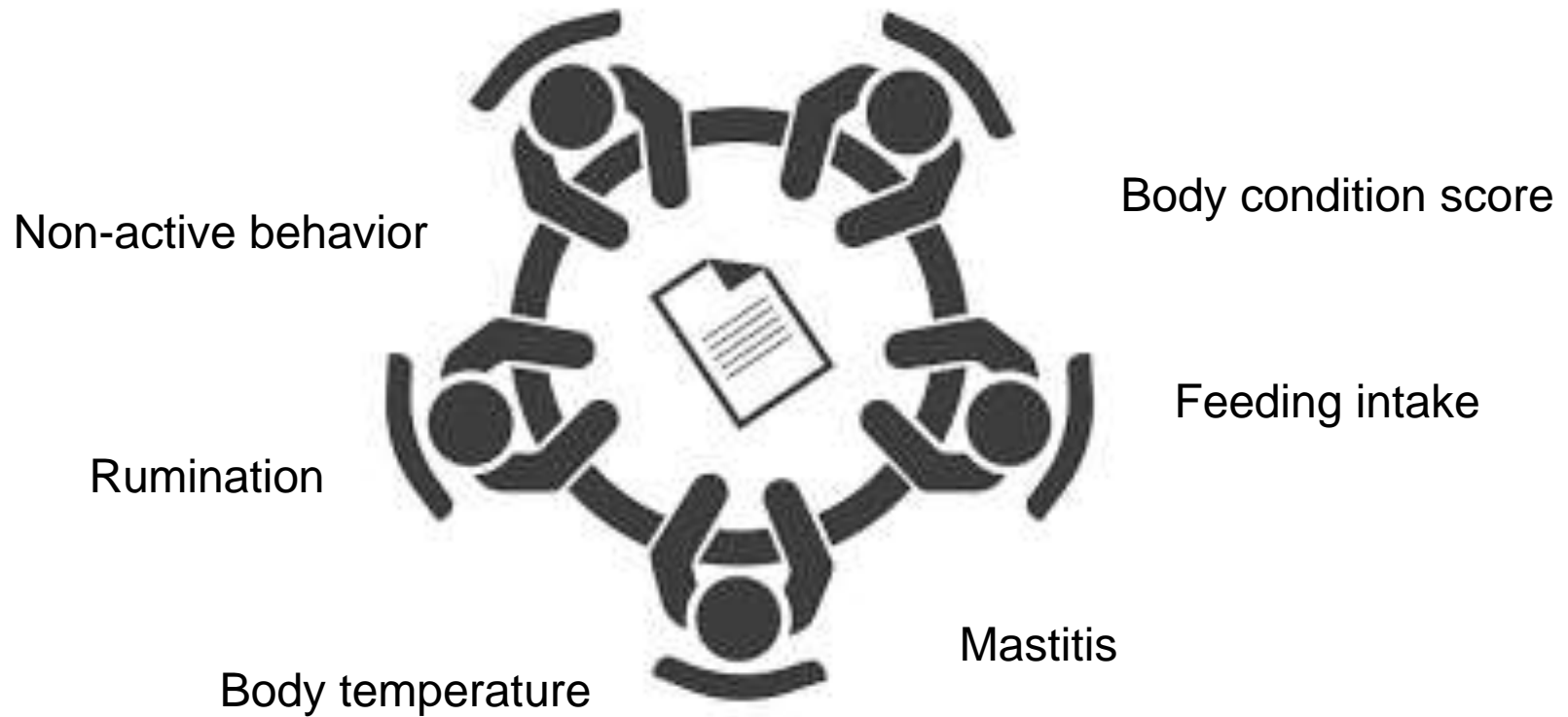Cohen's kappa coefficient was >0.81,

>0.81

Intercept and slope of linear regression did not differ significantly from 0 or 1

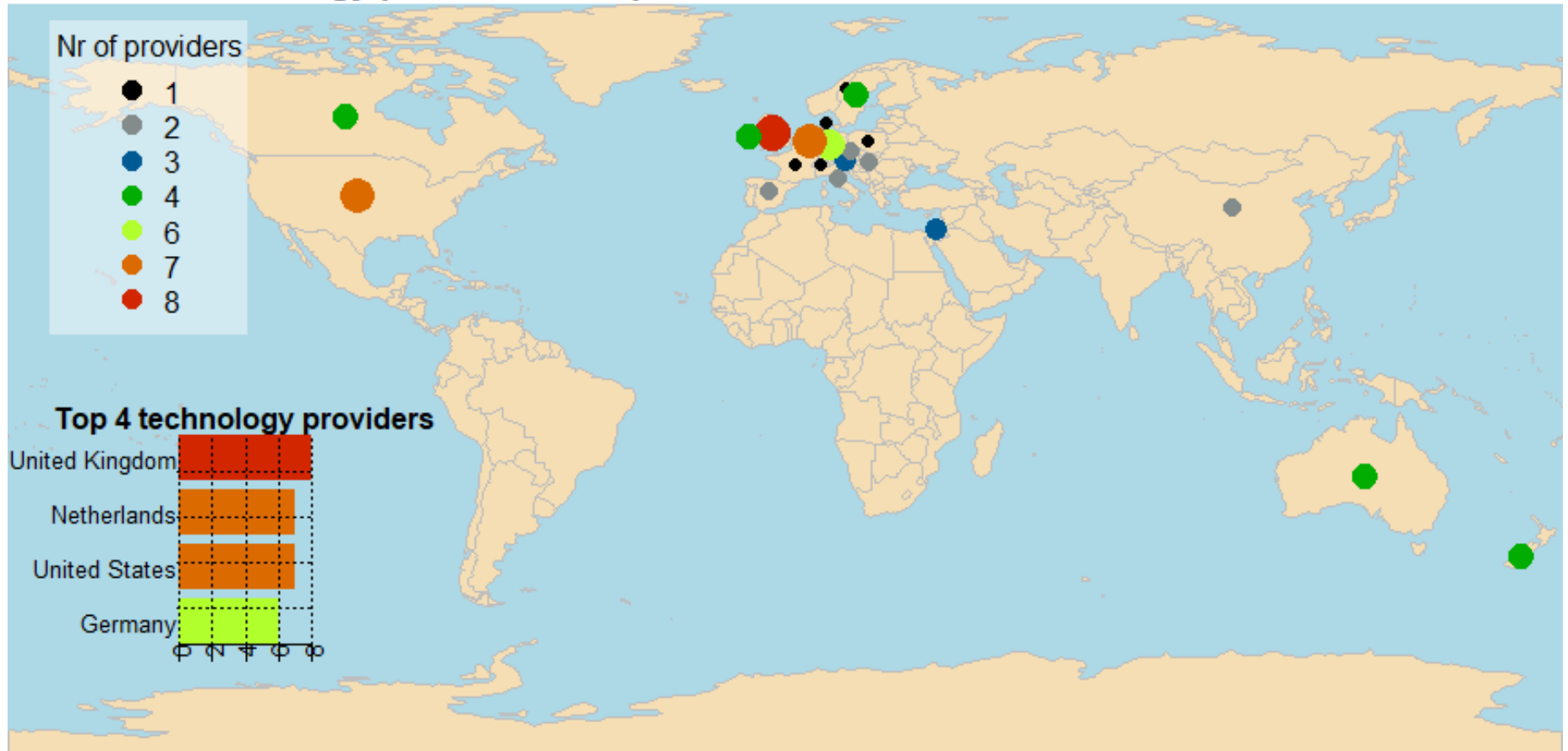Bland–Altman plots (plot included zero with the 95% interval of agreement

Welfare relevance

Non-active behavior

Body condition score

Rumination

Feeding intake

Body temperature

Mastitis

ClearFarm

Results

Results - market search

PLF technology providers with potential use for animal-based welfare assesment

Nr of providers
- 1
- 2
- 3
- 4
- 6
- 7
- 8

Top 4 technology providers

United Kingdom
Netherlands
United States
Germany

129 technologies / 67 providers / 21 countries

Results- market search

Accelerometers (28%),
load cells (28%),
milk quality (19%),
boluses (11%),
cameras (8%),others (6%)

Full list can be found at:
https://www.frontiersin.org/articles/10.3389/fvets.2021.634338/full#supplementary-material

Results – literature search

External validation rate - 14% of commercially available sensors with validation records:

1. **Accelerometers (30%)**
2. **Cameras (10%)**
3. **Load cells (8%)**
4. **Milk sensors (8%)**
5. **Boluses (7%)**

N=42

Validation results

High performance (precision and accuracy)

- Accelerometers - non-active bahaviour (e.g. lying and standing), rumination, grazing time

- Load cells- water and feed intake, body weight (calves)

Lower performance (precision and accuracy)

- Accelerometers – active behaviour, feeding time, drinking time, rumination (for calves and heifers)

- Load cells – locomotion score,

- Cameras- locomotion score, BCS

- Boluses – body temperature (cows, calves and heifers), rumen pH

- Milk sensors – mastitis detection, milk quality

Welfare relevance

Indicator	Good feeding	Good housing	Good health	Appropriate behavior
Body temperature	+−	+−	+	−
Body condition scoring	+	−	+	−
Lameness	−	+−	+	−
Mastitis	−	+−	+	−
Water consumption	+	−	+	+−
Drinking duration	+−	−	+−	+−
Rumination	+	+−	+	+−
Rumen pH	+	−	+	−
Grazing time	+	+−	+−	+
Feeding intake	+	−	+	+−
Feeding time	+	−	+−	+−
Active behavior	−	+−	+−	−
Non-active behavior	−	+	+	+−

[a]Symbols +, +−, − refer to "very relevant," "moderate," and "not relevant" evaluation, respectively.

From: https://doi.org/10.3389/fvets.2021.634338
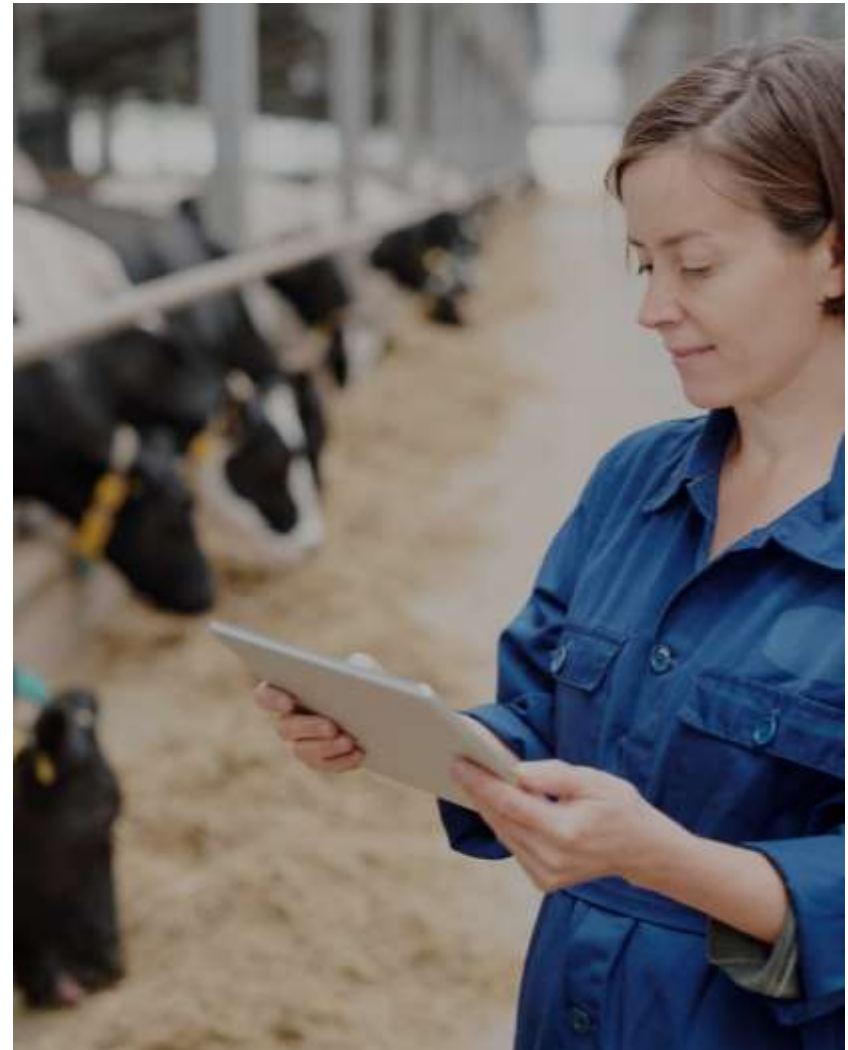
Welfare relevance

Good feeding:

- No prolong hunger or thirst

Good health:

- Free from injuries and disease
- should not suffer pain induced by inappropriate management
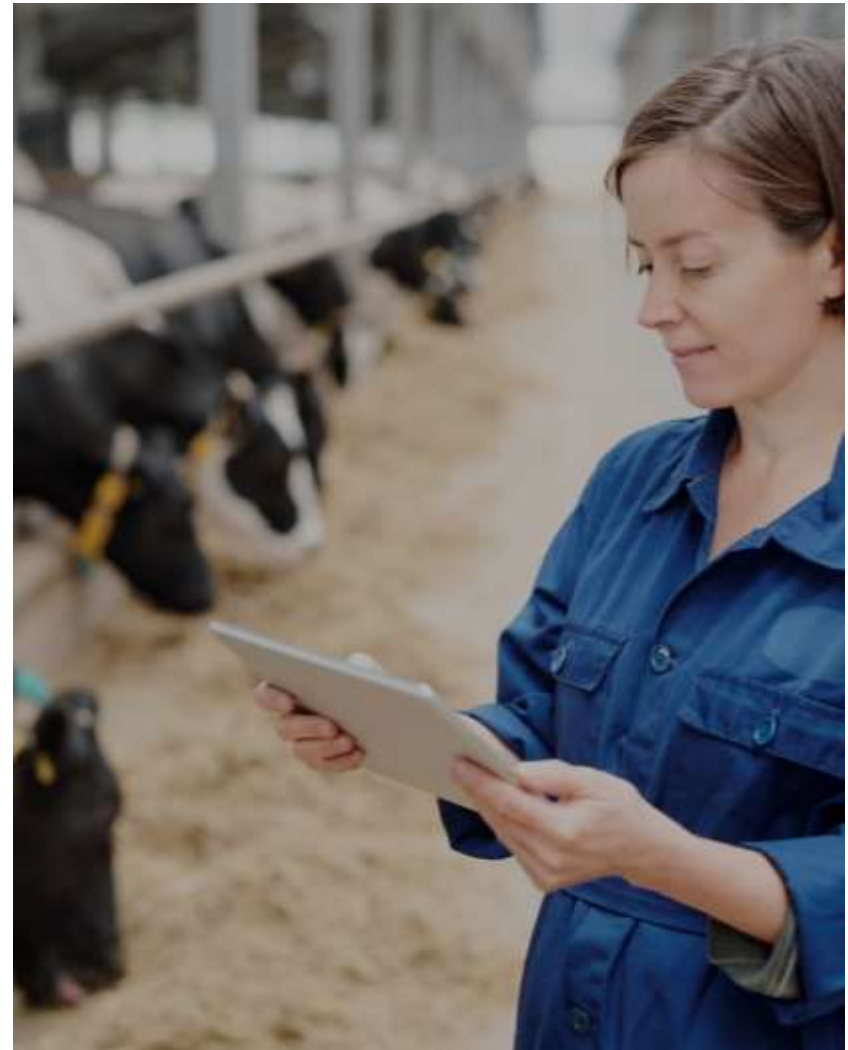
Welfare relevance

Good housing:
- thermal comfort
- resting comfort
- enough space to move freely

Appropriate behavior:
- expression of social behavior,
- expression of other behaviors,
- good human-animal relationship,
- positive emotional state

Conclusions

Conclusions

1) To increase actors' trust toward the PLF technology and prompt sensor-based welfare assessment, validation studies are needed.
2) Sensor technologies, also those with lower performance, can provide useful information on animal health and well-being.
3) Integration of PLF technologies in current protocols for animal welfare assessment would make them more robust

Thank you
for your attention!

Follow us at www.clearfarm.eu

@ClearFarmEU

ClearFarm

ClearFarm