POSITION PAPER

Lack of success in improving farm animal health and welfare demands reflections on the role of animal science

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1 Description of problem

Animal health and welfare (AHW) of farm animals is a highly complex issue involving the interests of various stakeholders and conflicts between important societal goals. First of all, farm animals have an inherent interest to sustain their life and prevent themselves from suffering pain or harm. Also, farmers, consumers, and animal scientists have a great interest in the AHW issue. Although decades of efforts by various disciplines of animal science have provided progress in various fields, they have not led to substantial improvements of AHW in farm practice, not even under the enhanced minimum standards of organic agriculture (Krieger et al., 2017). Researchers of animal welfare can claim, at best, that the AHW situation would have been far worse without scientific efforts (LeBlanc, 2013). Indeed, research work has created an enormous amount of scientific knowledge, but while filling many libraries, little of this theoretical know-how about nearly context-independent biological and physiological laws and regularities has been successfully implemented on farms. This contrasts with the enormous investments in the research on improving AHW. Regardless of reasons, be it inappropriate knowledge or insufficient implementation, this contrast questions any further spending of huge amounts of public money on scientific efforts that stubbornly proceed with the same predominant approaches. Here, it is hypothesised that unsolved conflicts between different interests on different scales are a major cause for the lack of improvements in AHW. Some of the conflicting areas are outlined below.

2 Farm animals want to survive

One of the main requirements of all living systems is adaptability to existing or changing living conditions. What makes a difference between biological evolution and animal husbandry is the fact that in the latter humans are responsible for the design of living conditions and the setting of the production goals, thus framing the interactions between farm animals and their living conditions. Survival depends on the ability of an organism to maintain a stable internal environment (e.g. body temperature, blood glucose) for this enables optimal functionality of vital systems during times of external environmental fluctuations and perturbations. Adaptation involves a series of orchestrated behavioural, physiological, and metabolic changes which rely on the availability of adequate resources (e.g. nutrients) as well as sufficient protection against abiotic (heat, cold) and biotic stressors (conspecifics, microbial pathogens). In theoretical biology, an enduring tradition referred to as 'self-determination' places heavy emphasis on the idea that biological systems employ

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a systematic constitutive organisation, the effects of which contribute to the determination and maintenance of its existential conditions (Montévil and Mossio, 2015).

Different concepts and terms describing changing regulatory systems have been coined. From these, allostasis, meaning 'stability through change', has become most widely used (Sterling, 2012). Regulatory mechanisms must change, for instance, in the transition period of dams from pregnancy to lactation, to maintain or achieve a state appropriate for the individual animal for the time of day or year, in response to disturbances, and in relation to individual requirements. Maladaptive and inefficient responses to the complex challenges presented by the living conditions lead to dysfunction and disease, indicating that the ability of the animal to cope is overstrained (Sundrum, 2015). Thus, adaptive responses are an essential means of survival.

3 Competition between animals and in animal's metabolism

Deficiencies in resources and/or protection cause competition between farm animals, not least at the feeding trough. Additionally, competition exists within an organism at metabolic level. Glucose, for example, plays a central role in dairy cows, for which both lactocytes and leukocytes are competing. An increase in demand imposed by milk synthesis or inflammation can cause a mismatch in the regulation of glucose allocation and plays an important role in postpartum immune dysfunction (Sundrum, 2019). With increased milk production and demand for glucose, fertility declines (Spencer, 2013) and digital adipose cushion in hoof tissue decreases, resulting in more hoof lesions and lameness (Oikonomou et al., 2014). Pushing the animal to produce more milk, meat, or eggs causes both increasing AHW problems and a decline of functionality (Rodenburg and Turner, 2012). While the death of an animal indicates an irreversible breakdown of adaptation, clinical signs of diseases, with different degrees of severity, often precede death. Primarily depending on the gap, the responses tend to be either adaptive and promote overall fitness or non-adaptive and variously increase the risk of becoming ill or dying, emphasising the ambivalent nature of stress.

Sensitivity to well-being and the perception of threats are highly individual (self-referential), depending, amongst other things, on size, ranking order, or gender. Animals take advantage of past experiences to prepare for potential challenges and ameliorate them before they occur (Ramsay and Woods, 2016). Behaviours, e.g. avoiding the aggressions of dominant animals, are not ends in themselves but are functionally intended to enable an organism to protect itself and stay alive (Gygax, 2017). Individual learning on the basis of past experience enables anticipatory responses. Correspondingly, an individual animal is the reference system for the appropriateness of the living conditions. The number of possible stressor combinations simultaneously challenging farm animals is infinite. Possible reactions of the animals to the same or different stressors vary greatly due to the large variations in the adaptation capacities. Thus, adaptive success depends not only on the environment as a whole and the responsiveness of the whole organism but on the interactions between both at the individual level (Sundrum, 2015). It is hardly possible to model this process, let alone obtain information that allows for a dependable prediction of outcomes. However, adaptive success can be assessed retrospectively based on the time periods in which an animal was free of signs of production diseases. Even though being disease-free is a necessary but not sufficient condition for well-being, the prevention of diseases associated with pain, suffering, and harm is a sine qua none and has utmost priority when striving for a high level of AHW.

4 Conflicting areas at the farm, regional, and national level

Modern animal production is mainly based on economic principles. A low level of production diseases is not considered an overriding and independent production goal. Instead, diseases are often perceived as an undesirable but apparently unavoidable side-effect of the production processes. The number of animals in a herd completely unable or insufficiently able to cope with their surrounding corresponds with the efforts of management to provide the needed resources and protection measures. Appropriate allocation of resources is essential for both high productivity and minimal level of production diseases. However, such efforts are time-consuming and costly and do not automatically pay out economically. Many farmers are not fully aware of AHW problems on their farms, but many also choose blissful ignorance to avoid their own responsibility in dealing with unpleasant situations for which they see few options (Gigerenzer and Garcia-Retamero, 2017). A problem that is not fully perceived as such and not approached cannot be solved. The fact that failure and preventive costs are production disease-related and strongly affect the economic viability of the farm system is often also ignored (van Soest et al., 2019). Thus, the capability of farm animals to survive, grow, reproduce, and cope with the living conditions play a major role in the sustainability of the livestock system (Blanc et al., 2006). In light of the conflicting aims between productivity and animal protection, where one can suffer to some degree at the expense of the other, an optimal balance between both is the only way forward. However, a self-referential assessment by farmers relying on their own subjective estimations about what might be good for the animals and the sustainability of the farm enterprise is not forward-looking. On the one hand, it is important for farmers to compare cause-effect relationships on their farm with those on other farms. On the other hand, livestock farming is characterised by a wide range of variables and their interconnectedness, affecting animal health and welfare in different ways. Thus, farms are ranging from very poor welfare situations to those where farmers are doing a very good job to protect farm animals from suffering. In general, the level of AHW is largely independent from the performance level (Cook et al., 2015) or the production method (Krieger et al., 2017). This indicates that AHW is an animal protection service which results from the entirety of processes taking place

within an individual farm system (Sundrum, 2018). To provide animal protection services, farm managers must ensure that living conditions are adapted to the needs of each animal to prevent excessive strain on their adaptability, which would lead to disturbed animal health and behaviour. Thus, valid statements require a systemic, functional, and result-oriented approach.

A scale ranging from very low to very high mortality rate and prevalence of production diseases in relation to the performance service per farm unit provides orientation. Whether intrinsically motivated or forced by economic reasons, farm management needs to know where and how to direct its efforts and allocate available resources. While production is easily quantifiable, the success of animal protection is not, or at least only by the degree of maladaptation in the form of mortality and morbidity rates in a farm system.

Accordingly, farmers should strive for the optimum balance between production and animal protection. The degree of the quality of animal protection could be categorised and communicated to retailers and consumers. Benchmarking would offer an appropriate approach to provide orientation when establishing farm-specific target figures and simultaneously deal with the issue of unfair competition. The current lack of benchmarking of farm services can be seen as one of the main barriers to fair competition and investment in the improvement of AHW.

5 Role of animal science

One task of science is to seek facts and provide understanding. Different groups of scientists coming to opposing conclusions on the basis of the same facts contradicts scientific principles. Such contradictions would be expected to lead to a fundamental scientific dispute. However, this does not seem to be the case in agricultural and animal science. An expounding example related to the current issue is given by Fraser (2008); here, different groups of prominent scientists reviewed scientific literature about the welfare of sows in gestation stalls and delivered contradicting recommendations. This addresses a dilemma that threatens 'to throw animal welfare science into disarray'. According to Fraser (2008), 'different scientists adopted the different value-based views of animal welfare – basic health and functioning, natural living, and affective states – as the rationale for different scientific approaches to assessing and improving animal welfare'.

Science is certainly not completely value-free, and scientists are not free of self-interest as they compete for research funding. Experts necessarily perceive problems and solutions from within their professional paradigms. They are incapable of forming judgements beyond their specific expertise (Millgram, 2015). The question is not whether but to what degree their perspectives and self-interests influence their conclusions. Scientists have their own discipline-born perspective; impartiality and objectivity oblige them to listen to other views and by so doing create inter-subjectivity. Only in this way can conflicting interests become transparent and understandable and the search for a balance between different interests initiated. However, scientists' primary interest is not necessarily dispute but rather the search for consistency within their own fields. The challenge for scientists is to put aside self-interest and strive for impartiality, independence, and unbiased views. As far as the author is aware, interdisciplinary dispute seldom takes place within agricultural and animal science.

The Welfare Quality® Project, funded by the EU Commission, is the most ambitious attempt at interdisciplinary discourse concerning animal welfare. About 44 scientific institutions from different countries and disciplines were involved (Welfare Quality Network, 2009). It has created species-specific protocols to assess animal welfare at the farm level. Although the attempt is honourable, the results are not convincing for various reasons. The protocols are the result of a compromise to include all criteria agreed to be AHW-relevant by the involved scientists and pragmatic aspects striving for repeatable assessment results on AHW in the stable. The concept necessarily excludes other perspectives, thus revealing a self-referential anthropomorphic approach. The approach follows the perspectives of selected scientific disciplines but disregards both the inherent aim of animals to survive and the self-referential assessment of animals on their well-being in any given situation.

While the AHW-relevant criteria mentioned above are essential for assessments and decisions made by farm management, it should not be disregarded that they only indicate rather than explain the underlying processes. The selection of those criteria implies that other aspects of the problem under study are ignored. This applies to both animal- and farm-related criteria, such as enhanced minimum standards. It logically follows that selected criteria often have insufficient explanatory and no predictive power for overarching aims. Selection of criteria touches upon a core problem of biology (Cassirer, 2000): the 'part-whole-problem'. Within an organism, the different parts and subsystems are not separate from each other but are self- and mutually reinforcing and work together towards the same goal: to keep the organism alive. There is no part that does not need the support and cooperation of nearly all other parts. Consequently, an organism cannot be fully understood without considering the purpose behind the biological processes. Adaptation is a functional and target-oriented process involving the whole organism. Correspondingly, behaviour and emotional states are not ends in themselves but a means to an end. Whether an organism adequately responds to challenges cannot be deduced from single parts. The same applies to the farm system, within which each subsystem is embedded (Sundrum, 2015). The entirety of the system can only be understood through the inherent purpose of the system.

Whether processes are beneficial or not depends primarily on the context in which they take place. Thus, they cannot follow a one-size-fits-all approach but require context-specific external validation. The same is true for the options of balancing the trade-offs between economic interests and AHW in a cost-effective manner. The Welfare Quality concept does not cover the conflicting aims between production and animal protection services and disregards their high relevance for the economic viability of the farm and management decisions.

Thus, it is not able to provide action-guiding knowledge as its approach towards AHW loses sight of the whole and disregards the inherent goals of organisms and farm systems. The functional and teleological approach is not considered with regard to the AHW issue, whereas animal science has adopted this approach when striving for the predominating goal of increasing productivity, although without explicitly naming or acknowledging it.

6 Possible solution

AHW problems arise from overstressing the capacity of farm animals to adapt to farm-specific living conditions. The extent of the problem is directly linked to the lack of efforts by farm management to adequately provide individually required resources and protection. Despite being legally responsible for ensuring appropriate living conditions for farm animals, many farmers are themselves overstrained by the fundamental conflict between the goals of economic viability for the farm system and high levels of AHW. As long as various stakeholder groups (legislators, retailers, consumer, farmer organisations, and, last but not least, scientists) classify mortality and production diseases as undesired but unavoidable negative side effects of production processes, thereby placing responsibility solely on farm management, there is no chance of achieving broad-scope improvements in the field of AHW. Above all, to balance economic and health conflicts in animal husbandry, a low prevalence of mortality and production diseases must first be seen as a separate production goal and then aligned with performance goals so that AHW and performance become a comprehensive production goal.

AHW problems are always context-variant, depending, among other factors, on the hygienic conditions, the degree of genetic selection for high productivity, the specific quality of the offered diet in relation to the genetic production capacity, the individual feed intake, as well as the individual capacity to deal with the gap between supply and demand. Thus, there is a need for a deductive approach, e.g. one that involves first gaining an overview of the degree of the gap between demand and supply and then identifying the predominant weak points in the farm-specific context. Those in charge need to be able to estimate the degree of AHW problems and the need for action in relation to other farms (orientation knowledge). Furthermore, the most influencing factors involved in the multifactorial processes, as well as estimations about the most effective and efficient strategies to overcome problems, have to be identified in the farm-specific context (action knowledge). Farmers are challenged to reduce the biological system overload and the degree of trade-offs.

In the past, intensive selection for increased meat, milk, and egg production has taken place, resulting in substantial increases in productivity and simultaneously causing undesirable side effects with respect to AHW problems in farm animals (Rauw et al., 1998). If genetic selection focuses only on increasing production of meat, milk, and eggs, there is a clear risk of increasing welfare problems related to high production levels, such as mastitis in dairy cows, cardiovascular diseases in broilers, or behavioural problems such as feather pecking and cannibalism in response to fear- and stress-inducing stimuli (Rodenburg and Turner, 2012). Correspondingly, farm-specific breeding goals have to consider the quality of available nutrients and the adaptation capacity of the farm animals in relation to the farm-specific living conditions (Sundrum, 2019).

7 Conclusion

The lack of substantial improvements of AHW problems is not the primary responsibility of animal science. The stagnation is, among other things, a result of missing guidelines and request profiles regarding the level of AHW for farmers and the relentless cheap-price policy in the production chain of food of animal origin. Nevertheless, in light of the long-lasting unsatisfying situation, animal scientists are challenged to reflect on the reasons behind the lack of implementation of scientific knowledge and their own role in the context of livestock production. The unilateral objective of increasing performance is still predominant. Without an extension of the one-sided disciplinary foci in animal science there will be no progress in AHW. All efforts to design future animal production should be redirected to reach the overarching goal of a sufficient productivity level in direct combination with low mortality and prevalence of production diseases. The generation of scientific knowledge with the primary focus on details under standardised experimental conditions is not enough. It is widely disregarding the context and the conflicts between various interests and is not sufficiently suited to solve AHW problems in farm practice. Scientific knowledge requires external validation in the farm-specific context in which the AHW problems emerge. Coping with biotic and abiotic environmental threats and changing living conditions is a performance of the whole organism. Survival without health impairments is the strongest criteria for successful adaptation and a high level of AHW. At the farm level, the rate of mortality and prevalence of production diseases reflect the animal protection service of farm management and the performance of the whole farm system in AHW. The performance in AHW cannot be traced back to single measures. It is resulting from the interconnectedness of various factors whose roles can only be estimated and understood retrospectively in a systemic approach.

REFERENCES

Blanc F, Bocquier F, Agabriel J, D'hour P, Chilliard Y (2006) Adaptive abilities of the females and sustainability of ruminant livestock systems. A review. Anim Res 55(6):489–510, doi:10.1051/animres:2006040

Cassirer E (1974) Das Erkenntnisproblem in der Philosophie und Wissenschaft in der neueren Zeit. Darmstadt: Wissenschaftliche Buchgesellschaft, Bd. 3

Cook NB, Hess JP, Foy MR, Bennett TB, Brotzman RL (2015) Management characteristics, lameness and body injuries of dairy cattle housed in high performance dairies in Wisconsin. J Dairy Sci 99(7):5879–5891, doi:10.3168/jds.2016-10956

Fraser D (2008) Understanding animal welfare. Acta Vet Scand 50(1):S1, doi:10.1186/1751-0147-50-S1-S1

Gigerenzer G, Garcia-Retamero R (2017) Cassandra's regret: The psychology of not wanting to know. Psychol Rev 124(2):179–196, doi:10.1037/rev0000055

Gygax L (2017) Wanting, liking and welfare: The role of affective states in proximate control of behaviour in vertebrates. Ethology 123(10):689–704, doi:10.1111/eth.12655

Krieger M, Sjöström K, Blanco-Penedo I, Madouasse A, Duval JE, Bareille N, Fourichon C, Sundrum A, Emanuelson U (2017) Prevalence of production disease related indicators in organic dairy herds in four European countries. Livestock Science 198:104–108, doi:10.1016/j.livsci.2017.02.015

LeBlanc S (2013) Managing critical periods – transition dairy cows. In: Dalin G (ed) Book of Abstracts of the 15th Conference on Production Diseases in Farm Animals. Uppsala, Sweden: Swedish University of Agricultural Science (SLU), 62–65

Millgram E (2015) The great endarkenment: Philosophy for an age of hyperspecialization. New York: Oxford University Press, 313 p

Montévil M, Mossio M (2015) Biological organisation as closure of constraints. J Theor Biol 372:179–191, doi:10.1016/j.jtbi.2015.02.029

Oikonomou G, Banos G, Machado V, Caixeta L, Bicalho RC (2014) Short communication: Genetic characterization of digital cushion thickness. J Dairy Sci 97(1):532–536, doi:10.3168/jds.2013-7212

Ramsay DS, Woods SC (2016) Physiological regulation: How it really works. Cell Metab 24(3):361–364, doi:10.1016/j.cmet.2016.08.004

Rauw WM, Kanis E, Noordhuizen-Stassen EN, Grommers FJ (1998) Undesirable side effects of selection for high production efficiency in farm animals: a review. Livest Prod Sci 56(1):15–33, doi:10.1016/S0301-6226(98)00147-X

Rodenburg TB, Turner SP (2012) The role of breeding and genetics in the welfare of farm animals. Anim Front 2(3):16–21, doi:10.2527/af.2012-0044

Spencer TE (2013) Early pregnancy: Concepts, challenges, and potential solutions. Anim Front 3(4):48–55, doi:10.2527/af.2013-0033

Sterling P (2012) Allostasis: a model of predictive regulation. Physiol Behav 106(1):5–15, doi:10.1016/j.physbeh.2011.06.004

Sundrum A (2015) Metabolic disorders in the transition period indicate that the dairy cows' ability to adapt is overstressed. Animals 5(4):978–1020, doi:10.3390/ani5040395

Sundrum A (2018) Beurteilung von Tierschutzleistungen in der Nutztierhaltung (Assessment of animal protection services in livestock farming). Berichte über Landwirtschaft 96(1)1–33, doi:10.12767/BUEL.V96I1.189

Sundrum A (2019) Nutrition and health-management in dairy production. In: Abubakar M (ed) Livestock Health and Farming. Rijeka, Croatia: InTech Publishing, doi: 10.5772/intechopen.89447

van Soest FJS, Mourits MCM, Blanco-Penedo I, Duval J, Fall N, Krieger M, Sjöstrom K, Hogeveen H (2019) Farm-specific failure costs of production disorders in European organic dairy herds. Prev Vet Med 168:19–29, doi:10.1016/j.prevetmed.2019.03.029

Welfare Quality Network (2009) Welfare Quality® Assessment Protocols: for cattle (sans veal), poultry and pigs [online]. Retrieved from <http://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols/> [at May 6, 2020]