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Effects of cubicle characteristics on animal welfare indicators in dairy cattle

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**Supplemental Table S1.** Data collected for the assessment of the animal welfare level of dairy cows using the Welfare Quality® protocol [modifications of the WQP\* are highlighted with bold letters]

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| --- | --- | --- | --- |
| Welfare Indicator | Source | Frequency calculation | Method for collecting data |
| Good Feeding | Body condition | ABM\* | Body condition score (BCS) observed on a sample of cows (Nfin)\* | Animal is assessed using the scale: 0 - regular body condition, 1 - very lean body condition, 2 - very fat body condition |
| Water provision Cleanliness  | RBM\* | Length, cleanliness and functionality of water troughs and bowls | **Troughs and bowls: length measured in cm,** and test of sufficient water flow. Check of cleanliness: 0 - clean: drinkers and water clean, 1 - partly dirty: drinkers dirty, but water fresh, 2 - dirty: drinkers and water dirty |
| Good Housing | Duration of the process of lying down | ABM | Mean time to lie down observed on a sample of at least 6 cows | Recording of time needed to lie down in seconds from the moment, the carpal joint was bent and lowered (before touching the ground), until hind quarter had fallen down and pulled front leg |
| Collisions during lying down | ABM | Observed on a sample of at least 6 cows | Animal collides with the housing equipment during the lying down movement: 0 - no collision observed, 2 - collision observed |
| Lying outside the lying area | ABM | Observed in representative segments of the barn | Percentage of animals lying partly or completely outside the designated lying area, out of all lying animals |
| Cleanliness of udder and legs | ABM | Cleanliness observed on a sample of cows (Nfin) | Assessment on lower hind legs, hind quarters and udder. Animal is assessed using the scale: 0 - no dirt or minor splashing, 2 - separate or continuous dirt plaques |
| Presence of tethering (tie stall) | RBM | --- | Only farms with cubicle housing systems were chosen for this study |
| Good Health | Lameness (loose house) | ABM | Lameness observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - not lame: timing of steps and weight-bearing equal on all four feet, 1 - moderately lame: imperfect temporal rhythm in stride creating a limp, 2 - severely lame: reluctance to bear weight on one limb or more than one limb affected |
| Integument alterations | ABM | Integument alterations observed on a sample of cows (Nfin) | Observation of one side of the animal. The number of hairless patches and lesions/swellings of a minimum diameter of 2 cm are recorded |
| Coughing | ABM | Mean number of coughs expressed per cow and per 15 min | Recording using continuous behavior sampling of sudden and noisy expulsion of air from the lungs during a total period of 120 minutes |
| Nasaldischarge | ABM | Nasal discharge observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - no evidence of nasal discharge, 2 - evidence of clearly visible discharge from the nostrils |
| Oculardischarge | ABM | Ocular discharge observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - no evidence of ocular discharge, 2 - evidence of clearly visible discharge (wet/dry); at least 3 cm |
| Hamperedrespiration | ABM | Hampered respiration observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - no evidence of hampered respiration, 2 - evidence of deep and labored respiration |
| Diarrhea | ABM | Diarrhea observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - no evidence of diarrhea, 2 - evidence of watery manure on both sides of the tail; > size of a hand |
| Vulvardischarge | ABM | Vulvar discharge observed on a sample of cows (Nfin) | Animal is assessed using the scale: 0 - no evidence of vulvar discharge, 2 - evidence of purulent efﬂuent from the vulva |
| Milk somaticcell count | QUE\* | Cows with subclinical mastitis within the last 3 months (milk recording) | Cow milk somatic cell counts are assessed using the scale: 0 - somatic cell count below 400,000 cell/mL for the last 3 months, 2 - somatic cell count above 400,000 cell/mL at least once in the last 3 months |
| Mortality | QUE | Annual cumulative incidence of mortality | Deﬁned as the percentage of dairy cows which died or were euthanized by a veterinarian or emergency slaughtered during last 12 months |
| Dystocia | QUE | Annual cumulative incidence of dystocia | Deﬁned as percentage of calvings where major assistance was required during the last 12 months  |
| Downer cows | QUE | Annual cumulative incidence of downer cows | Deﬁned as percentage of severe cases of downer cows during the last 12 months (>24 h lying) |
| DisbuddingDehorning | QUE | --- | Farmer is asked about management practices for disbudding/dehorning of the calves or dairy cows (procedures, anesthetics/analgesics) |
| Tail docking | QUE | --- | Not practiced in Germany except an emergency case (legislation) |
| Appropriate Behavior | Agonisticbehavior | ABM | Observed in representative segments of the barn | Recording using continuous behavior sampling during a total period of 120 minutes: Number of head butts, displacements, chasing and fightings |
| Access topasture | QUE | Days per year with at least six hours at pasture | Number of days per year on pasture, Number of hours per day on pasture |
| AvoidanceDistance test | ABM | Observed on a sample of cows (Nfin) | Starting at 2 m distance at the feed bunk; observer approached with an extended hand. If cow showed withdrawal, avoidance distance was estimated between the hand and the muzzle |
| Qualitative behaviorassessment | ABM | Observed in representative segments of the barn | Behavioral observation of the herd for being active, relaxed, fearful, agitated, calm, content, indifferent, frustrated, friendly, bored, playful, positive, lively, inquisitive, irritable, uneasy, sociable, apathetic, happy or distressed (20 min.) |

\*ABM=animal based measure; RBM=resource based measure; QUE=questionnaire; Nfin=Sample size for a finite population (according to herd size); WQP=Welfare Quality® protocol