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DAIRY CATTLE WELFARE AS A RESULT OF HUMAN-ANIMAL RELATIONSHIP – A REVIEW

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Abstract

Despite the various concepts of human-animal relationship, the welfarist approach to this problem is one of the most often considered in theory and used in practice. When dealing with issues related to dairy cattle welfare (DCW), it is necessary to take into account both the reality characteristic for animals used to obtain milk (e.g. the problem of automatic milking of cows) and for slaughter cattle (e.g. slaughter of culled animals). It is not surprising, therefore, that issues related to DCW are the focus of the attention of the public, researchers, breeders as well as the dairy and meat industries. The aim of this article was to possibly most comprehensively cover the above-mentioned issues, although due to its huge scope it was obviously necessary to limit the article to what I think are currently most important issues. That is why in the review I (1) characterized the issues related to the division of human responsibility for DCW; (2) discussed the importance of technology to human-animal relationship; (3) elaborated the matter of stress, emotionality of animals and their cognitive abilities in the aspect of "negative" and "positive" DCW; (4) considered the possibilities of non-invasive assessment of animal welfare in the future and (5) discussed topics related to improving the conditions of the slaughter of animals. In summary, it was proposed paying more attention than has been paid until now, to the assessment of positive DCW in scientific research and breeding practice. I also drew attention to the necessity of reliable information flow on the line of the breeder/milk producer – industry – consumer, as negligence in this area is one of the reasons for public disinformation regarding the level of animal welfare.

Key words: dairy cattle, human responsibility, animal welfare

Human-animal relations have a multi-level and interdisciplinary dimension. Despite a huge variety of ways to understand them, these relations have always been a consequence of answering the question "who/what is a human being?" and "who/what is an animal?". While the second question was usually not the most important in the history of mankind, most often in an almost intuitive way a human-animal relationship (HAR) was and is a consequence of human self-reflection. That is why in every historical (and even prehistoric) period we have cultural and civilizational

testimonies with a wide spectrum of human attitudes towards animals – from surrounding them with aura of mystery (original beliefs), through agricultural development, religious and philosophical concepts, to particularly complex problems of contemporary reality (Thomas, 1983; Aleorta and Sosis, 2005; Gepts et al., 2012).

Undoubtedly, for the present state of human-animal relation, the experiences of humanity from the last eighty years have been crucial. The unprecedented tragedy that the Second World War was, has affected all aspects of human life. This was also true for agriculture, including livestock husbandry. For example, as a result of military actions in Central Eastern Europe between the years of 1939–1945, pig population decreased by over 50% and cattle by over 15% (FAO, 1955).

On the other hand, a continuously growing need for products of animal origin, which grew after the year 1945, began to stimulate the growth of livestock population and the intensity of their use. It was possible due to the introduction of new production and reproduction methods/techniques (e.g. artificial insemination) in animals on a massive scale (especially in dairy cattle breeding) as well as selection conducted for quantitative improvement of production traits (Norman and Powell, 1999; Foote, 2002; Thornton, 2010).

Progressive intensification and mass-breeding of animals required providing them with environmental conditions at an incomparably greater level than before. Furthermore, treating animals more often in terms of "production units" led to a deterioration of the HAR at the farm level, which was reflected in social perception (Harrison, 1964). This state of affairs caused a reaction from some philosophers and ethicists who began to propagate the idea of "animal liberation" under utilitarian welfarism (Singer, 1975) and "animal abolitionism" based on the idea of animal rights (Regan, 1983). These proposals – especially in the societies of then capitalist countries – were widely disseminated, which was manifested, among others, by the formation of numerous non-governmental organizations, which since then postulated more or less radical solutions limiting "human animal's interests" to "non-human animal's interests" (Herzog and Golden, 2009; Carson et al., 2012).

In the meantime, also in research in the field of animal sciences, more and more attention was being paid to the concept of farm animal welfare (Fraser, 1999). It should also be noted that this concept was by no means the discovery of the last century, but – according to Thomas (1983) – in European culture it was present in various areas at least from the 16th and 17th centuries.

Dairy cattle welfare as the expression of human responsibility for animals

Problem of the human-animal relationships vision

Human attitude towards the well-being of farm animals including the well-being of dairy cattle is usually understood in two ways. On one hand there is so-called welfarist approach that allows people to use at least some products of animal origin, and on the other hand, abolitionist views of a more or less radical nature are promoted, which result in propagating the idea of a vegan lifestyle (Croney and Anthony, 2010; Cole, 2011; Weitzenfeld and Joy, 2014). Welfarist approach, implemented mainly in the framework of animal sciences, usually assumes *a priori* that one should maximize the well-being of livestock, but it cannot be equivalent to the well-being of

human (Saja, 2013). Such attitude is called species chauvinism by the supporters of animal abolitionism, because – according to them – it is the effect of a completely anthropocentric vision of a HAR in which there is no so-called equality of rights (Weitzenfeld and Joy, 2014). It somewhat relates to the specifics of understanding of the animals protection, which, e.g. in ecological meaning, happens between species, while abolitionists focus mainly on the relations between individuals (Callicott, 1980; Regan and Singer, 1989; Aigner et al., 2016). As a result of such approach to problems related to breeding practices it is possible, for example, not to notice the difference between the effects of separating a calf from a dairy cow and the removal of an infant from his mother. Such an extreme approach to the problem does not mean, of course, that there should be no discussion about the early separation of calves from dairy cows, which is done both within the framework of animal sciences (Marcé et al., 2010; Ventura et al., 2013; Johnsen et al., 2016; Nordquist et al., 2017) as well as within animal studies (Stuart et al., 2013; Hooley and Nobis, 2016). However, certainly an interdisciplinary approach to the problem in this and many other cases would serve both the well-being of human and the well-being of animals.

In my opinion, due to too profound differences in the understanding of HAR, it is not possible to form a dialogue between proponents of welfarist approach and representatives of extreme animal abolitionism. However, it is worth knowing that there are practical solutions (e.g. Ethical Matrix), which in problematic issues can help find a consensus between the interests of breeders/producers, animals, consumers and the environment (Mepham et al., 2006; Webster, 2014). In this spirit, The Universal Declaration on Animal Welfare (Gibson, 2011) was initially developed, and whose proposals – in my opinion – are worthy of public attention in the world.

An important area of the HAR dialogue is also the anthrozoology. Specific to this science is its high interdisciplinarity, which provides a possibility of having a debate between the representatives of biological, agricultural and humanistic sciences. Unfortunately, while in this research area many studies refer to wild and companion animals, relatively rarely they concern HAR in livestock, and even less often in cattle. For instance, in years 2013–2017, during conferences organized by The International Society for Anthrozoology, out of more than five hundred presentations, only nine directly or indirectly concerned cattle welfare (ISAZ, 2013, 2014, 2015, 2016, 2017). In the future, it would be advisable to use the research possibilities provided by anthrozoology on a much larger scale than before.

Taking into account the above, it is possible for the well-being of animals to be the subject of a dialogue within supporters of animal protection in a welfarist approach, or between welfarists and abolitionists – under the condition of rejecting extreme stances, which more often appeal to emotions and feelings (the post-truth) rather than to the actual state of affairs (the truth).

Human division of responsibility for animals

The welfarist concept of the well-being of animals in historical terms stands for an extension of understanding of human well-being as a systematic improvement of the quality of his life (Veissier and Miele, 2014). We can say that regardless of the definition and criteria for assessing the welfare of dairy cattle, in practice it is the

effect of interaction between the moral attitude of humans towards animals and the possibility of controlling the environmental conditions. At the same time, the background for these relations is the implementation of the principles of sustainable food production into the practice (Driessen, 2012). Welfare rules refers to all "stages" of HAR – starting from "planning" its genotype as part of a breeding work (e.g. shaping the relationship between economic weights for production and functional traits in selection indexes, and the choice of parental genotypes), and ending on animal culling/death (Scholten et al., 2013; Egger-Danner et al., 2015).

The level of human responsibility for animals depends on the species of animals, their psycho-biological characteristics, environmental conditions, or on the degree of antropogenization of their living conditions (system and intensity of farming) and on cultural conditions (Thornton, 2010; Fraser et al., 2013). Also it must not be forgotten that the current *status quo* in terms of use and breeding value of animals is the result of their domestication – a process that in the case of *Bos taurus* has for about 12,000 years been shaping the interactions in the animal-human-environment relationship, while in time changing each of these "components" (Herrero et al., 2013; Larson and Fuller, 2014).

One of the most important and at the same time very practical groups of quality indicators of the above mentioned relations are lifetime performance (LP) characteristics of animals (Rushen and de Passillé, 2013; Adamczyk et al., 2017 a). It is estimated that dairy cows can live up to over 25 years, whereas high-yielding cows are mostly used for only 2–3 lactations (Phillips, 2015). At the same time, although the problem of the threat to the welfare of dairy cattle is usually considered mainly in relation to intensively farmed animals, it would be a mistake to omit cattle of lower productivity (e.g. cows of local breeds), which, in a way, is considered to be long-lived in principle. Meanwhile, in practice also cows of local breeds, as a result of non-breeding factors (e.g. inability to maintain a larger number of animals due to limited resources, especially farmland), are culled far too soon, which has a negative impact on their lifetime performance as well as – so important especially for small populations – on the number of calves born during the cow's life (Adamczyk et al., 2017 a, b). For example, while culling cows due to metabolic diseases is considered by many to be typical primarily in herds of highly productive cows, this cause is in many cases the reason for slaughtering cows also with a much lower productivity (Mulligan and Doherty, 2008; Sundrum, 2015). Generally, regardless of dairy cattle genotype, the key issue in the aspect of animal welfare is usually associations between characteristics of cows' lifespan/survival and lifetime production. So it can indicate both the level of intensity of dairy cows' use and the quality of animals' life. Therefore LP allows for concurrently considering breeders' and animals' needs in dairy production process. Unfortunately, the main disadvantage in this case is that the assessment of animal welfare can be made only after the cows are culled so the final results of the LP analysis basically concern rather the future of other animals in the herd.

In the considerations regarding the HAR, it is impossible not to draw attention to what can be referred as the division of responsibility. It has been often assumed that the problem of animal welfare assessment concerns mainly the relations oc-

curring at the level of the farm/herd, where so-called "cowshed culture" is constituted. Meanwhile, decisions made by the breeders, and the farm workers, are in fact a specific lens that focuses not only on their knowledge, skills and moral attitude, but also on the local and global social, economic and/or political situation (Veissier et al., 2011; Burton et al., 2012; Atkins and Bowler, 2016). Therefore, the responsibility for animals is also in the hands of persons/companies/organizations that provide commercial, organizational and breeding support to cattle owners/breeders.

Going even further, the responsibility for livestock also rests with consumers and public opinion (de la Fuente et al., 2017). Therefore, society's knowledge regarding current conditions of dairy cattle breeding and farming should be at a level facilitating and making it possible to form a reliable opinion on animal welfare. Unfortunately, it seems that in this case we often deal with pseudo-knowledge, which is based on post-truths and stereotypes, not on the actual description of the state of affairs (Miele et al., 2011; Capper, 2017; de la Fuente et al., 2017). This is mainly due to, among others, insufficient communication between the food industry and the public opinion in the field of food safety at the level of animal welfare (Grandin, 2014; Cardoso et al., 2017).

Progress of dairy technologies – helpful or problematic in terms of human-animal relationship?

Thanks to introducing on a large scale more and more advanced data collection and processing techniques into the practice, milk producer "contacts" cows to a large extent through the information obtained from the herd management systems (Tscharke and Banhazi, 2016). Direct character of HAR on the farm is further impoverished by the progressing automation and robotization of dairy cattle handling. Based mainly on these sources of information about the animal, a man acquires only a specific digitized breeding and use image of it (Hostiou et al., 2017). In such circumstances, it is relatively easy for a milk producer to be tempted to look at his activity only in a utilitarian category.

Admittedly, compared to industrial poultry or pig farming, milk production at the farm level is much less anthropogenic (Thornton, 2010), but still – especially in large herds of highly productive cows – there is a risk of objectification of animals. It is more difficult for a human to see the responsibility for individual animals when he is not in direct contact with them, or it is in a very limited way. Meanwhile, a positive direct relationship between humans and animals is not only an expression of the humanity, but also improves the quality of human and animal life (Kellert and Wilson, 1993).

Certainly in the future one has to reckon with the further development of breeding and farming technology for dairy cattle (Edan et al., 2009), which however does not have to have a completely negative effect in relation to the HAR. For it should be remembered that it is, among other things, thanks to the use of modern techniques in practice, that the breeder can manage animal welfare (see chapter "The future of the non-invasive method for dairy cattle welfare assessment in practice"). One should also realize that limiting labour intensity of activities related to dairy cattle farming at the level of the herd, which is the main purpose of the automation of human activ-

ity, may constitute an attractive argument for future generations to undertake/take over agricultural activity. This particularly applies to family farms, which are more and more often being negatively affected by the migration of people from rural areas to cities (Jentsch and Shucksmith, 2017).

As can be deduced from the above considerations, one of the key problems regarding the relationship between a human and animal, is the system in which we comprehend milk production technologies used in practice: do we mean human-animal-technology relationship (HAT) or rather human-technology-animal relationship (HTA)? While in the first case technology results from the HAR, in the second case the human-technology relationship determines the human-animal relation. Thus, technology may (although it does not have to) create conditions in which animal welfare will be optimal from the point of view of animal's nature (in HAT) or it can practically make an animal dependent on utilitarian human benefits and his technical capabilities (from HTA point of view). This problem was noticed by Holloway et al. (2014), suggesting that in many cases robotization does not represent another, higher level of improvement in the welfare of dairy cows, although it may certainly look like it.

To summarize, the more a human realizes the conditioning of his relationship with animals, the more his sense of responsibility for them should increase. While in this matter there are objective limitations resulting from the functioning of a farmer in a given environment (resources, culture, economics, politics), he should make the most of those opportunities that he can influence. So as far as the activity of milk producers in Europe depends to a large extent on external factors (e.g. on the demand-supply of milk ratio between China and New Zealand), rapid development of technology and its application into agricultural practice does not necessarily have to lead to objectification of animals.

Stress, emotions and animal cognition as indicators of dairy cattle welfare

Negative and positive stress

In assessing the welfare of cattle, the reference to animal stress and the interpretation of symptoms of its occurrence play a key role, which is usually expressed in the form of physiological, behavioural and production indicators (von Keyserlingk et al., 2009). According to NRC (2008), generally speaking, stress can be called an inferred internal state of the organism caused by stressors affecting it. The animal may try to avoid stressors and/or seek to terminate them, and in other case, show willingness to obtain the stressor. Hence, apart from using the term "distress" to describe negative stress, Selye (1976) proposed the term "eustress", which the animal associates positively as a pleasant feeling.

Stress response in cattle has so far been usually perceived negatively, as a sign of lack of animal welfare or its significant decline or deterioration (e.g. Rushen et al., 1999; Forkman et al., 2007; Grandin and Shivley, 2015; Hulbert and Moisá, 2016; Meagher et al., 2016). This is due to the fact that stress was most often defined as a biological response of the organism to the threat to its homeostasis (e.g. Moberg and Mench, 2000; Koolhaas et al., 2011). As a result, the focus was placed mainly on "minimizing harm" and not on "maximizing the benefit" of animals. This thesis

is confirmed by the summary of the Welfare Quality® project, in which Miele et al. (2011) stated that while social opinion pays special attention to maximizing positive experiences in animals, scientists tend to minimize their discomfort/pain/suffering. Fortunately, in recent years there have been more and more mentions of the value of positive animal welfare in scientific research and breeding practice, although it is still relatively small in relation to cattle (Ohl and van der Staay, 2012; Nordquist et al., 2017).

An example of the consequence of understanding stress mainly in negative terms, is the widely disseminated idea of Five Freedoms, whose subsequent postulates begin with the phrase "freedom from..." (FAWC, 2009), placing the emphasis on not exceeding certain minimum animal welfare requirements. As a kind of complement to the current idea of the Five Freedoms, I would like to propose its "positive" version, aimed at the maximum well-being of animals, which should be the goal (Table 1).

Table 1. The idea of Five Freedoms in the "negative" (freedom from...) and "positive" (freedom to...) version

Items	Five Freedoms	
	in the "negative" version (according to FAWC, 2009)	in the "positive" version (own proposition)
1.	Freedom from hunger and thirst, by ready access to water and a diet to maintain health and vigour.	Freedom to fully meet nutritional needs, by optimizing quantity and maximizing quality of food and water.
2.	Freedom from discomfort, by providing an appropriate environment.	Freedom to fully meet comfort needs, by optimizing housing and management conditions.
3.	Freedom from pain, injury and disease, by prevention or rapid diagnosis and treatment.	Freedom to be healthy, by prevention or/and rapid diagnosis and treatment.
4.	Freedom to express normal behaviour, by providing sufficient space, proper facilities and appropriate company of the animal's own kind.	Freedom to fully meet behavioural needs, by optimizing housing and management conditions, and social relationships including human-animal relation.
5.	Freedom from fear and distress, by ensuring conditions and treatment, which avoid mental suffering.	Freedom to fully meet emotional needs, by maximizing positive emotionality in animals.

It seems that in the context of the Five Freedoms implied in this way, the understanding of cattle welfare may refer to what Rollin (2007) calls animal *telos*. In this approach, the maximization of their well-being would be to strive for the fullest possible expression of their nature as a species, which in the case of cattle could be called cattleness. The term would refer to the nature of modern domestic cattle (with the distinction of *Bos taurus* and *Bos indicus* and basic purpose types), and thus would take into account the genetic changes of animals that have occurred during domestication and breeding practice up until now. Of course, this does not diminish the importance of comparative research between domestic cattle and its close/distant relatives within Bovidae. However, in this case it is necessary to remember about the key differences in terms of physiology (e.g. metabolism intensity), morphology (e.g. conformation), behaviour (e.g. in relation to temperament, docility) and performance

traits of the animals (e.g. the level of milk yield) (Diamond, 2002; Phillips, 2002; Mignon-Grasteau et al., 2005; Adamczyk et al., 2013).

Emotional behaviours in dairy cattle

Emotions of an animal, so the level of its arousal, are expressed through emotional behaviours (Hurnik et al., 1995). Panksepp (2005) listed seven emotional action-oriented systems in animals. In a form adapted specially to cattle, they include sensations related to exploration, anxiety/fear, assertiveness/dominance, emotional ties in the animal-animal and human-animal relations, play behaviour and pleasures/lust (Mellor, 2012). In all cases, as a result of deprivation of the animal's needs, one can speak about the disruption of its welfare. On the other hand, however, except for anxiety/fear, remaining animal's states usually indicate it is experiencing more or less pleasurable emotions and are/may be in this approach successfully used to assess the positive welfare of cattle (Weary et al., 2017). Therefore, in Table 2 I have included behavioural traits that in my opinion could be its indicators, taking into account the age group of the animals. In this context, the validity of some of these features seems obvious (e.g. the small significance of exploration needs for the youngest calves), but there are also features that require a somewhat deeper analysis. For example, HAR in the case of newborn dairy calves, most often subjected to early separation from mothers, is mainly a substitute for unrealized and unfulfilled need for bonding with a cow (Johnsen et al., 2016). Even the most optimal human behaviour towards a calf is rather an attempt to minimize damage and not to maximize the well-being of the animal. Therefore, while the importance of positive bonds to the cow-mother (described as needs of bonds between conspecifics) has been described as very important, in terms of positive welfare of the calves, HAR plays a relatively small role.

Certainly, in the future, adjustments will be necessary regarding both individual features as well as their significance. Therefore, my proposal should be considered as an introduction to the future discussion.

It seems that among the methods of assessing the welfare of dairy cows, Qualitative Behavioural Assessment (QBA) – as part of the Welfare Quality assessment protocol – is the most directed towards positive welfare (EFSA, 2012). Although Ebinghaus et al. (2016) also mentioned other methods helpful in this case (in relation to the avoidance distance, tolerance to tactile interaction or release behaviour), the QBA method is still the most comprehensive. For according to Kirchner et al. (2016) it is not only suitable and useful for adult cattle, but also for assessing positive welfare in calves. From the twenty terms that may be considered in this case, the authors pointed out, amongst others: active, calm, content, enjoying, friendly, inquisitive, positively occupied, relaxed, sociable, happy. In this context, however, a big risk of animal anthropomorphisation may be a serious problem (Keeley, 2004; Phillips, 2015). Therefore, it is necessary to most clearly define individual characteristics. While there should be no major problems when interpreting animal behaviour at the level of sensory experience (e.g. pleasure of fodder eating), in the case of the term "happy" it can be problematic, although probably not impossible. For example Boissy et al. (2007) proposed that – as opposed to a sense of pleasure – a sense of happiness shall be understood as a longer, more stable but less intense state of satis-

faction of the animal testifying to the positive quality of its life, expressed in the form of positive emotional behaviours.

Table 2. The importance of positive behavioural indicators in assessing the welfare of dairy cattle

Positive behaviours in relation to:	Meaning of the indicator[1]				References
	for newborn calves[2]	for older calves[3]	for young stock[4]	for cows	
Exploration needs (exploratory behaviour)	+	+++	+++	++	Murphey et al., 1981; Jensen et al., 1998; Bouissou et al., 2001; Phillips, 2002; Waiblinger et al., 2002; Waiblinger et al., 2003; Boissy et al., 2007; Coulon et al., 2007; Bertenshaw and Rowlinson, 2008; Schmied et al., 2008 a, b; Abramowicz et al., 2013; Favreau-Peigné et al., 2013; MacKay, 2013; Ellingsen et al., 2014; Lombardi et al., 2015; Ebinghaus et al., 2016; Johnsen et al., 2016.
Sensory pleasure needs (e.g. brushing, nutritional pleasure)	+++	+++	+++	+++	
Needs to play (play behaviour)	+	+++	++	+	
Needs of bonds between conspecifics (e.g. allogrooming)	+++	+++	+++	+++	
Human-animal relationship	+	+++	+++	+++	

[1]The ability of an animal to express positive behaviours is described as low (+), average (++), high (+++).
[2]Calves during the first month after being born; [3]young animals between the second month after birth and reaching sexual maturity; [4]heifers from the period of reaching breeding maturity up until the first calving.

Cognitive ability in dairy cattle

We are probably gradually approaching the point at which, in addition to simple sensory experiences, we will be able to determine more complex emotional states and consciousness in cattle quite accurately. However, if we assume that perceptual abilities of these animals seem to be relatively well known (Adamczyk et al., 2015), then a much bigger challenge is the research into more complex cognitive abilities, which so far has been conducted on a relatively small scale in terms of positive cattle welfare, not to mention the need for a more careful inference (Hagen and Broom, 2003, 2004). This may be due to the fact that we are entering the research area more and more difficult for us, as people, to reach (Mery, 2013). Because in the stimulus-organism-reaction relation, it goes far beyond current analyses focused more on the stimulus-reaction relationship, which in many cases could have been enough. Meanwhile, when we shift the research focus to the animal organism, it is somewhat necessary to introduce and precisely define additional, complicated in their essence, terms (e.g. cognitive, awareness, emotions, feelings, suffering), which concern not only biological, but also psychical processes of the animal (Allen and Bekoff, 2007; Broom, 2010). Research in this area is all the more important because cognitive bias can potentially be a very valuable indicator of cattle welfare (Broom, 2010).

In this case, it is proposed to use current achievements in the field of cognitive abilities of primates (Griffin, 1984; Raby and Clayton, 2009). They can be a reference point to lower organized animals, provided that biological, psychological

and philosophical sciences cooperate in this field. Due to the nature of the research problem, a multidimensional approach in this case is indispensable, although I am aware that it may sometimes require conflicting visions of HARs and various concepts of understanding cognitive abilities to clash. For example, on one hand, numerous mathematical cognitive models are created within cognitive sciences, which are supposed to consider animal abilities such as perception, categorization, memory, learning and decision making (is this not a mechanistic point of view?), while behaviourist approach to the problem (e.g. Morgan's cannon) up until this day arouses discussions and lack of unanimity among researchers (Morgan, 1894; Pisula, 2009; D'Mello and Franklin, 2011; Allen, 2014). On the other hand, more and more often research concerns cattle personality (MacKay, 2013; Hedlund and Løvlie, 2015), while there may still be doubt, which I share, whether or not it is an abuse. In my opinion, instead of personalizing animals, it would be sufficient in this case to simply refer to biological and psychological aspects related to the temperament and character of animals. All the more, it seems to be justified that the psychological definition of a human personality – in relation to which an animal personality is defined – includes very complex, multidimensional aspects of human thinking, feeling and behaving, such as: behavioural style, intellectual and mental ability, special talents, motives acquired in the process of development and maturing, emotional reactivity, attitudes, beliefs and moral values (Coaley, 2014). Meanwhile, according to the proponents of animal personalization, a personality of both "human animals" and "non-human animals" is treated practically in the same categories in terms of patterns of affect, cognition, and behaviour (Gosling, 2008). Along with the tendency to personalize animals, including cattle, the understanding of the HAR changes. It is therefore a very important contemporary research problem of an interdisciplinary nature, which should be clearly explained.

Fortunately, with all the controversies arising from the perception of reality from different points of view, paraphrasing the statement of Shettleworth (2001), one can say that "intellectual flexibility should be facilitated by more widespread interdisciplinary training" in the investigation aiming at getting to know the objective reality.

Cognitive ability is closely related to the learning ability of animals (Broom, 2010). In 2003–2004, Kristin Hagen and Donald M. Broom published two papers on the learning ability of cattle in the aspect of positive welfare of heifers. Using the Y-maze test, they found out, amongst other things, that the discrimination learning of these animals towards conspecifics – key in social relations – was easier when additional cues such as breed differences were provided in the experiment (Hagen and Broom, 2003). Furthermore, they conducted a preliminary analysis of emotional reactions to operant learning in dairy heifers (Hagen and Broom, 2004). According to them, "cattle might be more agitated when they are just about to acquire a task, i.e. understand, and thus that they may have an emotional perspective on their own agency".

The above studies seem to be pioneering. Unfortunately, although more than a dozen years have passed since then, it is difficult to identify any later publications closely related to the subject of positive cattle emotionality in the aspect of its cognitive/learning ability, and thus the positive welfare of this group of animals.

The future of the non-invasive method for dairy cattle welfare assessment in practice

Contemporary, comprehensive assessment of dairy cattle welfare requires methods that not only work well in experimental conditions, but above all, in breeding and production practice (Fraser et al., 2013). These methods must not only be effective but also non-invasive in these conditions, which is an ethical requirement for human-animal relations, but also has a utilitarian dimension – distress causes, for example, a decrease in milk yield of cows and negatively affects their fertility (Phillips, 2002; Crowe and Williams, 2012).

Currently, thanks to systematic acquisition of data from the herd management systems, we can quite accurately control the health status of dairy cows, mainly based on production and, partly, behavioural and physiological indicators (von Keyserlingk et al., 2009). Automatic measurements and interpretation of milk yield changes during the day (milk flow sensors), the number of somatic cells in milk (measurement of electrical resistance of milk) and its warmth (temperature sensors in the collector of milk apparatus), physical activity of animals (pedometers, activity meters, accelerometers), regurgitation/rumination (sound analysis technique), or the condition of cows (automatic animal weighing and 3D image analysis of their back and rump) are now practically a standard in high-yielding cow herds (Schirmann et al., 2009; de Vries et al. 2011; Jacobs and Siegford, 2012; Barkema et al., 2015). However, the possibility to apply basic physiological indicators in the breeding practice, such as the level of stress hormones or the peripheral and autonomic nervous system reactions in cattle, is still a major problem. Although they are often used in scientific research (e.g. Stewart et al., 2010; Burdick et al., 2011; Chen et al., 2015; Frondelius et al., 2015; Kovács et al., 2015, 2016), they are usually invasive (e.g. measuring the level of stress hormones in the blood), or can be troublesome to use in production conditions (e.g. the need for relatively permanent placement of sensors in a specific area of the animal's body with the possibility of frequent wireless data transfer).

Current research shows that in the area of non-invasive methods of determining dairy cattle welfare indicators, positive effects can be expected in the future, based on the following solutions:

– non-invasive testing of stress hormone levels in secretions such as saliva, milk, urine, faeces and animal hair (del Rosario González-de-la-Vara et al., 2011; Palme, 2012; Moya et al., 2013),

– infrared thermography of skin – refers especially to the hairless or almost hairless areas of the body, e.g. muzzle, udder (Stewart et al., 2005; Polat et al., 2010; Alsaaod et al., 2014; Rekant et al., 2016),

– digital audiometry techniques and analysis of vocalisation of animals, especially in the cow-calf relationship and during slaughter of cattle (Manteuffel et al., 2004; Grandin, 2013),

– digital video techniques and image analysis in order to interpret cattle behaviour and perform comparison of behavioural patterns with abnormal behaviours (Poursaberi et al., 2010; Viazzi et al., 2014; Porto et al., 2015),

– wireless techniques of identification and localization of animals on the pasture

and in the barn, and cow health evaluation (Huircán et al., 2010; Gutiérrez et al., 2013; Ariff et al., 2014; Andrew et al., 2017; Kumar et al., 2017).

Moreover, there are studies, focused on the positive social relations in the herd/group of cattle and positive HARs (Yayou et al., 2015; Herbeck et al., 2017). They show that, in addition to emotional behaviour, an indicator of positive cattle welfare may, for example, be the content of oxytocin in body fluids. In this light, for example when examining the welfare of dairy cows during milking, we should take into account not only the level of stress hormones (e.g. adrenaline, cortisol), but also oxytocin (although the negative correlation between the level of oxytocin and adrenaline in cow blood is commonly known). Even though the invasiveness of the oxytocin level assessment method based on measuring its content in animal blood may be a problem, there are some studies suggesting that cow milk may also be tested for it (Prakash et al., 2009; Mishra et al., 2013). Anyway, in this context, cow milking might be perceived as an activity causing positive sensations in cows. Thus, one can assume that, for example, cows approach the milking robot not only to collect the concentrate, but also because of the sensation of pleasure during milking.

In addition to studies on a practical application of physiological indicators, other methods of assessing positive welfare of cattle are being researched. For example, Proctor and Carder (2015) decided to use for this purpose the percentage of visible eye of cows, which was justified because of promising earlier studies on the effectiveness of this method in the assessment of negative emotionality in cattle (Sandem et al., 2002). The effectiveness of this method, as demonstrated by Proctor and Carder (2015), also in terms of the analysis of positive cattle emotionality, is optimistic for its potential future use to assess animal welfare.

Using the above-mentioned methods, we usually focus on the analysis of an individual animal. However, one must keep in mind that with a simultaneous effective application of these methods in practice, they can provide additional quality of knowledge, whether referring to the relationship between individuals within a given technique, or – after combining different sources of information – creating a system more or less comprehensively analysing a wider reality. For example, thanks to the automatic x-, y-, z-positioning, it will be much more possible than before, to objectify the interpretation of not only the behaviours of individual animals, but probably also their reactions to conspecifics and in a HAR. Then, by comparing this information with the production data from the herd management system and/or, for example, thermal evaluation of animals, we gain an even more objective picture of welfare of both individual animals and their groups.

Generally speaking, in my opinion, research in the field of a non-invasive method of dairy cattle welfare assessment, should aim at creating a coherent animal welfare management system in real time, which in practice would take the reactivity of animals to stressors into account, but also monitor and control the microclimate in the barn, using data related to the Temperature Humidity Index, measurement of the concentration of carbon dioxide, methane and nitrogen compounds (Owen and Silver, 2015; Herbut and Angrecka, 2018). Due to an enormous amount of data, this system should be of an expert nature, so that the breeder has precise but also clear information, on the basis of which he will be able to make breeding and production

decisions. Such a system would also meet the requirements of sustainable food production at a farm level.

Improvement of cattle slaughtering conditions

There is no doubt that the problem of animal slaughter is one of the key and most controversial issues of ethics regarding the HAR. This problem is also related to ensuring proper transport conditions and handling of animals prior to slaughter (Chardon et al., 2016). At the same time, the answer to the question "whether a man can kill animals for consumption purposes?" is not only the most important problem disuniting representatives of the welfarist and abolitionist vision of animal protection, but even in the group of welfarism supporters there is no unanimity in this case. If, for example, Peter Singer quite unambiguously negatively responds to this question, then Temple Grandin definitely allows such a possibility (Singer, 2003; Grandin and Johnson, 2011).

If we take into consideration the cases of sudden, unintentional death of animals in farming conditions (e.g. sudden death), basically the problem of slaughter is generally related to cattle regardless of its purpose types (MCD, 2015; Boetel, 2017).

It should be noted that depending on historical and/or economic factors in a given region of the world, the amount of meat obtained from dairy cattle may range from 50% (e.g. in Canada) up to almost 100% (e.g. in Poland) (CMC, 2013; GUS, 2016; PZHiPBM, 2016).

Considering such sensitive nature of the problem of slaughtering animals, works on minimizing distress in slaughter cattle have been carried out for years. They mainly concern such construction solutions, handling procedures and slaughtering methods, which are a response to natural animal behaviour with a simultaneous minimal direct human participation (Grandin, 2015).

Although this may seem like a controversial thesis, according to Grandin (2013), during humanitarian slaughter of cattle, there is no difference in animal behaviour compared to other, less stressful situations in their lives (e.g. comparing animals staying in a squeeze chute in a slaughterhouse and in a barn). Perhaps this is also a result of avoiding showing distress at the behavioural level by these animals, because such behaviour in natural conditions exposes them to a predator attack (Bomzon, 2011). On the other hand, there are studies that found that the level of cortisol in cattle blood during farm-handling was at a similar level (Grandin, 1997), or even lower (Mitchell et al., 1988) than during slaughter-handling.

Taking into account the maximum adaptation of human behaviour/procedures to the natural abilities of animals, the basic principles of humanitarian treatment of cattle in a slaughterhouse would be (based on Grandin, 2010 a, b; Velarde and Dalmau, 2012):

– correct construction solutions and equipment (e.g. non-slippery floors, races with solid sides) and microclimate conditions (e.g. optimal Temperature Humidity Index, avoiding bright lighting) in accordance with applicable legal norms, not limiting to the minimum requirements in this regard,

– ensuring proper feeding before slaughter (absence of prolonged hunger and thirst),

– proper handling, including:

• the use of cognitive abilities characteristic for cattle (including the perception of the environment), the animal perception of its individual safe space (point of balance and flight zone), the will of the cattle to go forward and avoid going backwards,

• quiet handling of animals; not using electric prods or high-frequency sounds and restricting the visual field of the animal only to the direction it should follow (e.g. lighting of the restrainer entrance); using false floor to reduce balking; optimizing pressure of neck restraint,

• providing animals with the facilitation of movement (cattle ramps adapted to the natural abilities of cattle, smoothness of driving of the vehicles transporting animals, an optimal number of animals in relation to the place of staying),

• eliminating the fear of novelty (walls with homogeneous, non-vivid colours,

– best resembling conditions in the barn) and stress of isolation of the animals (performing activities on a group of animals and preventing the separation of them),

• efficient stunning of the animal,

– regular auditing/video auditing of animal welfare in a slaughterhouses, including:

• assessment of the condition and behaviour of animals (body and coat condition scoring, abnormal behaviour, lameness, cleanliness/soiling of animals, injuries, sores, swellings, cancer eye, ammonia levels in the indoor facilities),

• occurrence of adverse events (beating animals, noise, screaming, docking dairy cow tails),

• evaluation of the input-based engineering variables (space requirements for housing and transportation of animals, stunning equipment specifications).

Due to the scope of this article, I have limited myself only to the key issues related to the transport and slaughter of cattle. Nevertheless, even at this level of generality, it is visible that to a great extent, ensuring the welfare of slaughter animals depends on anthropogenic factors. If I wanted to summarize the general and specific requirements in this area, it seems to me that they could be understood as the pursuit of situations in which the animal voluntarily acts in accordance with the intent of the man, without the need of mutual negative relations (e.g. using electric prods, or any other type of human violence).

Whereas current theoretical and practical knowledge allows indicating to a large extent the principles of optimal (humane) treatment of animals during transportation and slaughter, it seems that the main problems associated with it may result from the negligence in implementing individual recommendations in the slaughterhouses and a lack of reliable information between beef producers and the public opinion.

Conclusions

Human-animal relations shape our understanding of animal welfare. So far, negative criteria have predominated in the assessment of cattle welfare, which were usually the result of treating the terms “stress” and “distress” as synonyms. Meanwhile, more attention should be paid to the positive welfare of animals, in which the viewpoint would change from “minimizing harm” done to the animal, to “maximizing its benefit”. This is an enormous and difficult field of research, including experiencing

"positive stress" by animals, which is manifested as positive emotions and positive actions of the animal.

In the future, when assessing the welfare of cattle, one should take into account that human-animal relationships will probably go beyond current "species limitations". On one hand, this will probably result in continuously increasing human biotechnological capabilities (transgenic animals), and on the other, increasing diversity and stratification of public opinion in the field of human-animal relations. Unfortunately, this situation further complicates, already difficult, ethical deliberation in this field. However, I believe that the essence of the problem is accessing people on a large scale with reliable knowledge and conducting dialogue at all levels of social life, while maintaining the basic condition of mutual respect.

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