

# Evaluation of animal welfare at slaughterhouses

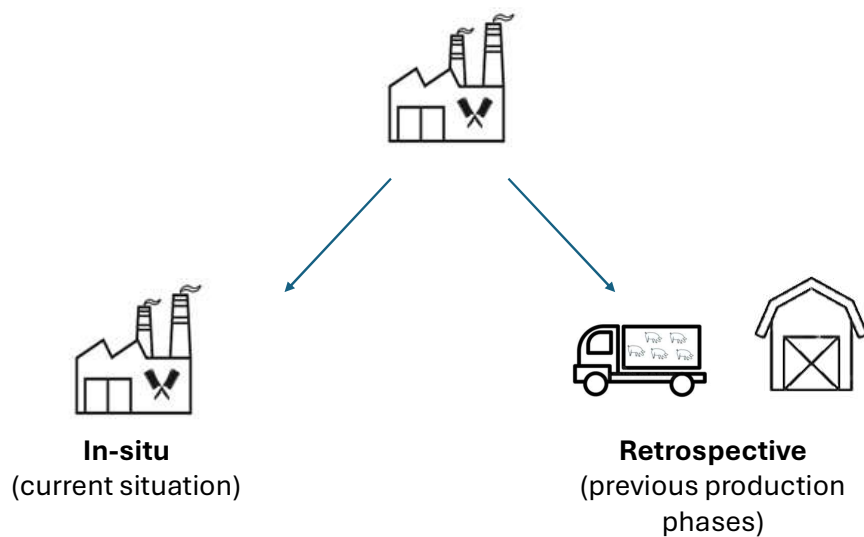
Antemortem

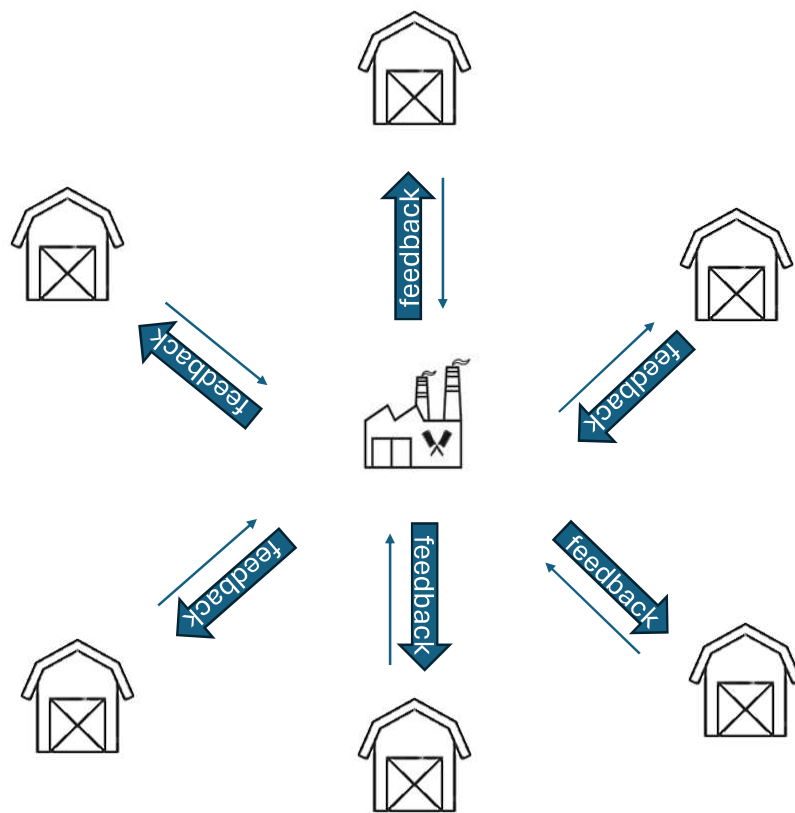


Postmortem

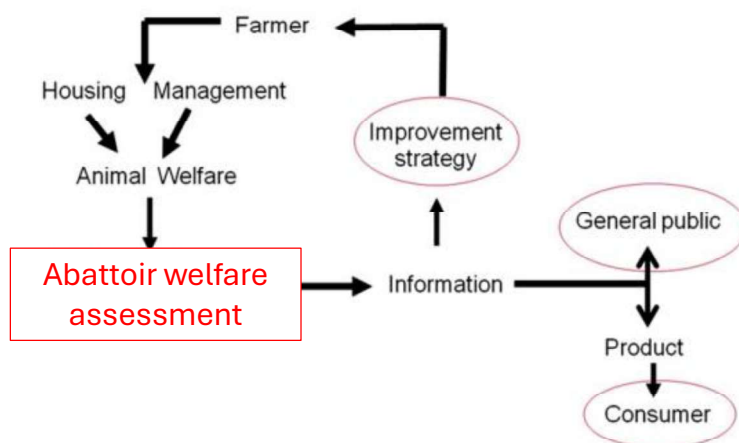


# Evaluation of animal welfare at slaughterhouses





(Grandin, 2017)



(Dalmau & Velarde, 2017)

# In-situ assessment

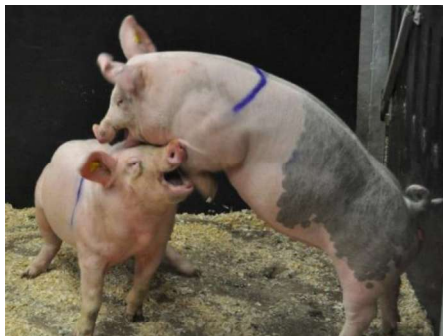
| Welfare principles    | Welfare criteria                                 | Measures                                                                         | Place                         |
|-----------------------|--------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------|
| Good feeding          | Absence of prolonged hunger                      | Food provision                                                                   | Lairage                       |
|                       | Absence of prolonged thirst                      | Water supply                                                                     | Lairage                       |
| Good housing          | Comfort around resting                           | Flooring, bedding                                                                | Unloading area and lairage    |
|                       | Thermal comfort                                  | Shivering, panting, huddling                                                     | Unloading area and lairage    |
|                       | Ease of movement                                 | Slipping, falling, stocking density of lorries, stocking density of lairage pens | Unloading area and lairage    |
| Good health           | Absence of injuries                              | Lameness                                                                         | From unloading to lairage     |
|                       | Absence of disease                               | Sick animals, dead animals                                                       | Unloading and lairage         |
|                       | Absence of pain induced by management procedures | Stunning effectiveness                                                           | Stunning area                 |
| Appropriate behaviour | Expression of social behaviours                  | -                                                                                |                               |
|                       | Expression of other behaviours                   | -                                                                                |                               |
|                       | Good human-animal relationship                   | High-pitched vocalisations                                                       | From lairage to stunning area |
|                       | Positive emotional state                         | Reluctance to move, turning back                                                 | Unloading area                |

Adapted from Welfare Quality® (2009)

# Retrospective assessment



Skin lesions



Aggressions

Short term

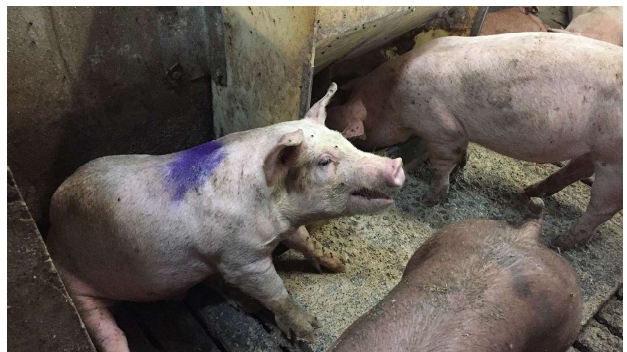


(Dalmau et al., 2009)

# Retrospective assessment



Lung lesions



Pneumonia

Long term

(Dalmau et al., 2009)



# Retrospective assessment



Tail lesions



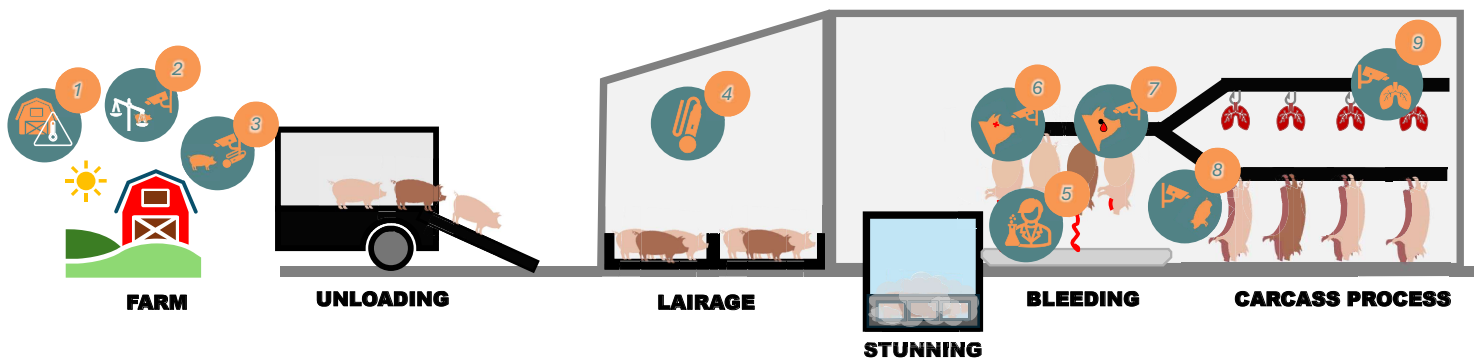
Tail biting



Long term

(Harley et al., 2012)

# Slaughterhouse sensors



- |   |                                                       |   |                                                   |   |                                                                      |
|---|-------------------------------------------------------|---|---------------------------------------------------|---|----------------------------------------------------------------------|
| 4 | STREMOD0 (FBN) – stress vocalizations                 | 6 | BlinkAI (Nuna Solutions) – stunning effectiveness | 8 | PigInspector (CLK GmbH) – Skin, ear and tail lesions and tail length |
| 5 | IGFBPs (FBN) – level of stress (exsanguination blood) | 7 | Tear Staining (ILVO)                              | 9 | Lesion-Detect (Innotech) – Lung lesions                              |

# Slaughterhouse sensors

Technologies developed to assess welfare of pigs at the slaughterhouse listed per area where they are applied, welfare indicator measured, type of technology, sensor, and provider. Sensors analysing the same indicator are presented in alphabetical order.

| Area                    | Indicator(s)                                               | Type of technology | Name of sensor                             | Provider                                  |
|-------------------------|------------------------------------------------------------|--------------------|--------------------------------------------|-------------------------------------------|
| Lairage                 | Noise                                                      | Acoustic sensor    | Noise Level Dashboard                      | Genba Solutions GmbH                      |
|                         | Space availability                                         | Computer vision    | Space availability                         | Genba Solutions GmbH                      |
|                         | Animal handling                                            | Computer vision    | AI4Animals                                 | Deloitte                                  |
| Slaughter area          | Stunning effectiveness                                     | Computer vision    | Argus                                      | Argus                                     |
|                         |                                                            |                    | smARt counting                             | Ro-Main                                   |
|                         |                                                            |                    | CET <sup>a</sup> Automatique               | Wel2be                                    |
|                         | Killing effectiveness                                      | Computer vision    | Monitoring of the CO <sub>2</sub> stunning | Genba Solutions GmbH                      |
|                         |                                                            |                    | Signs of life                              | Argus                                     |
| Carcass processing area | Lung lesions and pleurisy on carcass                       | Computer vision    | VisStick                                   | Danish Meat Research Institute            |
|                         |                                                            |                    | Bleeding Measurement in Pigs <sup>a</sup>  | CLK GmbH                                  |
|                         |                                                            |                    | ADAL                                       | Farm4Trade                                |
|                         | Carcass and viscera lesions                                | Computer vision    | ArtificialVet®                             | Company Mind                              |
|                         | Tail length, tail and ear lesions, injuries on the abdomen | Computer vision    | CLASSIFAI® BOX                             | Software Logistik Artland GmbH            |
|                         | Tail length, tail and ear lesions, injuries on the abdomen | Computer vision    | CLASSIFAI® BOX                             | Software Logistik Artland GmbH            |
|                         | Ear, skin, tail lesions and tail length                    | Computer vision    | PigInspector                               | CLK GmbH                                  |
|                         | Tail length and lesions                                    | Computer vision    | TailCam <sup>a</sup>                       | Danish Technological Institute - PigWatch |
|                         |                                                            |                    | TAILSCAN <sup>a</sup>                      | Farm4Trade                                |

<sup>a</sup> Sensor technology currently under development.

(Ramon-Perez et al., 2025)

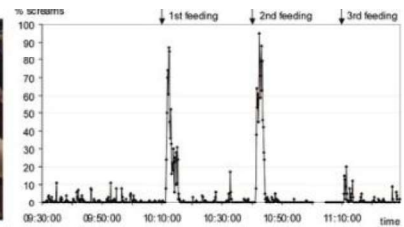
Technologies developed to assess welfare of pigs at the farm with potential for installation in the slaughterhouse, listed according to welfare indicator, type of technology, name of sensor, and provider. Sensors analysing the same indicator are presented in alphabetical order according to their names.

| Indicator              | Type of technology             | Name of sensor                                                         | Provider                                                                         | Observations                                                                  |
|------------------------|--------------------------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Cough                  | Acoustic sensor                | SoundTalks                                                             | SoundTalks NV                                                                    | Multisensor include environmental sensors                                     |
| Vocalisations          | Acoustic sensor                | ALIS Grumpy Sensor <sup>a</sup><br>STREMOOD <sup>a</sup>               | Greengage Global<br>Research Institute of Farm<br>Animal Biology (FRB)<br>Düppix |                                                                               |
| Movements and activity | Computer vision                | Düppix <sup>a</sup>                                                    | Düppix                                                                           | Count lying, eating, drinking, standing, aggressive behaviour                 |
|                        |                                | Healthy Climate Monitor                                                | Healthy Climate Solutions                                                        | Multisensor include environmental sensors, sound analyser, and thermal camera |
|                        |                                | PERK Analytics                                                         | Copecks SAS                                                                      | Record the position of the animal within the pen                              |
| Animal handling        | Computer vision                | PigGuard                                                               | Serket B.V                                                                       | Multisensor                                                                   |
| Body weight            | Computer vision                | PigCounter                                                             | PigRoobar                                                                        | Record drinking and eating behaviours                                         |
|                        |                                | Embedded vision prototype for livestock weight monitoring <sup>a</sup> | Lemberg Solutions                                                                | Counting pigs automatically                                                   |
|                        |                                | eVegrow                                                                | Pancom BV                                                                        | No longer commercialised as the company was dissolved                         |
|                        |                                | FarmSee                                                                | FarmSee Ltd                                                                      |                                                                               |
|                        |                                | Growth sensor                                                          | GroStat                                                                          | No longer commercialised as the company was dissolved                         |
|                        |                                | IDOL 65 camera                                                         | Dol Sensors                                                                      |                                                                               |
|                        |                                | Optiscan                                                               | Big Dutchman                                                                     | No longer commercialised as the company was dissolved                         |
|                        |                                | PigRoobar                                                              | PigRoobar                                                                        |                                                                               |
|                        |                                | PiGI                                                                   | Corntac                                                                          | No longer commercialised as the company was dissolved                         |
|                        |                                | PigVision                                                              | Asimatrix                                                                        |                                                                               |
|                        |                                | Pigscan <sup>TM</sup> ID                                               | Smart Agritech Solution of Sweden                                                | No longer commercialised as the company was dissolved                         |
|                        |                                | Oscan                                                                  | Innovent Technology Ltd                                                          |                                                                               |
|                        |                                | WeightCheck                                                            | Big Dutchman                                                                     | No longer commercialised as the company was dissolved                         |
|                        |                                | Weight-Detect <sup>TM</sup>                                            | Innovent Vision                                                                  |                                                                               |
|                        |                                | WUGOL One <sup>a</sup>                                                 | WUGOL GmbH                                                                       | No longer commercialised as the company was dissolved                         |
|                        |                                | ACCUL-ARM Survey Scale                                                 | Osborne                                                                          |                                                                               |
|                        |                                | Automatic Pig Weighing                                                 | Horvath Agri                                                                     | No longer commercialised as the company was dissolved                         |
|                        |                                | CIMA Automatic Marker                                                  | CIMA Animal Farming Equipment                                                    |                                                                               |
|                        |                                | CIMA Control Pig                                                       | CIMA Animal Farming Equipment                                                    | No longer commercialised as the company was dissolved                         |
|                        |                                | CIMA Identification                                                    | CIMA Animal Farming Equipment                                                    |                                                                               |
|                        |                                | CIMA Selection Gate                                                    | CIMA Animal Farming Equipment                                                    | No longer commercialised as the company was dissolved                         |
|                        |                                | PigScale                                                               | PigScale                                                                         |                                                                               |
|                        |                                | SKOLD Tristar                                                          | SKOLD Group                                                                      | Sorting scale                                                                 |
| Body temperature       | Infrared thermometer           | TriflexPro                                                             | Big Dutchman                                                                     | Sorting scale                                                                 |
|                        |                                | EVTSCAN thermometer                                                    | EVTSCAN                                                                          | Sorting scale                                                                 |
|                        |                                | IRT207 The Heat Seeker 8:1                                             | General Tools                                                                    | No longer commercialised as the company was dissolved                         |
|                        |                                | TN41BL1                                                                | Metrix Instruments                                                               |                                                                               |
|                        |                                | Vivo sensor                                                            | Telov                                                                            | No longer commercialised as the company was dissolved                         |
|                        |                                | Degreelact                                                             | Degreelact                                                                       |                                                                               |
|                        | Thermal camera                 | FLIR One Pro LT                                                        | FLIR                                                                             | Software                                                                      |
|                        |                                | FLIR FS Pro                                                            | FLIR                                                                             | FLIR One camera is required                                                   |
|                        |                                | H4 Intelligent Thermal Camera                                          | Guide Sensmart                                                                   | Require a smartphone                                                          |
|                        |                                | IR Pad 640                                                             | Digaberm                                                                         | No longer commercialised as the company was dissolved                         |
|                        |                                | IR Pad 320                                                             | Digaberm                                                                         |                                                                               |
| Drinking behaviour     | Camera with temperature sensor | T400                                                                   | InfRay                                                                           | No longer commercialised as the company was dissolved                         |
|                        |                                | T630                                                                   | InfRay                                                                           |                                                                               |
|                        |                                | TR266B                                                                 | Milesey Tools                                                                    | No longer commercialised as the company was dissolved                         |
|                        |                                | TR266E                                                                 | Milesey Tools                                                                    |                                                                               |
|                        |                                | X640D                                                                  | Yosoon Infrared                                                                  | No longer commercialised as the company was dissolved                         |
|                        |                                | WUGOL One <sup>a</sup>                                                 | WUGOL GmbH                                                                       |                                                                               |
|                        | Flow water meter               | Sonata Ultrasonic Residential Water Meter                              | Arad Group                                                                       | No longer commercialised as the company was dissolved                         |
|                        |                                | Water Monitoring                                                       | Pancom BV                                                                        |                                                                               |
|                        |                                | WMI Water Meter                                                        | AgroLogic LTD                                                                    | No longer commercialised as the company was dissolved                         |
|                        |                                | TAIL <sup>a</sup>                                                      | Düppix                                                                           |                                                                               |
|                        |                                | TailTred                                                               | Innovent Technology Ltd                                                          | Not clear if it is currently purchasable                                      |

<sup>a</sup> Sensor technology currently under development.

(Ramon-Perez et al., 2025)

# Acoustic sensors

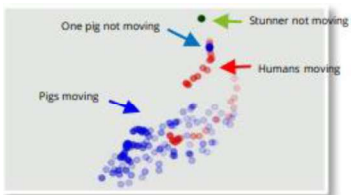
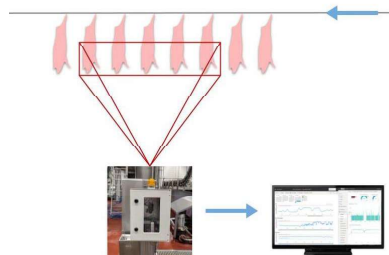
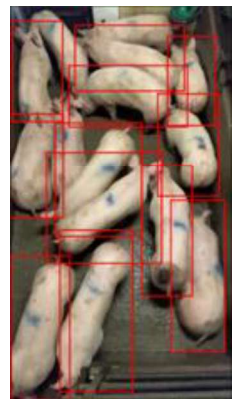


- Noise level
- Vocalisations

# Computer vision



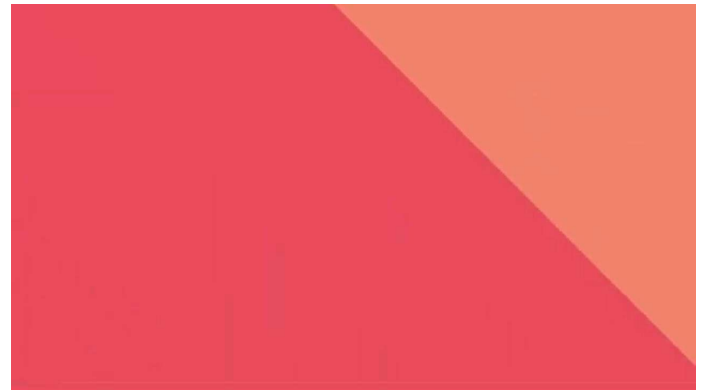
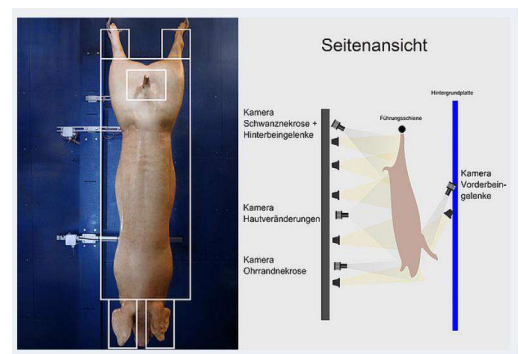
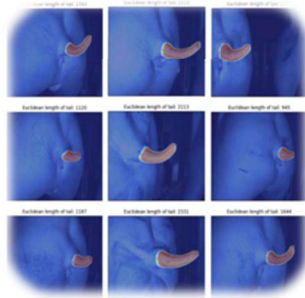
- Human handling
- Space availability
- Stunning effectiveness



# Computer vision



- Tail lesions
- Tail length
- Skin lesions
- Ear lesions



# Computer vision



- Lung lesions
- Hockburn lesions
- Foodpat lesions



# Animal Welfare Indicators Catalogue

- Interactive online tool
- Compilation of PLF technologies for monitoring animal welfare indicators in slaughterhouses
- Pigs and broiler chickens
- Each section is further divided into three stages:
  - *Pre-slaughter*: covers the period from when the animals arrive at the slaughterhouse until they enter the stunning area
  - *Stunning*: covers the stunning and slaughter procedures
  - *Post-slaughter*: includes all procedures carried out on the carcasses

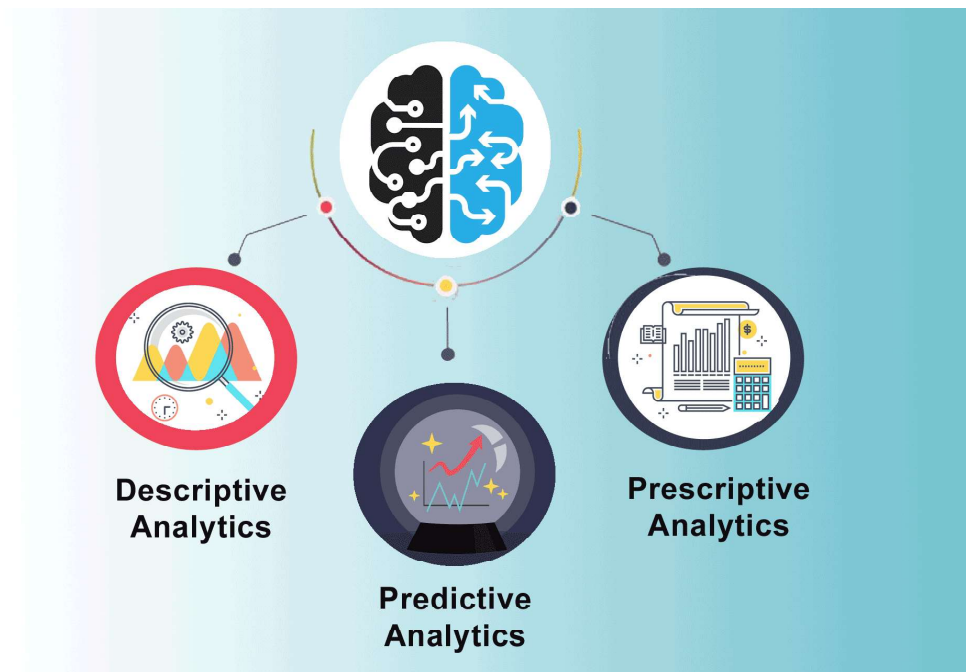
# Animal Welfare Indicators Catalogue



<https://www.awish-project.eu/>

# Potential

- Data from PLF sensors provides a great quantity of information with **ENORMOUS** potential
- It should be analysed using **appropriate mathematical tools**, particularly those based on artificial intelligence algorithms
- This data not only allows us to **monitor the animals' condition** at all times, but also offers **predictive insights** into what might happen in the future, based on current changes
- **Individualisation of the animals** instead of considering the group level welfare



# Descriptive analysis



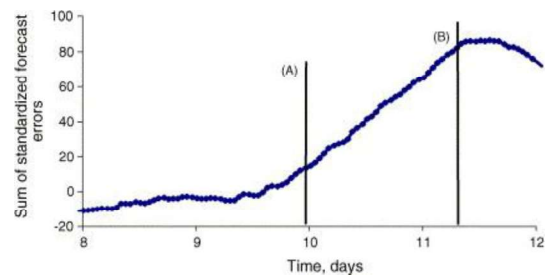
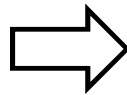
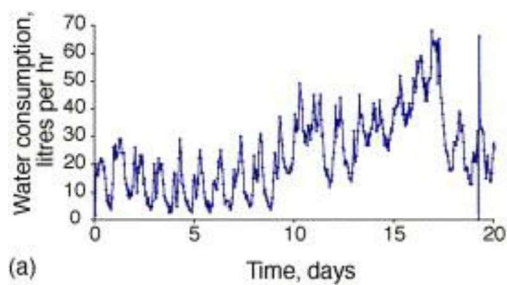
```
1 cow_data_day(43582, '2021-02-01')
=====
Feeding Score: 7.5
Housing Score: 7.5
Health Score: 8.89
-----
Total Score: 7.96
=====
eating: 7834.69
ruminating: 14133.38 - Smaller than 15720
temperature: 38.74243
drinking.times: 6.0
lying: 17988.46
standing: 20738.99
walking: 7523.18
pH: 5.93153
SCC: nan - No data

1 cow_data_day(101371, '2022-08-29')
=====
Feeding Score: 10.0
Housing Score: 10.0
Health Score: 10.0
-----
Total Score: 10.0
=====
eating: 17582.69
ruminating: 29606.23
temperature: nan - No data
drinking.times: nan - No data
lying: 20849.72
standing: 56180.38
walking: 9316.55
pH: nan - No data
SCC: nan - No data
```

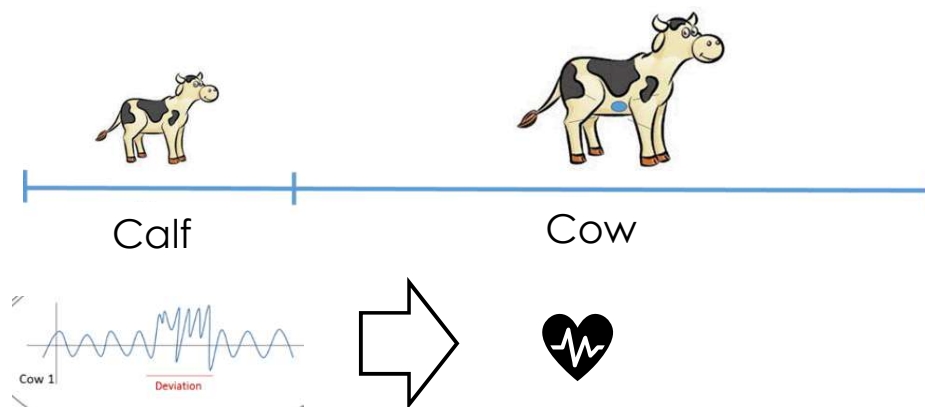
# Predictive analysis



- Water intake
- Estimation of gastrointestinal disease (diarrhoea)



# Prescriptive analysis

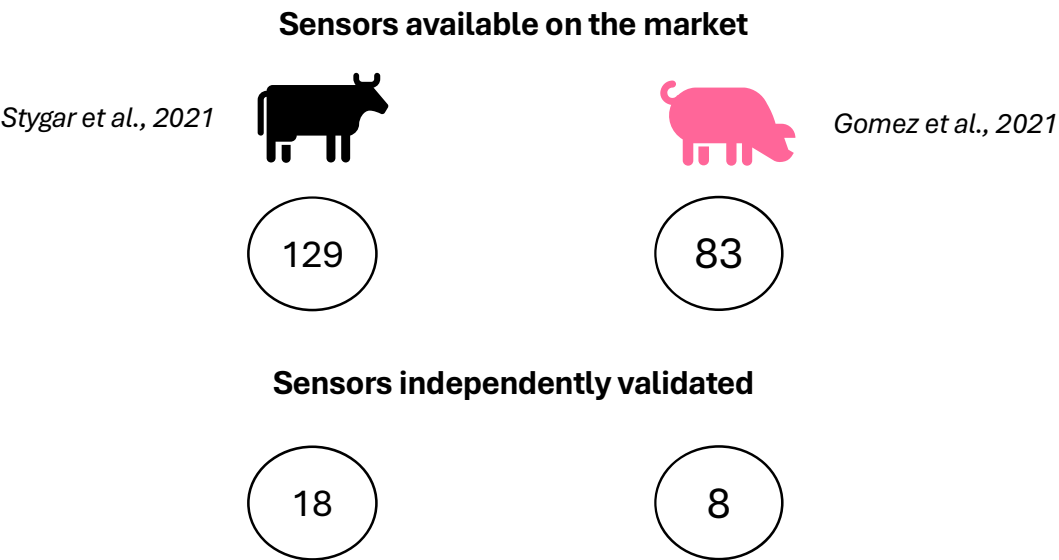


- Adjust feed and housing
- Closer monitoring of at-risk animals
- Selecting animals with lower-risk traits

# Limitations

- Technical limitations (i.e., internet connection, electricity)
- Animal limitations (adaptability and invasiveness)
- Data protection
- Validation

# Validation



## Take home messages



PLF sensors herald a new era in animal monitoring



Sensors for livestock animals are set to see strong growth in the coming years



This will increase the demand for staff specialising in data analysis and management



There is great potential for research and innovation in the development of new sensors



... But there are still many challenges ahead

Thank you very much for your attention.  
Do you have any questions?

Pol Llonch ([pol.llonch@uab.cat](mailto:pol.llonch@uab.cat))  
Angela Ramon ([angela.ramon@uab.cat](mailto:angela.ramon@uab.cat))

