



Welfare assessment of dairy cows in automatic milking systems

*A protocol for assessing animal welfare in an
automatic milking system*

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Information

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*A protocol for assessing animal welfare in an
automatic milking system*

**Senior advisor Jens Hindhede
Ph.D Stipendiate Tine Rousing
Ph.D Stipendiate Christine Fossing
Head of research unit Jan Tind Sørensen Ph.D**

*Department of Animal Health and Welfare
Danish Institute of Agricultural Sciences*

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Correspondence:
Jan Tind Sørensen
Department of Animal Health and Welfare
Danish Institute of Agricultural Sciences
Research Centre Foulum
P.O. Box 50 DK-8830 Tjele Denmark
jantind.sorensen@agrsci.dk

Abstract

In general there is an increased focus on animal welfare in commercial farms. However the knowledge about the effects of the production systems and a management with advanced technology and non-traditional diurnal routines on the welfare of cows in herds with AMS is limited. Furthermore, experiences from previous studies indicate that there is a large variation between herds in general regarding animal welfare due to the effect of interactions between production system and management. Consequently there is a need for development of welfare indicators relevant for AMS herds as well as a welfare assessment system at herd level providing a decision support tool.

In general welfare indicators which are relevant for inclusion in an operational welfare assessment system should have the following qualities:

- They have to be based in scientific knowledge
- They should be able to detect changes over time.
- They should be measurable on commercial farms within a realistic framework.
- They have to be capable to offer decision support to the farmer.

Welfare indicator candidates are found among both indirect indicators related to systems and systems application, as well as animal behaviour and health, relating more directly to the animals in question. The aim of this protocol is to suggest welfare indicators and demonstrate the aggregation of welfare indicators into a welfare assessment protocol based on:

- The individual welfare relevance of the indicators.
- The marginal welfare information value of the indicators (given other welfare indicators in the protocol)
- The applicability of the indicators for on-farm studies (repeatability, reproducibility and resource requirements)

A full welfare indicator protocol has been described including observations from the system (housing and pastures) and systems applications such as: animal density, management (feeding, drinking, grazing, milking, replacement, health surveillance, disease treatments) and the cow traffic system.

Welfare indicators based on behaviour studies (6 times a year) focus on: Man-animal relationship, behaviour at/in AMU, getting up behaviour, resting behaviour, social behaviour and diurnal behaviour pattern, and usage of the stable.

Welfare indicators concerning health are based on regular clinical examinations (4 times a year) focusing on: hoof and leg disorders, lameness, skin lesions, udder infections, body condition, clinical diseases.

Furthermore, incidences of disease and death are included as health indicators.

Table of contents

1. General introduction	1
2. The concept for a welfare assessment system.....	2
3. The protocol design	4
4. Behaviour and Health indicators	5
4.1 Behaviour	5
4.2 Health.....	8
5. Systems and Systems application (management) indicators.....	11
5.1 System.....	11
5.2 Systems application.....	14
5.3 Additional Systems and Systems application for the pasture period	17
6. Bibliography.....	21

1. General introduction

Automatic milking systems (AMS) offers the dairy farmer the possibility to increase productivity and change daily management routines. Also the daily life of the cow is changed from two daily milking periods to a systems designed to cater individual variation between cows in milking frequency and milking time. Thus; a dairy cattle herd with AMS differs substantially from 'conventional' loose housed dairy herd with fixed milking time. It is therefore difficult to know potentials and limitations with regard to animal welfare in dairy herds with AMS.

In general there is an increased focus on animal welfare in commercial farms and it is expected that animal welfare will be an important aspect for public accept of AMS. Furthermore, experiences from previous studies indicate that there is a large variation between herds in general regarding animal welfare due to the effect of interactions between production system and management (Sandøe et al. 1997).

Therefore, there is a need for development of welfare indicators relevant for AMS herds as well as a welfare assessment system at herd level providing a decision support tool. The purpose with this report is to present an indicator protocol for assessing animal welfare at farm level in an AMS-dairy cattle herd.

2. The concept for a welfare assessment system

A concept for assessing animal welfare at farm level has been developed at the Danish Institute of Agricultural Sciences as a decision support tool for the farmer (Sørensen et al. 2001a; Sørensen et al. 2001b; Rousing et al. 2001, Bonde et al. 2001).

It is imperative for the assessment of animal welfare that a certain agreement on the meaning of animal welfare has been reached. Different approaches for assessing animal welfare at farm level has been developed often with quite different purposes (Johnsen et al. 2001). In our concept animal welfare should mirror that positive and negative experiences matters from the animals point of view, as proposed by Simonsen (1996). The experiences of the animals cannot be measured directly. They have to be assessed indirectly. Two kinds of information may be relevant: Information about the systems and how it is managed and 2) information on how animals respond to the way they are kept and are being treated. Each source of information can be subdivided into two giving four sources of information: the system, systems application, animal behaviour and animal diseases as shown in Fig. 1.

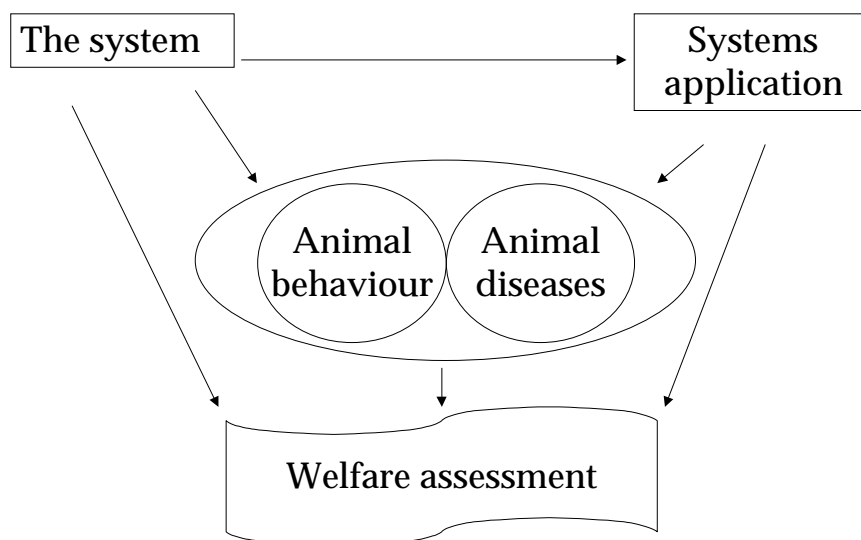


Fig. 1. Sources of information for assessing animal welfare on an animal farm (Sørensen et al 2001a).

A welfare assessment system consists of a range of welfare indicators. A welfare indicator suitable for inclusion in an operational welfare assessment system should have the following qualities:

- A basis in scientific knowledge
- The ability to reflect development over time
- Realistic measurability on the type of farm in question
- The capability to offer decision support to the farmer.

Aggregating welfare indicators into a welfare assessment protocol calls for a systematic procedure, which is described by Rousing et al. (2001). Three steps are suggested:

1. All suggested indicators should be thoroughly evaluated for their relevance to animal welfare.
2. Considering that we have information on all the indicators on the list except for the indicator in question, we can evaluate the marginal increase in information adding this indicator to the list. For example; observation of abnormal getting up behaviour in cows may be supplemented or replaced by clinical registration of skin lesions and information on systems (cubicle size) and systems application (bedding and animal density). However, behavioural observations might be important information when investigating the probable cause of skin lesions.

3. The feasibility of the suggested indicators for on-farm studies (investigate each of the indicators for suitability for on-farm studies). This evaluation relates to time and costs when carrying out registrations or testing. Selection of an indicator depends on whether information is all ready routinely available or the information can be obtained as a supplement to ordinary consultations by e.g. veterinarians or husbandry advisors. This third step regards developing methods and tests for use on farms.

The welfare indicator protocol documents the current measures included in a welfare assessment system. It is primarily a research tool for developing operational assessment systems with different resource demands. The welfare assessment concept the protocol is the basis for recordings on the farm for a predefined period (often a year). A welfare assessment report presenting the results is produced and is discussed with the farmer (Bonde et al. 2001). The report should be useful as a decision support tool for the farmer.

The welfare assessment system is evaluated. An expert panel on animal welfare is asked on their opinion on animal welfare on case farms given different levels of information from the welfare assessment reports. At each level of information the experts are also asked to specify useless information and information, which could improve the animal welfare assessment. Finally the experts are interviewed on their opinion on applying the welfare assessment system as decision support.

3. The protocol design

Welfare indicator candidates are found among both indirect indicators related to system and systems application as well as animal behaviour and health, relating more directly to the animals in question.

Thus, the lists below present a full welfare indicator protocol, in which each indicator is motivated by three qualities:

1. The individual welfare relevance of the indicators.
2. The marginal welfare information value of the indicators (given other welfare indicators in the protocol)
3. The applicability of the indicators for on-farm studies (repeatability and reproducibility)

Each quality is scored as **high, medium or low**. No indicators with a low individual relevance were included in the final protocol.

The protocol is organised in two main categories: animal behaviour and health indicators (Chapter 4) and systems and systems application (Chapter 5). Indicators especially relevant on pasture are presented in section 5.3. The protocol is developed for a one-year welfare assessment period.

The abbreviation AMS (automatic milking system) refers to the total production system including automatic milking. The abbreviation AMU (automatic milking unit) refers to a milking robot. For example there can be 2 or 3 AMU's in on AMS.

4. Behaviour and Health indicators

4.1 Behaviour

Behaviour measurements are included in the operational welfare assessment system. The behaviour performed by the animals in the housing systems is compared to known descriptions of normal behaviour patterns (behaviour normally used to attain functional goals). In this way behaviour measurements, and behaviour tests, can reveal whether the animals are adapted to the production system or whether the animals show any signs of strain.

In dairy herd with AMS behaviour studies are conducted 6 times during a year and the focus will be on:

- Man-animal relationship,
- Behaviour at/in AMU,
- Getting up behaviour,
- Resting behaviour,
- Social behaviour
- Diurnal behaviour pattern and usage of the stable.

<i>Behaviour</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Man-animal relationship	<p>Medium: The human-animal relationship may have strong effects on farm animal behaviour, welfare and performance. Genetic predisposition as well as (early) experience, quality and quantity of human contact and handling procedures are factors that influence the human-animal relationship. Even though human-animal contacts are reduced in AMS herds to handling at calving, insemination and veterinary treatment and when cows are driven to the AMU for milking, the quality of the human-animal-relationship is relevant for the welfare of the cows. Because fearful animals are expected to be unpleasant affected by recurring contact with humans. Furthermore, animals showing fearful behaviour are often exposed to adverse handling because they react inappropriately to the handling procedures. The result might be a prolonged complicated human-animal-relationship</p>	<p>High: Fear tests are considered as a more direct measurement of the man-animal relationship. Information on systems application, housing conditions and breeding support the behavioural tests of fear.</p>	<p>High: Manual testing in the home environment (not building test arenas) by scoring cows according to their acceptance of an approaching (known) person.</p>

<i>Behaviour</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Behaviour at / in AMU	<p>High: To stimulate the milking frequency following involuntary activities are often practised in the AMS to “encourages” the cows to enter the milking unit: Coax the cows by offering a feed reward in the AMU. Force the cows to the AMU by applying controlled traffic (one way traffic). Restrict the cows admission to drinking water in some areas of the barn or in the field. This reveals that there might be a welfare problem related to the AMS in it self. Following information are relevant for the cows welfare: cows willingness and motivation to visit the AMU herd diurnal rhythm conflicts between system and animal general loading of AMU. As milking is a returning procedure it is assumed to be a significant welfare problem if cows are unpleasantly affected by the fully technical milking procedure through dislike of the milking procedure it self or due to other circumstances (e.g. difficult access to the milking unit, queuing, social stress)</p>	<p>High: Behaviour registrations at and in the AMU are suggested to be the most direct indicator for assessing cows: Willingness to visit AMU Social behaviour at the AMU Possible dislike at milking System description and systems application of AMU may support the behavioural findings.</p> <p>May be supported by skin lesions and system description and systems application.</p>	<p>High:</p>
Number of visits AMU			Computer-data: Number of visits in the AMU
Time visiting AMU			Computer-data: Time for visiting the AMU
Refusing by AMU			Computer-data: Refusing by AMU.
Dislike behaviour in AMU			Manual monitoring at milking. Information from the “alarm list”
Queuing at AMU			Manual count of location of cows position
Aggressions at AMU			See “Social interactions”

<i>Behaviour</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
"Getting-up behaviour"	High: A very frequent physical activity among cows is 'getting up' and 'lying down'. Abnormal getting up and lying down behaviour (regarding both appearance and the time factor) is associated with discomfort to the cows and presence of increased risk of injuries.	Medium: May be supported by hock and carpal injuries, teat injuries and lameness as well as caluses and dirtiness, which strengthen the relevance of abnormal getting up and lying down behaviour as being a welfare problem. Supported by system description and systems application.	Medium: Manual behaviour sampling is considered relevant. Measuring "getting up behaviour" seems to be the more operational method compared to measuring "lying down behaviour" which can only be evaluated by observing cows spontaneously lying down. Timing and scoring getting-up behaviour as more or less abnormal
Resting behaviour	High: Resting behaviour is assumed to be highly relevant as a welfare indicator in AMS herds as diurnal level of activity may be affected. An indistinct diurnal level of activity may cause unrest in then resting areas. Furthermore, cows resting on the slats outside the cubicles and cows lying in the cubicles in an abnormal way could indicate that the cubicles are uncomfortable, perhaps difficult to get access to or to high stocking rate	High: Whereas quality of cubicles and bedding material could tell us something about the risk of unrest and discomfort, behaviour studies relates more directly to the animals in question. Supported by caluses and dirtiness and system description and system application	Medium: Manual count of abnormal resting behaviour
Social behaviour Aggressions Social licking	High: Social behaviour is considered to be an important welfare indicator in AMS herd as social behaviour is challenged in systems characterised by non-stable diurnal behaviour. Medium: Aggression is a relevant welfare indicator and consists in animals being chased, injured and maybe even being ousted from resources. Being a result of general strain, aggressions also indicate a welfare problem in the aggressive animals. Medium: As opposed to aggressive social behaviour social licking – if not excessive occurrence - may be included in the protocol as an indicator of good welfare.	Low: Causes of aggression could be many. There might be considerable overlap to the other indicators. Aggressive behaviour as a welfare indicator has to be supported by information on system, system application, man-animal relationship, and number of cows lying outside cubicles if causes shall be found. Should be further supported by lesions and dirtiness	Low: Being developed

<i>Behaviour</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Diurnal behaviour pattern / usage of Stable	High: It is difficult to document that activity in itself affects welfare. However in the AMS it is interesting to examine the cows usage/utilisation of the stable and to what degree the instinctive synchronisation of behaviour is challenged. Further, from a welfare aspect it is interesting to collect information on behaviour in the case of e.g. limited access to resources as feeding and resting areas as well as queuing at AMU and disquiet.	Medium: Measurement on diurnal behaviour pattern (position) as well as cows usage of the stable are suggested to be one of the most direct indicator for the overall influence of the AMS-system on the animals. May be supplied by computer data; number and timing of visits, refusals, cows put on alarm list.	Medium: Manual testing: “Interval scans”(counts) of as well location and posture of the cows.

4.2 Health

Disease can be regarded as an important welfare indicator, because it is in many cases associated with negative experiences such as pain, discomfort or distress. The disorders, which have the greatest impact on welfare, are either acute disease processes, causing suffering or long-term progressive conditions involving chronic pain. One indicator in a welfare assessment on farm level may be the prevalence and intensity of certain health problems in the herd. A protocol for systematic clinical examination is developed focussing on important welfare aspects. As a supplement to this important indicators for disease incidence and death are included.

<i>Health</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Clinical disease	High: Disease is uncomfortable and may be painful for the individual animal	High: No other term may replace this value as an expression for this condition	High: Animals are observed at close range
Body score	High. Cachexia or obesity is considered to be uncomfortable and may increase risk of disease and injuries caused by equipment	High: No other term may replace this value as an expression for this condition.	High: Animals are observed at close range
Udder health	High: Udder lesions and sunburned udders may cause pain and add to risk of disease. mastitis is considered to be painful to the cow	High: No other term may replace this value as an expression for this condition. May be supported by behaviour at milking	Medium: Examination of the udder including palpation and examination of the milk. Animals have to be tied
External parasite infestation	Medium: High parasite infestation causes irritation to the animal – and may cause selfmutilation and skin disease	Medium: May be supported by skin lesions	High: Animals are observed at close range

Health	Independent relevance as a welfare indicator	Marginal information value	Applicability for on-farm studies
Cleanliness	Medium: Extreme dirtiness causes irritation to the skin– and may cause skin disease and selfmutilation indicating underlying system problems i.e. dirty cubicles and dirty and smoothly floors. Dirtiness also cause a need for mechanical action which may be harsh to the skin	Medium –High: May be supported by system cleanliness.	High: Animals are observed at close range
Skin lesions	High: Many skin lesions suggest irritation to the skin– or pain. May cause skin disease	High: No other term may replace this value as an expression for this condition. May be supported by systems description, social behaviour and lying behaviour, but also risk for injuries caused by protrusions	High: Animals are observed at close range
Lameness	High: May express pain from hooves especially significant for the cow-traffic in AMS. May increase the risk for udder problems and cachecisia. May influence social behaviour and the human-animal-relationship	High: No other term may replace this value as an expression for this condition. May be supported by information about floor condition, foot bath and hoof trimming, but in the grazing period also lane type and condition	High: Observation of animals standing and walking
Calluses	High: Large calluses may cause pain and predispose for joint disease	High: No other term may replace this value as an expression for this condition. May be supported by systems description – risk for calluses caused by cubicles and equipment and lying behaviour	High: Animals are observed at close range lying behaviour
Long hoofs	Medium: Extremely long hooves may cause hoof disease and pain	Medium: Lameness may support this value as an expression for this condition, but also information on floor condition and hoof care	Medium: Animals are observed at close range. It can be difficult to see if there is a lot of waste material on floor
Incidents of disease and death	High: The incidents gives an information regarding disease over a period of time, whereas the information harvested on clinical examination is dependable on the status on the farm at the time of the visit.	High: Can not be replaced by clinical examination. Could be supported by interviews on courses of the diseases	Medium: Conductivity measured by AMU combined with information on somatic cell count from the milk-recording cheme. Easy data but indirect in relation to mastitis. Mortality from the milk recording scheme.

<i>Health</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Incidents of mastitis	High: The incidents gives an information regarding mastitis over a period of time, whereas the information harvested on clinical examination of the udder depends on the status on the farm at the time of the visit	High: Can not be replaced by clinical examination.	Medium: Records such as conductivity and SCC are easy to collect likely to be accurate as collected on AMS-unit computer for each cow but may have a low sensitivity in relation to mastitis. Supplied with data from the central data base

5. Systems and Systems application (management) indicators

The welfare of farm animals is affected by the production system itself as well as the way the individual farmer applies the system. Welfare relevance is a question of how production system and management consider or restrain the physiological and behavioural needs of the animals, and to what extent the health of the animals is affected. Knowledge on how system and management might affect the animals can be included in a welfare assessment system and provide information of risk of welfare problems as well as causal factors.

Any strategy requiring system and management routines to be recorded will have certain limits and pitfalls. First, although different aspects of these indicators have been studied under experimental conditions, there is still considerable ignorance of the effect on welfare of a number of minor features in different housing systems. Furthermore, interactions between different factors are currently poorly understood. The marginal welfare information value is typically low, so there is still a need for a strategy that focuses directly on the livestock response. In practice it might be necessary to focus on a limited number of key measurements. Most system indicators and some management indicators are reasonable easy to define and measure, whereas several management indicators are difficult to assess but nevertheless have a serious impact on animal welfare. Surveying housing system and housing equipment as well as interviews with the farmer seem to be applicable methods of measurement.

5.1 System

<i>System description</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Cubicles/Stalls			
Dimension, Number:	High: Too small stalls means that cows lie in unnatural positions and develop calluses or they are forced to lie in aisles.	Medium: May be supported by pressure sores, getting-up behaviour, resting behaviour and dirtiness.	High: The dimensions of the stalls and numbers are noted and measured
Floor type	High: The floor of cubicle may be important for the cow motivation for resting in the cubicles. Cows may prefer rubber mats, straw bedding, madras, etc. to concrete floor	Medium: May be supported by pressure sores, getting-up behaviour, resting behaviour and dirtiness.	High: Floor type observed and noted
Partition between cubicles	High: Can cause difficulty in getting-up and lying down behaviour.	Medium: May be supported by skin lesions, pressure sores, getting up behaviour and dirtiness	High: The partition type observed
Position in building	High. Loading – especially for low ranking cows - regarding long distances to feed, water, milking etc. Fight with other cows may result in injuries	High	High: Measurements of stable

<i>System description</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Corridors/Passage areas (incl. resting and eating areas) and doors with entrance to and from the field			
Dimensions	High: Too narrow passages will load especially low ranking cows, as they may be kept from feed, milking etc. by other cows. Injuries may result from fighting or may be caused by protrusions into corridors.	Medium: May be supported by skin lesions and pressure sores. May further influence the human-animal-relationship, because the cow has limited possibilities for avoidance.	High: Dimensions of corridors measured and the quality noted.
Floor: type, material, surface and condition	High: Dirty and smooth floor may cause cow to slip, which may result in injuries and load the hoof condition. May influence the cow traffic as a result of cow aversion to walking on floor.	Medium: May be supported by cow dirtiness, skin lesions, pressure sores, lameness, and hoof condition. May further influence the test of human-animal-relationship, because the cow has limited possibilities for avoidance.	Medium: Floor type, condition, is recorded from observations and farmer information (difficult if more floor types and large variation in surface etc.).
Gates: Material, size, types and position (Feed-Resting-Milking-Grazing)	High: Limitation of the cows free movements – especially important if traffic is controlled by gate system. Further injuries may result from fighting due to crowding or may be caused by protrusions of gates	Medium: May be supported by skin lesions and pressure sores and location of cows in the stable.	High: Observation & measurements of gates
Foot bath Dimension and position	Medium : Aversion to pass the bath may cause stress, but foot baths may prevent foot problems	Medium: May be supported by skin lesions, pressure sores and hoof condition.	High: Observation of foot baths dimension and position in the barn.
Brushes Numbers, positions and condition	Medium: Brushes help cows with grooming, associated with pleasant experience. Limited access to brushes may exclude low ranking cows and may cause fighting.	High:	Medium: Observation of number, type, position and condition of brushes.
Feeding table/Forage and yolks fence (Type of forage fence, fixing possibilities, dimensions and numbers)	High: Calluses occur if dimensions of gates are inconvenient. Low ranked cows are forced to wait eating; and social stress or fighting may occur.	Medium: May be supported by condition score, skin lesions and pressure sores.	High: Measurement of dimensions and observation of types and numbers of gates.

<i>System description</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Concentrate dispenser (outside the AMU) Type, entrance, dimensions, number and position	Medium: Feeding concentrates outside AMU may relieve the AMU resulting in less competition / fights and queuing at the AMU. Calluses occur if dimensions of gates are inconvenient.	Medium:	High: Observation of number and location and measurement of dimensions
Water trough size, types, numbers and position	High: Inconvenient position, too high stocking rate and low water capacity may load especially low rank cows.	Medium:	High: Observation of position and measurement of dimensions and water capacity
Indoor climate (Ventilation, regulation)	Medium: Insufficient ventilation may add to risk of airway infection and may be uncomfortable for the individual cow. High temperature in summer, daytime may load cows and traffic /activity and influence grazing activity.	Medium: May be supported by information of respiratory infections and respiratory disease, number of visits at AMU and location of cows.	Medium: Observation of stable walls, roof and type of ventilation. Location of cows observed. Low: Indoor climate difficult to describe in few terms (Temperature, humidity etc.)
Light, diurnal	Medium: Insufficient light may load cow and cow-traffic in the night, but also influence the cow diurnal rhythm.	Medium:	High: Observation of policy and time for electrical light
Collection area Dimensions, forcing equipment, position	High: Used when cows are fetched for milking. Social stress related to crowding and injuries caused by fighting may be the result. Further injuries may occur if protrusions into collection area.	Medium: May be supported by skin lesions and willingness to visit the AMU	High: Measurements of collection area, which is often very flexible and suites different number of cows

<i>System description</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Milking unit/AMU			
AMU. Numbers, Type and position. Gates dimensions and materials	High: The AMU position in the barn important for convenient traffic. Unsuitable materials or dimensions may result in calluses, injuries or aversion to entering.	Medium: May be supported by cows willingness to arrive AMU, dislike behaviour in AMU, skin lesions and calluses.	High: Measurement of dimension of AMU and observations of position, type and materials (including the floor)
Washing of udders	High: Approach of robot must be gentle, washing of udder and actual milking procedure must be gentle– if not risk of injuries to teats and self injuries due to fright response. Washing must be efficient else infections i.e. mastitis. Heavy washing may increase risk for infection.	Medium: May be supported by udder lesions and infections, number of fetched cows, cows willingness to arrive AMU, dislike behaviour in AMU.	Medium: Demand trained observer for examining the milking process
Separate sections			
Treatments after AMU Dry cows Calving boxes Boxes for sick cows Milking outside the AMU	High -	Medium	High: As rest of stable – floor, stall- dimensions, stocking rate, bedding, access to feed and water – see the individual parts for details.

5.2 Systems application

<i>Systems application</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Cubicles			
Stocking rate	High: High stocking rate means that the low ranked cows are loaded and forced to stand or lie in aisles. Queuing increase involuntary standing, which may increase risk for lameness	Medium: May be supported by resting behaviour and cows location in the stall, dirtiness and pressure sore.	High: The number of cubicles and cows are counted and the stocking rate calculated
Scraping frequencies and bedding type and amount	High: Defective bedding or absent bedding material may result in development of calluses or cows resting in aisles. Inefficient scraping result in dirty cows	Medium: May be supported by dirtiness and pressure sores.	High: Type and amount of bedding and the scraping frequencies is recorded from measurement and farmer information. Cubicles cleanliness is observed

<i>Systems application</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Corridors/Passage Scraping frequency of floor	High: Dirty and smooth floor may cause cow to slip, which may imply injuries and load the legs and hoof condition. May influence the cow traffic as a result of cows aversion to walking on floor	Medium: May be supported by cow dirtiness, lameness, pressure sores and hoof condition. May further influence the test of human-animal-relationship.	Medium: Floor cleanliness is observed.
Gates: <i>Strategy:</i> <i>One way or</i> <i>Selection Criteria</i>	High: Limitation of cow free movements – especially important if traffic is controlled by gate system, which load especially low ranking cows	Medium: May be supported by skin lesions and pressure sores and location of cows in stable.	High: Observation of criteria supplied with farmers information
Foot bath Application	Medium: Water mix quality important for effect on foot problems	Medium:	Medium: Foot baths condition from farmer information and condition observed
Feeding	High: High stocking rate means competition about the feed - especial if not fed ad libitum. Low ranked cows are forced to wait eating; and social stress or fighting may occur	Medium	Medium: Observation of Feeding strategy/feed ration for roughage and concentrate Feed remains on the feeding table observed.
Water trough Condition	High: Water provision and quality	Medium:	High: Observation of watering capacity and water quality, cleanliness
AMU (CD = Computer Data)			
Number of cows per AMU stocking rate	High - If too high stocking rate queuing and long waiting time – cows keeps away from milking and more cows must be fetched. Crowding in collection area resulting in social stress and injury due to fighting	Medium: May be supported by number of fetched cows and willingness to go to milking and observations of distributions of cows position in the stall	High: Observation of number of cows

<i>Systems application</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
<p>AMU milking criteria: Parity, lactation state, Milk yield etc.</p> <p>Number of milking/cow/day</p> <p>Rejection criteria: Minimum time interval Between milking</p>	<p>High: Number of visits to AMU relate to cow willingness to visit AMU as well as loading of the AMU and hereby queuing and possibility for cows freely to visit AMU.</p> <p>Refusing relates to a general conflict between cows motivation to visit AMU and strategy. Rejections also relate to loading of AMU and hereby queuing and deterioration of the cows possibility for visiting the AMU</p>	<p>Medium: May be supported by behaviour measures in AMU.</p>	<p>High: CD Milking time (flow): Total, Avg. Milking frequency: Total, Avg. Successful milking</p> <p>Refused cows</p>
<p>Unsuccessful milking, criteria (Patience) Localisation of rear/front teats Attachment of rear/front teats</p>	<p>High: Unsuccessful milking relate to loading of AMU and hereby queuing and possibility for cows freely to visit AMU. Often cows have to be milked by manual help – which may strain the human-animal-relationship due to cows being fetched and driven into the AMU.</p>	<p>Medium: May be supported by behaviour measures in AMU. May be supported by test for the human-animal relationship.</p>	<p>High: CD Unsuccessful milking Variation in time for teat-cup attachment/M</p>
<p>Alarm list criteria Time since last milking, Max</p>	<p>High: Being put on the alarm list may strain the human-animal relationship as cows have to be milked by manual help being fetched and driven into the AMU. Not being put on alarm list, but mastitis present and painful</p>	<p>Medium: May be supported by behaviour measures in AMU, test for the human-animal relationship and clinical mastitis (and incidens) as well as clinical udder examination</p>	<p>High: CD Alarm list Cows with to long time interval since last milking (fetching)</p>
<p>Fetching involuntary cows Criteria Method</p>	<p>High: May strain the human animal as cows have to be forced/driven to AMU – which may strain the human-animal-relationship</p>	<p>Medium: May be supported by behaviour measures in AMU. May be supported by test for the human-animal relationship</p>	<p>Medium: Number of fetched cows and fetched procedure observed and based on information from the farmer</p>
<p>Feeding concentrate Time and frequency, Total, per cow Supplied/fed Refused</p>	<p>Medium: Cows may be coaxed to visit AMU by a feed reward. May result in cows often visiting the AMU, being refused and hereby overload the AMU</p>	<p>Medium: May be supported by number of visits and number of refusals to the AMU.</p>	<p>High: -CD</p>

5.3 Additional Systems and Systems application for the pasture period

<i>System description</i> AMS+Grazing	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Conditions for grazing Field position, dimension,	High:	Medium: May be supported by	Medium: An overview (map) of all the lots with size and orientation to the barn are noted and measured Total hectares pasture available on the farm and position and dimensions of the lots/fields for grazing cows. Grass mixture/clover, pct Water irrigation system
Grazing strategy Planned period, months Planned grazing intake per cow daily (SFU) Grazing system Planned grazing, days/lot Buffer strategy when grass production in the field is scarce or abundant			Medium: Low cow densities so that grass uptake is in pace with re-growth?) Grazing system: a. Strip grazing, sedentary grazing b. Rational grazing (grazing for some days (3-4) and then moving to another lot where they first will be mowed after re-growth)
Lane type, surface and condition	High: The lane may be important for the cow traffic and cows motivation for going to the field. Cows dislike hard and stony lanes as well as muddy lanes, which may also result in injuries and load the hoof condition. Too narrow passages will load especially low ranking cows, as they may be kept from feed, milking etc. by other cows. Injuries may result from fighting or may be caused by protrusions into corridors.	Medium: May be supported by dirtiness, lameness, hoof condition, skin lesions and pressure sores. May further influence the test of human-animal-relationship, because the cow has limited possibilities for avoidance.	Medium: Lane type, condition is noted and recorded from observations and farmer information (difficult if the lane conditions is seriously influenced by weather conditions) Dimensions of "bottle necks" measured and the quality noted
Distance to the field	Medium: Distance up to 400 m seems not to influence the number of AME visits		
Fencing type, especially in bottle necks (lanes)	Medium:	Medium:	Medium:

<i>System description AMS+Grazing</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Gates: Material, size, types and position (Feed-Resting-Milking-Grazing)	High: Limitation of the cow free movements - especially important if traffic is controlled by gate system. Further injuries may result from fighting due to crowding or may be caused by protrusions of gates	Medium: May be supported by skin lesions and pressure sores and location of cows in the stall and on the pasture.	High: Observation & measurements of gates
Water trough in the field size, types, numbers and position	High: Inconvenient position, too high stocking rate and low water capacity may load especially low rank cows.	Medium:	High: Observation of position and measurement of dimensions and water capacity
Collection area, outdoor Dimensions, forcing equipment, position	High: Used when cows are fetched for milking. Social stress related to crowding and injuries caused by fighting may be the result. Further injuries may occur if protrusions into collection area.	Medium: May be supported by number of fetched cows and cows willingness to go to milking as well as skin lesions.	High: Measurements of collection area, which is often very flexible and suites different number of cows
Shadow/ shelter in the field, capacity	Medium: Shelter and shadow in rainy and hot periods influence the cow comfort positively.	Medium: May be supported by supported by cows location in the field	Medium: Number of trees, m ² of shadow
Stocking rate in the field	High: High stocking rate means that the low ranked cows are loaded and without free access to grazing Possibilities for higher ranked cows to chase away a cow at the entrance to the field. Cow traffic from the field will typical be in groups. Cows behaviour is more synchronised when grazing than in the barn, which implies queuing in at the AMU, more unrest and reduced number of milking.	Medium: May be supported by cows position, dirtiness and pressure sore.	High: The number of cows and disposal grass area are noted and the stocking rate calculated

<i>System application AMS+Grazing</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Gates outside the barn: Strategy for controlling cow traffic: Time for opening and closing	High: Limitation of cows free movements – especially important if traffic is controlled by gate system. Load especially low ranking cows Gate in the Barn→Field Gate in the Field→Barn Gate outdoor →Field Gate outdoor: Field→ Place outside the barn	Medium: May be supported by skin lesions and pressure sores and location of cows in stable and on pasture as well as cows visits in the AMU.	High: Observation & measurements of gates and farmer information
Cow criteria for field access Passing the AME	Time interval from cows is given access to the field and until entering.		I.e. NL: Milking interval is 6 hours and following cows no access to the field: Within 2 hours before their minimum milk interval Failed attachment in AMS Milk yield far below expected yield
Feeding in the barn	High: High stocking rate means competition about the feed - especial if not fed ad libitum. Low ranked cows are forced to wait eating; and social stress or fighting may occur	Medium	Medium: Observation of Feeding strategy/feed ration for roughage and concentrate Feed remains on the feeding table observed.
Grass intake per cow daily			Grass intake per cow daily. Measured to the best of one's judgement +/- 2 FE
Water trough Condition	High: Water provision and quality	Medium:	High: Observation of watering capacity and water quality, cleanliness Will cows voluntary returned from the field start to drink (If no drinking water in the field)?
Fetching involuntary cows Criteria Method	High: As cows have to be forced/driven to AMU – which may strain the human- animal-relationship. Group size from grazing. The temperature/climate has a significant impact on how much time cows spend on pasture, when the traffic is free.	Medium: May be supported by behaviour measures in AMU. May be supported by test for the human-animal relationship	Medium: Number of fetched cows and fetched procedure observed and based on information from the farmer

<i>System application AMS+Grazing</i>	<i>Independent relevance as a welfare indicator</i>	<i>Marginal information value</i>	<i>Applicability for on-farm studies</i>
Feeding concentrate, Time and frequency total, per cow Supplied/fed Refused	Medium: Cows may be coaxed to visit AMU by a feed reward. May result in cows often visiting the AMU, being refused and hereby overload the AMU	Medium: May be supported by number of visits and number of refusals to the AMU.	High: -CD

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