EU-PLF

Deliverable 1.1

List of Key Indicators and Gold Standards (pigs/poultry)

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PU	**Public**	**X**
PP	**Restricted to other programme participants (including the Commission Services)**	
RE	**Restricted to a group specified by the consortium (including the Commission Services)**	
CO	**Confidential, only for members of the consortium (including the Commission Services)**	

Introduction

Key Indicators (KIs) are defined here as parameters that give information on a domain that is relevant for farm management and value creation. In this report we address KIs related to the domains: animal welfare, health, production and environmental load. To allow on-farm validation and testing of the performance of PLF techniques in measuring these KIs, also reference methods ('gold standards', GSs) are defined to determine the value of each indicator at farm level. Thus, in relation to each defined KI in the domains animal welfare, health, production and environmental load, an agreed methodology for assessing and reporting the incidence / severity or extent of that KI will be described.

It is essential for a farm centred (instead of technology driven) development and application of automation through PLF techniques that those KIs are selected that a) provide useful input to daily management and b) deliver significant socio-economic value in relation to costs of measuring.
In a later stage a number of KIs that show high potential to be measured with PLF technologies will be selected for further development and testing to allow on-farm implementation.

KIs may be expressed on different scales. Some may be expressed on cardinal scales (for example Somatic Cell Counts (SCC)) and others on ordinal scales (for instance lameness assessed by an observer in three classes (not lame, moderately lame and severely lame). However, it may be possible to move from ordinal scales for characteristics like lameness and skin lesions, when categorized by a human observer, to cardinal scales based on continuous monitoring results using PLF techniques. KIs are currently also measured in a variety of ways ranging from sophisticated technology to visual assessment.

KIs are currently used for different purposes. They can give important information to the daily management of the farm. For example, somatic cell count (SCC) is linked to the prevalence of mastitis and can trigger treatment of an individual cow. But KIs may also be used by other actors in the chain. In the dairy industry, for example, to reduce milk price for farms with more than 400000 cells/mL in bulk milk. Another example of other actors using KIs is the assessment of the % of broilers with pododermatitis in official controls to establish the maximum allowed stocking density. Also, existing farm certification and assurance schemes use a number of defined KIs to provide the structure for agreed levels of compliance (or non-compliance) against the requirements of certification standards.

Procedure

Key Indicators related to the different domains: animal welfare, health, production and environmental load for dairy cows, calves, fattening pigs and broilers were identified through expert consultation and literature analysis. For each KI the Gold Standard for measuring the KI was defined. Together, KIs for a specific domain capture the main aspects of the

performance of a farm in that domain. For each of the Key Indicators and their related Gold Standard (possible) technologies with the potential to measure these were defined.

The European Welfare Quality® project developed standardized ways of assessing animal welfare with an overall focus on animal based measures (e.g. directly related to animal body condition, health aspects, injuries, behaviour, etc.). The major outcome from the Welfare Quality® project was a definition of welfare principles and criteria for these principles.
Each welfare principle is phrased in such a way that it communicates a key welfare question. Four main principles are identified: good feeding, good housing, good health, appropriate behaviour. They correspond to the questions:

- Are the animals properly fed and supplied with water?
- Are the animals properly housed?
- Are the animals healthy?
- Does the behaviour of the animals reflect optimized emotional states?

Each principle comprises two to four criteria. Criteria are independent of each other and form an exhaustive but minimal list. Welfare principles and criteria are summarized in Table 1.

Table 1: The principles and criteria that are the basis for the Welfare Quality® assessment protocols.

Welfare principles	**Welfare criteria**	
Good feeding	1	Absence of prolonged hunger
	2	Absence of prolonged thirst
Good housing	3	Comfort around resting
	4	Thermal comfort
	5	Ease of movement
Good health	6	Absence of injuries
	7	Absence of disease
	8	Absence of pain induced by management procedures
Appropriate behaviour	9	Expression of social behaviours
	10	Expression of other behaviours
	11	Good human-animal relationship
	12	Positive emotional state

This addresses the domains ‘health’ and ‘welfare’. We aimed to keep this structure and therefore added the principles ‘Good environment’ (corresponding to the question ‘Does the system prevent excessive environmental load?’) and ‘Good production’ (corresponding to the question ‘Do the animals produce well in relation to their genetic potential?’) to specifically include the domains production and environmental load. Related criteria for these principles were also defined (Table 2). Not all criteria (8, 12 and 14) for the different principles are

addressed in this project and we have only focused on those criteria that with the current knowledge have the potential to be assessed automatically.

Table 2: The principles and criteria that are added to the Welfare Quality® principles for this project.

Principles	Criteria	
Good environment	13	Absence of bad indoor climate
	14	Absence of negative impact on outdoor environment
Good production[#]	15	Good feed conversion

[#]**Criterion for good production is also included in some of the criteria in Table 1.**

The work resulted in the tables below describing Key Indicators with their related Gold Standards and indicating their relation to the four different domains for all four species included in this project. Also possible technical solutions that could have the potential to be able to measure the Key Indicators in an automated way are indicated.

Broilers

Domain	Principles	Criteria	Key Indicators	Measures of Key Indicators that could be linked to technologies	Technologies that have the potential to be used for measuring Key Indicators	Gold standard
Welfare	Appropriate behaviour	Good human-animal relationship	Avoidance distance	Avoidance distance test performed in the flock	Video/image from the barn	Welfare Quality assessment
Welfare	Good health	Absence of injuries	Foot pad dermatitis	Proportion of birds with dark skin underneath the foot	Using analysis of video images recorded at the slaughterhouse; Activity meters; Video/image from the barn; RH sensor	Welfare Quality assessment
Welfare	Good health	Absence of injuries	Hock burn	Proportion of birds with dark spots on the back of the hock joint	Using analysis of video images recorded at the slaughterhouse; Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Dust sheet test	Proportion of damp in the air	Video/image from the barn; RH sensor; Particle counters/gravimetric	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Litter quality	The moist and colour of litter	Video/image from the barn; Water meter; T sensor; Particle counters/gravimetric	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Plumage cleanliness	Proportion of dirt on feathers	Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Ease of movement	Stocking density	Average weight of birds per square meter	Video/image from the barn; Weigh scale	Welfare Quality assessment
Welfare	Good housing	Thermal comfort	Huddling	Percentage of flock showing huddling behaviour	Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Thermal comfort	Panting	Number of birds breathing rapidly in short gasps in the flock	Video/image from the barn; Sound in the barn; T sensor	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Lameness	The birds ability to walk	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Breast blister	Percentage of birds with breast blisters	Video/image from the barn; T sensor; RH sensor	Welfare Quality assessment
Production	Good production	Good feed conversion	Feed intake	Regular measures of feed intake	Weighing technology	Reference Measurements
Production	Good production	Good feed conversion	Growth	Regular measures of weight Density of birds in the flock	Weighing scale; Video/image from the barn	Reference Measurements
Production and Welfare	Good feeding	Absence of prolonged hunger	Emaciation	Proportion of birds with low body condition score in the flock	Using analysis of video images recorded at the slaughterhouse; Using analysis of video or images from the barn for body condition score; Video/image from the barn; Weigh scale	Welfare Quality assessment

Domain	Principles	Criteria	Key Indicators	Measures of Key Indicators that could be linked to technologies	Technologies that have the potential to be used for measuring Key Indicators	Gold standard
Environmental load and Health	Good feeding	Absence of prolonged thirst	Drinker space	Water usage in the barn, function and number of nipples, cups or bell drinkers	Video/image from the barn; Water meter	Welfare Quality assessment
Environmental load and Production	Good feeding	Absence of prolonged hunger	Feed delivery/conversion	The proportion of delivered feed and growth rate of the birds	Using analysis of video images recorded at the slaughterhouse; Using analysis of video or images from the barn for body condition score; Video/image from the barn; Weigh scale	Welfare Quality assessment
Environmental load, Health, Production and Welfare	Good environment	Absence of bad indoor climate	Air quality	Level of CO2, NH3, CH4, odour and dust	Particle counters/gravimetric ; Kwh meter/gas meter; IR /photo acoustic analyser; Photo acoustic/ NOx analyser; GC /photo acoustic analyser	Reference Measurements
Environmental load, Health, Production and Welfare	Good environment	Absence of bad indoor climate	Indoor climate quality	Actual Temperature, Humidity, Draft, Level of NH3 odour and dust	Video/image from the barn; T sensor; RH sensor; smoke generator/camera; Particle counters/gravimetric ; IR /photo acoustic analyser; Photo acoustic/ NOx analyser; GC /photo acoustic analyser	Reference Measurements

Fattening pigs

Domain	Principles	Criteria	Key Indicators	Measures of Key Indicators that could be linked to technologies	Technologies that have the potential to be used for measuring Key Indicators	Gold standard
Welfare	Appropriate behaviour	Expression of other behaviours	Stereotypies / abnormal behaviours			
Welfare	Appropriate behaviour	Expression of other behaviours	Exploration / manipulation of objects			
Welfare	Appropriate behaviour	Expression of social behaviour	Social behaviour	Observations of positive and negative social behaviours	Video/image from the barn; Sound in the barn	Welfare Quality assessment
Welfare	Appropriate behaviour	Good human-animal relationship	Fear of humans	Observations of animals showing a panic reaction towards humans in the pen	Video/image from the barn; Sound in the barn	Welfare Quality assessment
Welfare	Appropriate behaviour / Health	Expression of other behaviour / absence of disease	Smoothness of activity: number of bouts, rhythm (both might be related to QBA or early sign of a disease), distance between animals (to detect isolation) + synchronisation of activities between animals	observation of animal general activities	Activity meters; Using analysis of video or images from the barn for body condition score; Sound in the barn	activity patterns
Welfare	Good feeding	Absence of prolonged thirst	Access to water	Behaviour of animals around drinkers (crowding…)	Activity meters; Using analysis of video or images from the barn for body condition score; Correspondence between food ingested and weight gain	
Welfare	Good housing	Comfort around resting	Bursitis	Total time spent lying, Time spent lying per lying bout, Number of lying bouts during a day, Attempts to get up and to lie down and Getting up and lying down movements (difficulties)	Using analysis of video images recorded at the slaughterhouse; Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Manure on the body	Proportion of manure on the body	Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Ease of movement	Space allowance	Number of pigs per square meter	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare and Environmental load	Good feeding	Absence of prolonged thirst	Water supply	Water usage, Numbers of drinkers, Function of drinkers and Cleanliness of drinkers	Video/image from the barn; Water meter	Welfare Quality assessment
Health	Good health	Absence of injuries	Lameness	The pigs ability to walk	Activity meters; Video/image from the barn	Welfare Quality assessment

Domain	Principles	Criteria	Key Indicators	Measures of Key Indicators that could be linked to technologies	Technologies that have the potential to be used for measuring Key Indicators	Gold standard
Health, Production and Welfare	Good health	Absence of disease	Respiratory disorders	Number of coughing and sneezing within a fixed amount of time	Sound in the barn; Particle counters/gravimetric	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Laboured breathing	Number of pigs with a laboured breathing or pumping breathing	Sound in the barn; Particle counters/gravimetric	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Twisted snout	Number of pigs suffering from Atrophic Rhinitis		Welfare Quality assessment
Production	Good production	Good feed conversion	Feed intake	Regular measures of feed intake	Weighing technology	Reference Measurements
Production	Good production	Good feed conversion	Growth	Regular measures of weight	Weighing scale; Video/image from the barn	Reference Measurements
Production and Welfare	Good feeding	Absence of prolonged hunger	Body condition score	Number of visits to the feeder, Time of the day of these visits, Amount of feed eaten at each visit, Total time spend eating per day and per visit and Weight changes	Sensors used for feeding in the barn; Using analysis of video or images from the barn for body condition score; Correspondence between food ingested and weight gain; Video/image from the barn; Weigh scale	Welfare Quality assessment
Environmental load and Production	Good feeding	Absence of prolonged hunger	Feed delivery/conversion	The proportion of delivered feed and growth rate of the pigs	Using analysis of video images recorded at the slaughterhouse; Using analysis of video or images from the barn for body condition score; Video/image from the barn; Weigh scale	Welfare Quality assessment
Environmental load, Health, Production and Welfare	Good environment	Absence of bad indoor climate	Indoor climate quality	Actual Temperature, Humidity, Draft, Level of NH3 odour, dust and light	Video/image from the barn; T sensor; RH sensor; Smoke generator/camera; Particle counters/gravimetric; Dynamic olfactometry	Reference Measurements
Environmental load, Health, Production and Welfare	Good environment	Absence of bad indoor climate,	Air quality	Level of CO_2, NH_3, CH_4, odour and dust	Particle counters/gravimetric; Kwh meter/gas meter; IR/photo acoustic analyser; Photo acoustic/NOx analyser; GC/photo acoustic analyser	Reference Measurements