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Original research

Analysis of direct parameters of cow welfare assessment on dairy farms

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Abstract. A high level of public concern about the welfare of farm animals and compliance with international standards and consumer requirements is triggering the development of animal welfare assessment systems and their implementation on dairy farms. In addition, the welfare assessment allows identification and assessment of existing problems of animal welfare on the farms, allows farmers to solve these problems and ensure proper management, monitor compliance with legal requirements, identify risk factors that have a potential negative impact on animal welfare, present objective information on systems of keeping animals for consumers. The aim of the research was a modern meta-analysis of criteria related to the direct response of animals and their impact on welfare, as well as justification of the use of criteria in systems for assessing the welfare of dairy herd animals. The research data presents an analysis of the direct criteria and justification of the system of 10 protocols and standards for the welfare of the dairy herd, namely: Cow Comfort, Welfare Quality, IDSW, Code of Welfare, Svenskt Sigill, Freedom Foods, AssureWel, RSPCA Dairy Standards, NSF Global Animal Wellness Standards, ClassyFarm. All parameters investigated in these protocols were divided into two groups: 1) indirect - based on resources (farm management, housing conditions) and 2) direct - based on the animals themselves (behaviour, health). It has been established that objective results of the assessment of welfare can be obtained using direct criteria, namely the study of behaviour (postures and gaits, during rest, interaction with humans or other animals, the presence of stereotypical behaviour or positive states, vocalization) as well as health criteria I (lameness, calving, cleanliness and condition of the animal's coat, presence of complications from surgical procedures). Research on indirect animal welfare criteria and protocols will be covered in our next articles.

Keywords: cattle behaviour; dairy production; well-being indicators

Аналіз прямих параметрів оцінки благополуччя корів на молочних фермах

Анотація. Оцінювання благополуччя стада – основа для розвитку та впровадження благополуччя тварин на молочних фермах і саме наука відіграє важливу роль у створенні здійсненних систем і протоколів для цієї оцінки. Зараз все частіше ми можемо спостерігати занепокоєність громадськості щодо благополуччя сільськогосподарських тварин. У цьому контексті оцінка благополуччя має допомогти виявити та оцінити існуючі проблеми з благополуччям на фермі, допомогти фермерам вирішити ці проблеми, проконтролювати дотримання законодавчих вимог, визначити фактори ризику, які в подальшому можуть негативно впливати на благополуччя тварин, надати дійсну та правдиву інформацію про системи утримання тварин для споживачів. Цей огляд описує поточний стан знань, що стосуються наукової літератури щодо показників благополуччя дійних корів, що базуються власне на тваринах. Аналізуючи сучасні світові протоколи досліджень умовно всі параметри можна поділити на дві групи: непрямі, тобто ті, що засновані на ресурсах (менеджмент ферми, умови утримання) і прямі, що засновані власне на тваринах (поведінка, здоров'я). Встановлено, що оцінка за допомогою непрямих параметрів є дещо простішою, але оцінка за допомогою прямих параметрів є значно ефективнішою та результативнішою, адже заснована саме на станах тварини. Наша мета полягала в тому, щоб надати огляд показників на основі тварин для оцінки благополуччя на фермі. Тому ця стаття зосереджена на вивченні прямих параметрів оцінки благополуччя тварин на молочних фермах, враховуючи останні розробки в підходах і методах, що використовуються для оцінки благополуччя великої рогатої худоби в світі. Дослідження непрямих параметрів оцінки благополуччя тварин буде висвітлено в наших наступних статтях. Дане дослідження сприятиме подальшій розробці базового, ефективного та здійсненного протоколу оцінки благополуччя корів на молочних фермах України.

Ключові слова: поведінка худоби; молочне виробництво; показники благополуччя

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Introduction

In Ukraine, research is being conducted on the assessment of animal welfare and the existence of a legal framework (Nedosekov et al. 2020; Nedosekov & Krytsia 2021; Nedosekov & Petkun, 2021; Matvienko et al., 2022; Petkun & Nedosekov, 2022). However, there is not enough information about both the calculated indicators and the results of a systematic welfare assessment.

Accurate and frequent cow welfare assessment is the first step to improving cow welfare on the farm. However, there is still no «gold standard» for assessing welfare. (van Eerdenburg et al., 2021)

It is worth noting that a production system is unsustainable if animals show signs of pain, illness or stress. Therefore, it is extremely important to be able to assess the reaction of animals to the system (Winckler C., 2006). Properly designed assessments can identify risk factors for inadequate welfare, assist in the development of an action plan, and be used to monitor and evaluate changes in practice (Dunston-Clarke et al., 2020).

The analysis of scientific studies shows an emphasis on positive animal welfare (Ohl & van der Staay, 2012; Nordquist et al., 2017; Keeling et al., 2021). However, in the concept of the "Five Freedoms", the consequences of understanding stress are reflected mainly in negative terms, so the following postulates of which begin with the phrase "freedom from..." (FAWC, 2009), emphasizing the observance of a certain minimum for animals. As a kind of addition to the current idea of five freedoms, Krzysztof Adamczyk proposed its «positive» version aimed at the maximum welfare of animals, which should be the main goal (Adamczyk, 2018).

The Five Freedoms address both physical fitness and mental distress and are best viewed as a practical, comprehensive checklist for evaluating the strengths and weaknesses of any livestock system (Moran & Doyle, 2015).

Furthermore, there is a view that objectivity is not possible in the measurement of animal welfare because it is based on what is socially considered "acceptable" (Ohl & van der Staay, 2012). However, one can still strive for objectivity within the framework of ethical consensus (van Eerdenburg et al., 2021).

In general, indicators for assessing welfare can be divided into two categories:

1) ***Indirect indicators:*** environmental criteria, influencing factors or resource indicators, features of the production and management system, such as stall length, feeding and drinking areas, area, litter quality, access to pastures, etc. Assessment is relatively simple, as most environmental criteria are easily, quickly and reliably recorded. In addition, recording welfare problems based on environmental parameters can be used to identify the causes of low welfare and correct them. On the other hand, indirect indicators lead to a «risk assessment» of the welfare state, but not to an assessment of their actual impact on the animal. Resource-based and management-based measures mostly reflect risk factors for welfare deterioration rather than directly measuring animal welfare (Blokhuis et al., 2010). Indirect criteria for the welfare of the dairy herd, including farm management, and housing conditions, will be considered and analysed in the following scientific articles.

2) ***Direct indicators*** record the reactions of animals to a specific environment. These animal criteria fall into the categories of behaviour, health, and physiology. Examples include stress hormone levels, aggression, fear and abnormal behaviour, disease symptoms, and mortality. Animal-based criteria such as behaviour and health can be taken as indicators of the animal's feelings and as direct indicators of the animal's condition (Calamari & Bertoni, 2009).

Other aspects that affect animal welfare are animal behaviour and health (direct criteria); their measurement is often difficult. Direct measures of animals provide information about the response to the environment and are more direct indicators of welfare than their counterparts, but direct indicators of welfare themselves do not indicate the causes of its disturbance (Figure) (Calamari & Bertoni, 2009).

Direct parameters related to animals, such as health or behaviour, can be taken as indicators of animal feelings and as measures of body condition. Therefore, the welfare assessment should be based primarily on such animal-related parameters. In practice, resource-based or management-based parameters may also be included in on-farm assessment protocols if they are closely related to animal-related activities and because they can provide a basis for identifying the causes of welfare problems (Winckler, 2006).

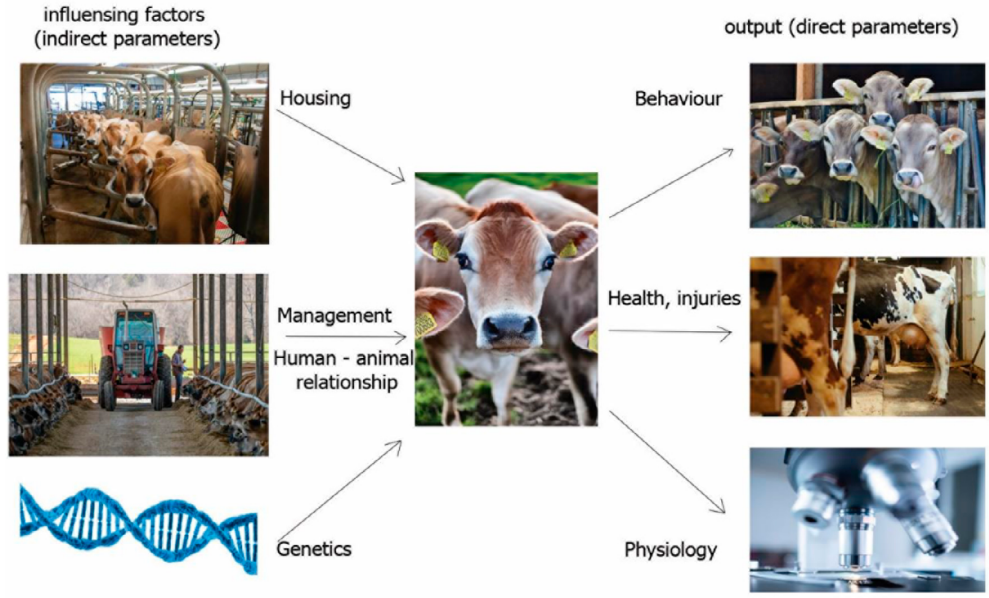

Figure. Influencing factors and animal-based parameters concerning animal welfare (Winckler, 2006, modified)

Materials and methods

In our research, we used a descriptive method of analysing direct criteria and substantiating the welfare assessment system on dairy farms. 10 dairy herd welfare protocols and standards were used for the analysis: Cow Comfort, Welfare Quality, IDSW, Code of Welfare, Svenskt Sigill, Freedom Foods, AssureWel, RSPCA Dairy Standards, NSF Global Animal Wellness Standards, and ClassyFarm.

All investigated parameters were divided into two groups: 1) indirect – based on resources (farm management and housing conditions), and 2) direct – based on the animals' state (behaviour and health).

Results

The direct criteria in assessing the welfare of cows on dairy farms include the study of 1) behaviour, namely the study of posture and gait, behaviour during rest, the presence of antagonistic elements, the manifestation of stereotypical behaviour, the presence of "positive states" and 2) the level of morbidity and the animal condition, which includes the study of lameness, mastitis, assessment of the animal body condition and appearance, the coat condition, secretions from the nose, eyes, and the presence of procedures complications. Next, we consider these criteria in more detail.

1. Behaviour.

Certain analysis of behaviour allows for identifying problems with animal welfare based on changes in motor behaviour, lying time, demonstration of stereotypical behaviours, etc. (OIE, 2019).

The basic criteria of behaviour research are:

Abnormal posture and gait. Positions that indicate pain may include a tucked-in belly and tail, a hunched back, or standing still for long periods. An abnormal gait may include an unusual gait (e.g., walking backwards) or uneven weight distribution, as seen when a cow is lame (Moran & Doyle, 2015).

Behavioural disorders during rest may be associated with insufficient recreation, reduced chewing activity, increased risk of lameness, and changes in the skin and joints. In general, this parameter is very important for evaluation, since dairy cows spend 10–12 hours a day lying down.

Time estimation, such as total lying time, is not suitable for short-term monitoring systems. However, parameters related to lying down or standing up (time required, frequency of abnormal, altered or disrupted movements) can be quantitatively or qualitatively recorded also over shorter periods using continuous behavioural sampling and/or scanning sampling (Cook et al., 2005).

This parameter can also be investigated by counting the number of standing animals (van Eerdenburg et al., 2013). Based on the fact that if a cow feels comfort, she chooses to lie down, but cows that are standing (not consuming feed and not drinking water at the same time) are a direct indicator of insufficient comfort for cows.

Expression of antagonistic elements

When describing antagonistic behaviour, the following descriptors are used:

1) head beating; which occurs during physical contact when one animal hits or pushes another animal with the forehead, horns or base of the horn with a forceful movement; at the same time, the other animal does not surrender its current position;

2) displacement; is a physical contact where one animal forces another animal to give up its position;

3) persecution; where one animal makes another animal move;

4) fight; where two animals push their heads against each other while standing with their feet on the ground, both applying force to each other;

5) coercion; where one animal uses physical contact with a recumbent animal to get it to stand up (Moran & Doyle, 2015).

Stereotyped behaviour is a term applied to repetitive behavioural sequences that have no apparent purpose or benefit and are caused by disruption of natural behaviour patterns or repeated attempts to cope with a problem (Mason & Rushen 2006). This is a behaviour that replaced the natural one that was suppressed by artificial management conditions. Different species have different stereotypes, and the type of stereotyped behaviour is usually related to the root cause. In cattle, these are usually oral stereotypes associated with nutrient and feed deficiencies. Stereotyping, which is a consequence of the limitation of movements, is also common. Tongue playing or rolling, bar biting, foreskin or scrotal biting, and urine drinking are behaviours commonly referred to as bovine stereotypes (Moran & Doyle, 2015).

Stereotypic behaviour is observed to varying degrees in calves, heifers, dairy cows, and feedlot cattle. Winckler (2006) believes that due to low repeatability, continuous monitoring of behaviour should be used for registration, with control during specific periods, for example after feeding.

Vocalization is not characteristic of most resting cows (van Eerdenburg et al., 2013). Therefore, this parameter can be used to study the number of animals in a state of stress or fear.

The approach reaction is a qualitative and direct parameter for measuring the level of human-animal relations. Simply put, this is the distance that a person can approach an animal that is at rest. Cows are social animals and are usually curious about humans. Except if the cow previously had a negative relationship with the person who had taken care of it. A good relationship between humans and animals is the basis for creating a calm, stress-free atmosphere on the farm.

Qualitative Behavior Assessment (QBA) is a direct measure of how animals behave and interact with each other and their environment, i.e., their "body language" (Welfare Quality, 2009).

Social and non-social play can be used as an indicator of welfare because calves are motivated to play only when their basic needs are met (Lawrence, 1987). The game allows you to reflect on a positive experience, as well as to shape such an experience. Yes, it has been proven that calves play more if their need for food is fully satisfied. The manifestation of such play in calves is expressed as locomotor and social activities, as well as activities directed towards the environment (Jongman et al., 2020). Moreover, social licking can also be considered an indicator of long-term positive affective states in adult cattle.

2. Morbidity rate.

These criteria are mostly investigated by analysing farm records. Unfortunately, not all farms keep the necessary records. In this case, it is possible to research the farm itself.

Lameness indicates a painful condition and discomfort and is considered one of the most serious cattle welfare problems. Many possible lameness assessment systems mainly rely on gait recording. In general, each animal is scored on a scale of 4 to 9 points according to gait-related behaviours such as short strides, difficulty with limb loading, or difficulty turning when walking on hard floors. Locomotion assessment systems revealed a significant correlation with indicators of hoof damage (Winckler & Willen, 2001). This parameter can be determined by analysing farm records, namely by counting cases of lameness in animals over a certain period. This will significantly reduce the on-farm assessment time, but at the same time, the measurement will not be as accurate as an actual on-farm lameness study.

Mastitis or metabolic disorders are relevant to welfare but require complex diagnosis or long-term and regular data recording. Farm records often suffer from poor accounting, errors in data collection and reporting, or lack of treatment for sick animals. Therefore, in many cases, it seems that reliable information is difficult to obtain. However, since disease criteria are so important, the possibility of using (standardized) agricultural records should be further investigated (Winckler, 2006). Some protocols collect data on the

number of somatic cells in milk for 3 months. According to this protocol, a somatic cell counts greater than 400,000 is considered to indicate subclinical inflammation (Welfare Quality, 2009).

Calving ease is a direct indicator of proper farm management and breeding. This indicator is studied by analysing farm data, namely the percentage of cows that required veterinary intervention during childbirth.

Body condition scoring (BCS) can be done using different scales and systems. In (dairy) cattle, both underfeeding and overfeeding can be considered a potential welfare problem, as cows that are over-conditioned during the dry period are more likely to develop cystic ovarian disease and lameness (Winckler, 2006).

Appearance attributes that may indicate impaired welfare include:

- the presence of ectoparasites,
- abnormal colour, structure or hair loss,
- excessive contamination with faeces, dirt
- swelling, injuries or lesions,
- secretions (for example, from the nose, eyes, reproductive tract),
- abnormal posture (for example, rounded back, low head),
- exhaustion or dehydration (OIE, 2019).

This parameter is examined directly on the farm during the general assessment.

Complications from procedures

Surgical and non-surgical procedures may be performed on dairy cattle to facilitate the management, improve human safety, and treat certain diseases.

However, if these procedures are not followed properly, animal welfare can be reduced.

Surgical treatment such as dehorning, tail docking or castration is relevant to welfare for a variety of reasons. They cause pain during and after procedures, can lead to reduced function (e.g., increased flies in docked-tailed cattle) (Eicher et al., 2002) and compromise the integrity of the animal. The percentage of affected animals, time and type of procedure can be used as criteria for the study.

Very often, for the study of this parameter, it is important to obtain information on whether these manipulations are carried out with anaesthetic and analgesic drugs. In all standards of welfare, these surgical manipulations are necessarily performed with anaesthesia.

Discussion

The use of animal-based criteria is directly related to the animal's experience and ability to cope with the given environment (De Vries et al., 2014). In turn, these criteria can be measured directly on the animal or indirectly, by collecting data available on the farm (EFSA, 2012).

Broom (1988) claims that in the process of assessing the welfare of animals, direct criteria are of decisive importance because, between the input data of rearing conditions and the actual welfare of the animal, it is necessary to take into account its condition, and ability to cope with the environment.

According to scientists (De Vries et al., 2014), direct criteria can be considered more objective and justified than management-based indicators, but, at the same time, not as practical. To obtain a comprehensive assessment of animal welfare, it is important to observe animals and look for adverse effects in response to their environment through direct parameters (Ventura et al., 2021).

Behaviour. Niclas Högberg (2013) argues that behavioural deprivation plays a significant role in animal welfare. It is therefore important to assess what can be done with both risk-based and animal-based measurements. Behavioural measures include studies of agonistic behaviour, access to pasture, avoidance distance, and qualitative assessment of behaviour (Welfare Quality, 2009).

In horned cows, the frequency of antagonistic elements of social behaviour is positively correlated with the appearance of skin lesions. Pilot studies in dairy herds have shown that antagonistic interactions can be reliably recorded during the first hours after feeding, showing the highest inter-day repeatability for this period of the day. However, short-term recordings of social behaviour should be limited to interactions involving physical contact (Winckler et al. 2002).

The intensification of keeping cattle and keeping dairy cattle contributes to the emergence of behavioural problems that are not observed in animals that are in their natural and familiar environment. Restrictions on normal behaviour due to production systems imposed on them are often at the root of negative changes in the behaviour of cattle. Therefore, there is concern that intensive animal husbandry has led to a deterioration in the welfare of the animal (Moran & Doyle, 2015).

Scientists also note the importance of studying the time of lying down and resting. Sufficient lying time is important, as reduced resting time can affect both the performance and welfare of dairy cows. A lying cow is more likely to chew and salivate than a standing cow, which reduces the risk of rumen acidosis. A recumbent cow also has increased blood circulation through the udder (about 5 L/min) compared to a standing animal (about 3 L/min). This improves udder function and milk production (Tucker et al., 2021). Increased blood flow while lying down stimulates milk production (van Eerdenburg et al., 2021).

When a cow stands for a too long time, the pressure inside the joint capsule increases and causes hypoxia and ischemia, increasing the risk of lameness. In addition, competition for a comfortable resting place can provoke social conflicts between cows, increasing the chronic stress response that predisposes herds to disease and reproductive problems (Tucker et al., 2021).

In turn, the measurement of behaviour is mostly focused on detecting animals' negative emotional states. Unfortunately, not enough attention is paid to the assessment and improvement of positive emotional states.

Morbidity rate. Scientists (Heath et al., 2015) claim that lameness is an important problem for welfare and production on dairy farms. To establish the prevalence of lameness on a farm, a sample of cows must be evaluated. Larger sample sizes provide more accurate results, but take more time and incur more cost. Sequential sampling provides the opportunity to stop sampling at an early stage without compromising accuracy and can be used to determine acceptable lameness levels on a farm. The sample size depends on the purpose of the evaluation and the level at which the evaluations are intended to be used. For example, the protocol of the Red Tractor Assured Dairy Farm Scheme (which provides for 11,000 UK dairy farms (CHAWG, 2013)) uses a sample size of 10 cows per farm (where the average UK farm has 125 cows (DairyCo, 2013)) and, as expected, will provide accurate estimates for the UK dairy herd as a whole. Larger sample sizes are needed at the farm level, as the estimates made will be of interest, rather than simply contributing to an overall estimate (Heath et al., 2015). In turn, Main et al. (2010) reported that a sample size of 100 cows is required for larger herds. However, if the aim is to identify farms rather than individual animals with lameness, then focusing on the number of cows with severe lameness at the end of milking is an effective strategy.

Regarding body condition assessment, in lactating animals, body conditions outside the acceptable range, significant changes in body weight and a significant reduction in milk yield may be indicators of poor welfare (OIE, 2019). Severe loss of body condition from the dry period to the period approaching calving increased the occurrence of the delayed placenta. In addition, animals that are too thin can be seen as having welfare implications because they have failed to meet their physiological needs and may suffer from prolonged starvation.

Winckler (2006) notes that contaminated skin and hair can cause itchiness, impair the skin's thermoregulatory properties and antimicrobial protection, and can cause skin inflammation. Skin damage and swelling reflect the impact of the environment on the

animal's body. Changes occur, for example, due to contact with hard floors, pressure on feed racks or impacts, due to improper design of buildings and stalls. The main areas of the body at risk are the wrist joint, hip joint, hock and knee joints, and neck/withers. Similarly, infection with ectoparasites leads to itching, pain and discomfort depending on the pathogen. The association between the incidence of mastitis and contaminated skin has also been studied (Valde et al., 1997).

Waiblinger et al. (2003) have shown that animal–human relationships have a significant impact on animal health, performance, and welfare. Approach and avoidance responses can be used to assess animal–human relationships in untethered dairy cows. Avoidance of distance to an unknown person in the conditions of restraint was significantly correlated with the behaviour of the staff. Zulkifli (2013) notes the presence of a negative relationship between latent fear and farm animal performance.

It is noted (Waiblinger et al., 2003) that the negative relationship between humans and animals harms the output of milk, an increase in the amount of residual milk, on milk production, with reduced milk productivity, as well as the quality of milk in terms of reducing the content of fat and protein (Breuer et al., 2000) and conversely, positive relationships were associated with mammary health of cows (Ivemeyer et al., 2011) and growth rate of dairy calves (Lürzel et al., 2015).

Conclusion

It has been established that farm animal welfare assessment is a necessary tool for identifying animal health and welfare problems in a dairy herd.

Our analysis allows us to distinguish two groups of criteria: 1) resource-based parameters and 2) animal-based parameters, which include behaviour: studies of posture and gait, behaviour during rest, presence of antagonistic elements, stereotypic behaviour, positive states, vocalization and the quality of the relationship between human and animal, as well as health criteria (study of lameness, mastitis, ease of calving, coat condition, cleanliness of the animal, complications from surgical procedures).

Behavioural criteria are studied mainly on the farm, during welfare assessments, by observing animal behaviour, or using the "approach response" to determine the level of the human–animal relationship. Health criteria are mainly taken from farm records. If the records are not informative enough, additional studies can be conducted.

We believe that the evaluation of these criteria is the basis for creating effective protocols for the assessment of cow welfare, and their research and implementation will ensure the development and deeper understanding of cow welfare.

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