

EU-PLF

Deliverable 1.2

List of Key Indicators and Gold Standards (cows)

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Dissemination level		
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PP	Restricted to other programme participants (including the Commission Services)	
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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.

Dairy cows

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 social behaviour	Agonistic behaviour	Displacement, Chasing, chasing up from lying area, avoidance of other animals	Sensors used for feeding in the barn; Activity meters; Individual position system; Video/image from the barn; Sound in the barn	Welfare Quality assessment
Welfare	Appropriate behaviour	Good human-animal relationship	Avoidance distance	Avoidance distance test performed at the feeding rack	Individual position system; Video/image from 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 the animals general activities	Activity meters; Individual position system; Video/image from the barn	Activity patterns
Welfare	Appropriate behaviour / Housing	Expression of other behaviours/Access to pasture	Grazing behaviour	Grazing behaviour, standing or walking slowly with head down	Activity meters; Individual position system; Video/image from the barn	Activity patterns
Welfare	Appropriate behaviour / housing	Expression of social behaviour / ease of movements	Blocks in traffic flow or at feeding gate	Group of animals crowding and not moving	Activity meters; Individual position system; Video/image from the barn	Activity patterns
Welfare	Good feeding	Absence of prolonged thirst	Access to water	Behaviour of animals around drinkers (crowding...)	Activity meters; Individual position system; Using analysis of video or images from the barn for body condition score	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Lying	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), Lying position, Lying partly or completely outside the lying area, Colliding with housing equipment during lying down	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Manure on the body	Proportion of dirt on cows; cows lying outside the lying area	Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Ease of movement	Activity	Time spent up and active	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
Welfare	Good housing	Ease of movement	Slipperiness of the floor	Animals slipping when walking	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare and Environmental load	Good feeding	Absence of prolonged thirst	Water supply	Water usage, Water flow, Numbers of drinkers, Function of drinkers and Cleanliness of drinkers	Correspondence between food ingested and weight gain; Video/image from the barn; Milk and SCC meters; Water meter	Welfare Quality assessment
Welfare and Production	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, Body condition score	Sensors used for feeding in the barn; Photo acoustic/ NOx analyser; Correspondence between food ingested and weight gain; Video/image from the barn; Milk and SCC meters; Weigh scale; Using an analysis of video or images from the barn for body condition score	Welfare Quality assessment
Health and Production	Good health	Absence of disease	Diarrhoea	Presence of liquid manure, Prolonged lying in recumbent position	Activity meters; Correspondence between food ingested and weight gain; Video/image from the barn	Welfare Quality assessment
Health and Production	Good health	Absence of disease	Milk quality	SCC, Fat and Protein	Milk and SCC meters	Reference Measurements
Health, Production and Welfare	Good health	Absence of disease	Abnormal breathing	Pumping, Respiratory frequency > 40/min		Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Respiratory disorders	Coughing, Sneezing	Sound in the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Bitten tail/ear	Damage to the tail or ear with or without fresh blood		Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Bursae	A swelling of the front knee or hook	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Claw lesions	Inflamed, red and swollen skin at the claw border	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Joint lesions	A clear thickening of the joint border due to accumulation of extra fluids	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 injuries	Lameness	Walking ability	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Spots of hard skin	Spots of hard skin on the shoulders or withers		Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Integument alterations	Hairless patches and lesions/swellings		Welfare Quality assessment
Production	Good production	Good feed conversion	Feed intake	Weight and type of feed	Weighing technology	Reference Measurements
Production	Good production	Good feed conversion	Milk production	Milk meter in the milking parlour in relation to feed intake and feed delivered	Milk meter	Reference Measurements
Production, Health and Welfare	Good health		Mounting	Activity	Activity meters; Video/image from the barn	
Production, Health and Welfare	Good health	Absence of injuries	Calving difficulties	General activity	Activity meters; Video/image from the barn; Sound in the barn	
Production, Health and Welfare	Good housing	Comfort around calving	Start of calving	General activity, Vulva discharge	Activity meters; Video/image from the barn; Sound in the barn	Reference Measurements
Environmental load 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 ; Dynamic olfactometry; Kwh meter/gas meter; IR/photo acoustic analyser; Photo acoustic/NOx analyser; GC /photo acoustic analyser	Reference Measurements
Environmental load and Welfare	Good environment	Absence of bad indoor climate	Indoor climate quality	Actual Temperature, Humidity, Draft, Level of NH ₃ odour, dust and light	T sensor; RH sensor; smoke generator/camera; Particle counters/ gravimetric; Photo acoustic/NOx analyser	Reference Measurements

Dairy calves

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	Play behaviour	Observations of the occurrence of running, jumping and frolic behaviour	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare	Appropriate behaviour	Good human-animal relationship	Avoidance distance	Avoidance distance test performed at the pen	Video/image from the barn	Welfare Quality assessment
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
Welfare	Good housing	Comfort around resting	Lying position	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), Lying position	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Comfort around resting	Manure on the body	Proportion of dirt on calves	Video/image from the barn; RH sensor	Welfare Quality assessment
Welfare	Good housing	Ease of movement	Activity	Time spent up and active	Activity meters; Video/image from the barn	Welfare Quality assessment
Welfare	Good housing	Ease of movement	Slipperiness of the floor		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	Correspondence between food ingested and weight gain; Video/image from the barn; Water meter	Welfare Quality assessment
Health and Production	Good health	Absence of disease	Diarrhoea	Presence of liquid manure, Prolonged lying in recumbent position	Activity meters; Video/image from the barn; Correspondence between food ingested and weight gain	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Abnormal breathing	Pumping, Respiratory frequency > 40/min	Sound in the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of disease	Respiratory disorders	Coughing, Sneezing	Sound in 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 injuries	Bitten tail/ear	Damage to the tail or ear with or without fresh blood	Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Bursae	A swelling of the front knee	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Claw lesions	Inflamed, red and swollen skin at the claw border	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Joint lesions	A clear thickening of the joint border due to accumulation of extra fluids	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Lameness	Walking ability	Activity meters; Video/image from the barn	Welfare Quality assessment
Health, Production and Welfare	Good health	Absence of injuries	Spots of hard skin	Spots of hard skin on the shoulders or withers	Video/image from the barn	Welfare Quality assessment
Production	Good production	Good feed conversion	Growth	Regular measures of weight in relation to feed delivered	Weight scale	Reference Measurements
Environmental load and Welfare	Good environment	Absence of bad indoor climate	Air quality	Level of CO ₂ , NH ₃ , and CH ₄ , odour and dust	Particle counters/gravimetric ; Dynamic olfactometry; Kwh meter/gas meter; IR/photo acoustic analyser; Photo acoustic/NOx analyser; GC /photo acoustic analyser	Reference Measurements
Environmental load and Welfare	Good environment	Absence of bad indoor climate	Indoor climate quality	Actual Temperature, Humidity, Draft, Level of NH ₃ odour, dust and light	T sensor; RH sensor; Smoke generator/camera; Particle counters/gravimetric ; Dynamic olfactometry; Photo acoustic/NOx analyser;	Reference Measurements
Environmental load and Production	Good feeding	Absence of prolonged hunger	Feed delivery/conversion	The proportion of delivered feed and growth rate of the calves	Using analysis of video images recorded at the slaughterhouse; Using a analysis of video or images from the barn for body condition score; Video/image from the barn; Weigh scale	Welfare Quality assessment; Feed delivered and growth rate