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Introduction to the concept of "welfare potential" of production systems and its practical relevance to welfare labelling

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Farm animal welfare is inextricably linked to, and limited by, the welfare potential of the production system. Welfare potential is determined by the method of production, with key housing features and the genetics of the animal being the primary defining factors. Housing systems with close confinement, or using animals selected for productivity to the detriment of welfare, such as fast-growing broilers, cannot deliver good welfare as the causes of poor welfare are an inherent part of the system. Good management, while not a determinant of the welfare potential, is essential for a system to achieve its potential. Viewing systems in terms of their welfare potential reduces the risk of making ongoing incremental changes to systems where welfare can never be high. It sets a framework for evaluating the inputs into a system which are key to ensure an acceptable level of welfare. This approach has practical relevance for certification schemes, as it allows for a tiered ("bad, better, best") approach to food labelling based on method of production (e.g. intensive indoors, higher welfare indoors, free-range). Paired with robust welfare outcomes assessment and auditing, this can provide clear and simple information on the farming system to the consumers, while ensuring that the system delivers good welfare. There is an urgent need to move away from systems with a low welfare potential, as they can never deliver acceptable levels of welfare, and to support farmers in their transition towards systems with a higher welfare potential.

KEYWORDS

animal welfare, welfare potential, method of production, labelling, farm animal welfare

1 Introduction to the concept of "welfare potential"

1.1 What is animal welfare?

The concern for animal welfare stems from the understanding that animals are sentient beings, capable of experiencing positive and negative emotions that can make them feel good or bad (Broom, 2016; Browning and Birch, 2022). Animal welfare can be a difficult concept to understand because there is no universally agreed definition (Mellor, 2016; Stamp Dawkins, 2021). Ethical concerns about the treatment of animals led to the

establishment of animal welfare science as a discipline, and early definitions of welfare reflected three broad categories of concerns (Fraser et al., 1997): the 'feelings' approach: welfare is a concern because animals can experience affective mental states such as emotions, 2) the 'biological functioning' approach: welfare is related to health and normal physiological functioning, and 3) the 'natural living' approach: welfare depends on the animal being able to perform natural behaviour.

While it is accepted that all three are important facets of welfare (Fraser et al., 1997), the relative importance of each has evolved over time. The 'feelings' orientation has gained increasing prominence in the last decades with the advancements in scientific thinking and the development of methods to assess mental states in animals. Sentience and the ability to suffer is the main reason for public concern about welfare (Mendl et al., 2017). With respect to 'natural living', it is increasingly acknowledged that natural does not necessarily imply good welfare (Dawkins, 2003; Webster, 2016; Browning, 2019). Animals in natural environments may experience fear of predation and are more exposed to the elements, conditions considered to lead to poor welfare in farm animals. Understanding what is natural for an animal, however, is essential to be able to provide for the animal's behavioural preferences, allowing them to choose to engage in behaviours that are important to them. Behavioural preferences may be a more appropriate term for the third orientation of welfare (Browning, 2019) and it implies a degree of agency that the animal has in their environment, being able to choose when and which behaviours to engage in (Špinka, 2019). To design higher welfare farming systems with the animals' needs in mind, it is important to understand their species behavioural repertoire as well as the environment to which their ancestors have adapted to over thousands of years.

1.2 Introducing the notion of "welfare potential"

In simple terms, the welfare potential of a production system refers to the capability of that system to meet all three facets of animal welfare. A system with a high welfare potential allows an animal to express their behavioural preferences, ensures their good health and normal biological functioning, and promotes positive mental states while minimising negative experiences.

The welfare of farm animals is inextricably linked to, and limited by, the welfare potential of the production system they are housed in (Lymbery, 2002). While the welfare potential of a production system is dependent on the inputs into that system, good stockmanship and management are crucial for the system to achieve its welfare potential (Lymbery, 2002; Lymbery, 2019). However, once the inputs are determined, the welfare potential of the system cannot be improved further by the management factors, but it can be reduced by poor management (Table 1). Only a system with a high welfare potential and a high standard of management is capable of providing truly good welfare.

1.3 Determinants of farming systems with high welfare potential

Much of the concern for animal welfare stems from the intensification of production that has occurred in the second half of the 20th century. This process has resulted in much bigger, highly specialised farms, where large numbers of animals are kept in confined and barren conditions with increasing productivity as the main goal, at the expense of the animals' health and welfare. In such systems, the value of an individual animal has decreased (Winter et al., 1998). The physical design of the environment has been primarily developed to minimise input (e.g., cost, labour, space) and maximise ease of handling/management. In addition, animals have been bred to be increasingly productive often at the expense of their welfare. While in more recent years scientific understanding of the needs of farm animals has grown, bringing with it some improvements to the systems, these improvements may have limited benefit to the animals if the system used has an inherently low welfare potential based on the housing design or genetics of the animals used.

Caged systems for laying hens, for example, restrict the animal's movement and opportunity to perform important intrinsically

TABLE 1 How the welfare potential of a production system determines the likely welfare experienced by the animal in that system.

Welfare potential of production system	Standard of management of system	Likely welfare experienced by animal
HIGH	HIGH	HIGH
	MEDIUM	MEDIUM
	LOW	LOW
MEDIUM	HIGH	MEDIUM
	MEDIUM	MEDIUM
	LOW	LOW
LOW	HIGH	LOW
	MEDIUM	LOW
	LOW	LOW

Colour of cells indicates the welfare potential of the system with darker colours indicating a higher potential.

motivated behaviours such as foraging and dustbathing (EFSA Panel on Animal Health and Welfare (AHAW), 2023a). Animals in intensive systems have been selected for increased productivity, leading to many of the main welfare issues inherent to intensive production systems. For example, fast growth rate in broiler chickens is associated with significant leg disorders, cardiovascular problems, and high mortalities in these birds, while the breeder flocks suffer from chronic hunger (Hartcher and Lum, 2020). These health and welfare issues are inextricably tied to the genetics of the animals used and therefore cannot be improved without altering breeding goals.

Systems which offer the animals more opportunities for positive experiences and chances to express important innately motivated behaviours through the addition of more space and resources (e.g. well-designed aviaries and barn systems with verandas for poultry, straw-based systems for pigs, group housing of sows and calves) and which use breeds selected for better welfare outcomes rather than productivity alone (e.g. European Chicken Commitment criteria for broiler chickens, ECC) already have a far higher welfare potential than standard intensive systems.

More extensive systems (e.g., free-range, pasture based, organic) offer the animals outdoor access, more space, more resources and in many cases focus on lower productivity in favour of improvements in health and welfare (e.g. IFOAM- Organics International breeding programme which focuses on "Welfare before productivity"). They provide a more diverse environment and the opportunity for the animals to make choices and express preferences according to variable parameters (weather conditions, time of day, availability of resources, individual preferences; Legrand et al., 2009; Chielo et al., 2016; Delsart et al., 2020; Rowe and Mullan, 2022). However, to have a high welfare potential, extensive systems must also provide for the physical wellbeing needs of the animals, for example, by providing adequate and sufficient shelter. Such systems, if well designed, would have a higher welfare potential as they are more able to meet the physical, mental, and behavioural needs of the animals.

Thus, it is the method of production that is the principal determinant of the welfare potential of a system, with key housing features and the genetics of the animal being the primary defining factors. While small improvements to intensive production systems have been made, the welfare potential of such systems is still low due to their inherent limitations described above, and despite the best management, cannot improve further (Leterrier et al., 2022). Specific features of the housing environment and genetics of the animals which determine the welfare potential of a system are listed, and examples provided, in Table 2.

Management is not a determinant of the welfare potential, but good management is essential for a system to achieve its welfare potential. For example, management cannot overcome the restrictions imposed on hens by the caged environment. Indeed, this has been acknowledged in the recent EFSA Scientific Opinion on the welfare of laying hens which has recommended that cages should no longer be used (EFSA Panel on Animal Health and Welfare (AHAW), 2023a). Similarly, because many welfare issues in broilers are resulting directly from the selection for faster growth, optimizing litter or air quality management cannot compensate for the welfare issues experienced by these fast-growing birds. For example, providing an outdoor range and perches has been shown to have little benefit to fast growing broilers as their ability to use these resources diminished with time likely due to increased problems walking (Weeks et al., 1994). Again, EFSA have acknowledged genetic selection for fast growth rate as a major issue in broiler production as it leads to significant welfare problems for these birds such as musculoskeletal disorders, reducing their ability to reach essential resources, such as food and water, and their ability to perform internally motivated behaviours such as foraging (EFSA Panel on Animal Health and Welfare (AHAW), 2023b).

Conversely, poor management can reduce the likely welfare of the animals within a system and can occur in any system. More extensive outdoor systems are associated with a higher risk of predation or certain parasitic diseases, have more variable food quality, and the animals may be less used to handling (Temple and Manteca, 2020). Often the value of more extensive systems is dismissed because of these risks for poor welfare (Elson, 2019; Temple and Manteca, 2020). However, taking a welfare potential approach allows us to disentangle the method of production from poor management which may lead to the poor welfare observed in more extensive systems in some studies. A recent review of the welfare of dairy cows in different systems concluded that systems with more access to pasture offer the potential for better welfare, but the management of the farms determines the actual welfare experienced by the animals (Mee and Boyle, 2020). Provided the welfare potential of the system is high and the standard of management is good, then the actual welfare experienced by the animals in that system is likely to be high. Specific management factors linked with poor welfare have which can occur across system types are identified and described in Table 2.

1.4 Ensuring that the welfare potential of a system actually translates into good welfare

It is important to note at this point that the concept of welfare potential does not make any assumptions about the actual welfare experienced by an animal in a system. It only proposes that the system has the potential to allow an animal to express their behavioural preferences, ensure their good health and normal biological functioning, and promote positive mental states while minimising negative experiences. Understanding the actual welfare experienced by the animals in that system is also important. To that effect, animal-based welfare outcome measures should be used. Regularly monitoring appropriate welfare outcome measures can help identify welfare problems early on. They can also be used to set improvement targets, benchmark producers and should be an integral part of any continuous improvement plan. Low performance on any key welfare outcome measure should lead to a refinement of one or more of the inputs into the system (housing, breeding, management practices). A framework combining resource, outcome, and continuous improvement approaches has been suggested as best practice for effectively improving farm animal welfare (Main et al., 2014; Butterworth, 2018).

TABLE 2 Factors which can limit the welfare potential of a farming system and examples of management factors which can limit the ability of the system to achieve this potential.

WELFARE POTENTIAL	
Factors which determine the welfare potential are set by the method of production and are determined before the animal enters the system (housing features and genetics of the animals).	
Housing Features	
Level of confinement and limitations on available space	The animal is confined to a small area and is restricted in moving about the environment. The animal does not have enough space to perform important behaviours and/or cannot escape from the negative behaviours of other individuals. Examples of systems with physical limitations: Sow stalls and farrowing crates, battery and enriched cages for laying hens, veal crates, tethered cattle, any system using high stocking densities. Limits of the environment can physically prevent the animal from moving freely and having separate functional areas within their environment. Restrictions on movement, space and/or high stocking densities can also limit the ability of social animals to interact appropriately with one another or engage in important positive social behaviours (e.g., play) and highly synchronous behaviours. Confined environments also limit the resources that can be made available to the animal further hampering their ability to engage in important and/or intrinsically motivated behaviours such as rooting and foraging, resting, nest building, or grooming behaviours (e.g. dustbathing in poultry, water provision for ducks).
Outdoor access	The animal is confined indoors with no opportunity to go outside. This limits the animal's ability to perform certain behaviuours (e.g. grazing, foraging, rooting). There is no/insufficient natural light or fresh air. Examples: Indoor only systems for pigs and poultry, lack of pasture access for dairy cows.
Thermal environment	The animal lacks opportunities to regulate their thermal environment and cope with environmental conditions. Examples: poorly ventilated indoor environments, outdoor environments lacking appropriate shelter.
Genetics/Breeding	
Yield per animal	Selection for increased productivity at the expense of welfare – many welfare issues are linked to the genetics of the animals. Examples: fast growing broiler breeds (leg health, cardiovascular problems, chronic feed restriction in breeders), hens with high egg yields (keel bone fractures), hyperprolific sows (piglet mortality), high milk yield in dairy cows (leg heath, morbidity, mortality).
MANAGEMENT	
Management factors can apply across systems and/or be modified during the lifetime of the animal	
Diet/Nutrition	Lack of appropriate or sufficient feed. Feed not nutritionally adequate for the animal or animal is in state of chronic hunger due to feed restriction. Examples: chronic hunger in broiler breeders and sows.
Mutilations	Painful mutilations are routinely performed. Examples: Beak trimming in laying hens, tail docking, castration, and tooth resection of piglets, dehorning and disbudding of cattle.
Enrichment	Lack of sufficient or species-appropriate enrichment material.
Mixing Practices	Unfamiliar animals are mixed at least once and no practices put in place to mitigate potential aggressive encounters.
Handling	Animals are handled in a manner likely to cause stress and fear and/or do not experience frequent positive interactions with stockpeople. Examples: rough handling, inappropriate and/or misuse of handling aids, dragging/holding of animals by limbs.
Stockmanship	Lack of training of staff in animal husbandry and animal welfare. Lack of affinity and empathy with the animals.
Environmental conditions	Poor air quality and thermal environment. Lack of access to shelter and shade in outdoor environments. High levels of ammonia built up in housing.
Health Management	Inadequate or inappropriate facilities and protocols for identifying and handling sick or injured animals. Examples: No daily inspections, no provision of treatment and/or veterinary care, poor emergency killing protocols, no/inadequate sick pen.

List adapted from factors identified by Winter et al. (1998), hazards and welfare consequences from EFSA Panel on Animal Health and Welfare (AHAW), (2022), and ranking of welfare issues from expert consensus from Rioja-Lang et al., (2020).

In measuring the actual welfare experienced by an animal, it is important to take account the different facets of animal welfare. A measure that takes into account only one facet, e.g., physical health, can lead to inaccurate assessments if the other facets are not included (Browning, 2022). There can also be a trade-off between the comprehensiveness of the assessment and the time/experience needed to perform the assessment (e.g., De Vries et al., 2013; Andreasen et al., 2014). With any welfare assessment, it is important to take into account not only the occurrence of a measure, which just gives a snapshot of welfare in time, but also the frequency, intensity, and duration for which it occurs, and to weight any measure according to the likely impact on the animal (Webster, 2016; Ryan et al., 2021; Browning, 2022).

2 Practical application of the "welfare potential" concept to food labelling schemes

European citizens are calling for harmonized information on where their food comes from and on the conditions under which the animals

were housed (Sechi et al., 2015; Eurobarometer, 2016; Alonso et al., 2020). At present, there is no EU-wide legislation requiring information on method of production to be displayed on pack, except for shell eggs. Food packaging can be highly misleading (e.g. images of small-scale more extensive farms on products from factory farmed animals), and the variety of animal welfare certification labels can be confusing for consumers (Lundmark et al., 2018; Rowe et al., 2021; Ingenbleek and Krampe, 2022), which can lead to a distorted marketplace Welfare labelling, when used appropriately, can be an effective way to drive demand for higher welfare products, and in turn incentivise and support farmers that adhere to higher welfare standards.

In recent years, there has been a significant increase in the number of animal welfare labelling schemes being developed in Europe and globally. The majority of those schemes are voluntary, industry and/or NGO led and aim to label higher welfare products so that they are more easily identifiable for the consumers (e.g., Beter Leven; Für Mehr Tierschutz; RSPCA Assured). Those schemes typically rely on a robust third-party auditing protocol to assess the welfare of the animals on farm (and often beyond the farm's gate) and can be referred to as "animal welfare labelling".

Other, and fewer, labelling schemes have been designed instead to be applied to all products, from low to high welfare products, and typically display information on the housing system (e.g. standard indoors, improved indoors, outdoors, organic) from which the products originate, rather than being based on a lengthy welfare assessment. One example of this is the Haltungsform label in Germany which displays information on method of production on a four-tiered scale with accompanying terms (1-4; indoors, indoors plus, outdoor access, premium). Those labels tend to not be associated with a welfare auditing process but provide consumers with clear, simple and often systematic information on method of production - they can be referred to as "method of production labelling". In these schemes, production systems are categorized according to their welfare potential, which allows for a tiered approach to labelling, resulting in a simple and effective method of production labelling, where not only higher welfare systems are promoted but instead all systems are clearly labelled and typically ranked according to their welfare potential. This has already been successfully implemented for shell eggs since 2008 in the European Union (Commission Regulation (EC) No 589/2008), with the mandatory codes (0-3) displayed on shell eggs indicating whether laying hens were kept in cages (3), in indoor barn systems (2), in free-range (1) or in organic systems (0). The introduction of this first EU-wide mandatory method of production labelling, based on the welfare potential of different housing systems for laying hens, has been key in the transition towards cage-free egg production in the EU (Eurogroup for Animals, 2020). Scientific approaches to the development of resource-based labelling systems based on the opportunities for positive experiences provided by those resources have also been developed (Rowe and Mullan, 2022).

It is important however that method of production labelling is paired with robust welfare outcomes assessment and auditing to ensure that the welfare potential of a given system actually translates into good welfare. Combining resource-based assessment, based on the welfare potential of the method of production, with animal-based outcome measures has been suggested as the most effective means to drive improvements in animal welfare (Tuyttens et al., 2023). Few labelling schemes combine both of the approaches above, in order to provide consumers with transparent information on method of production as well as on animal welfare, and are typically based on a robust welfare assessment. They can be referred to as "method of production and welfare labelling". The French (Étiquette Bien-Être) Animal is a good example of a method of production and animal welfare label. This label provides consumers with information on the production system through a simple pictogram and accompanying terms (e.g., indoors, improved indoors, free range, free range with tree cover), as well as on the actual welfare level based on a five-tiered colour graded scale (A-E), clearly distinguishing higher welfare levels (A-C) from low welfare levels (D-E). The welfare note is based on a robust annual third-party welfare assessment carried out throughout all stages of the animals' life and is composed of over 200 criteria (for broilers) covering key system inputs (e.g. stocking density, breed), management practices (e.g. litter management, lighting regime, culling methods) as well as animal-based measures (e.g. gait score, behavioural indicators such as activity levels and enrichment use). This label enables consumers to buy animal products from the production system of their choice, while also giving them the guarantee that the welfare potential of their preferred production system has led to the expected level of welfare for that particular farming system (e.g. free range system with tree cover + score A).

3 Conclusion

While poor welfare can occur in any production system, not all production systems have the potential to deliver a high, or even an acceptable level of welfare. The welfare potential of production systems can be increased by providing the animals with housing conditions that can meet their species-specific needs and by selecting healthy, robust breeds able to demonstrate good welfare outcomes within that environment. Adopting good management practices through appropriate diet, handling, and health management is key to ensure that the higher welfare potential of a production system will actually result in a higher level of welfare for the animals, and this should be assessed through active welfare outcomes monitoring programs. Standard intensive systems, where animals are typically confined, crowded in barren conditions and often selected for high performance traits at the expense of their health and welfare, have a low welfare potential by design, and will never result in acceptable levels of welfare, regardless of the quality of the stockmanship and husbandry practices applied. Consumers increasingly want to be able to easily identify products according to the method of production, and therefore on the basis of the welfare potential of the systems from which they come from. Method of production labelling, underpinned by strong welfare outcomes assessment, empowers them to make informed decisions when they shop, and is expected to be a key driver for the much-needed transition towards higher welfare systems, where

animals can have a good quality of life and farmers are supported in their investments into higher welfare systems and practices.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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