



# Pigs in heaven: Enhancing the lives of breeding boars

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## ABSTRACT

The recognition of animals as sentient beings has raised societal awareness of the welfare of farmed animals. This has been instrumental in increasing the legislative pressure towards welfare-conscious farming practices and, more lately, greater consumer demand for ethically sourced products. Besides, improved animal welfare is a key driver for enhanced performance, particularly in breeding boars, as welfare conditions strongly influence reproductive outcomes. The stressors associated with confinement impact testicular physiology and semen quality and the efforts to improve the welfare of breeding boars have so far focused on mitigating the negative consequences associated with stressors. The Five Freedoms framework and the European Food Safety Authority (EFSA)'s 'welfare consequences' approach prioritise the alleviation of suffering. In breeding boars, key welfare negative consequences include movement restriction, isolation stress, inability to engage in exploratory behaviours, locomotory disorders, and prolonged hunger. The negative consequences, which can be mitigated by improved housing and management practices, should be tackled in any commitment to improve the welfare of breeding boars. Animal welfare science, however, has recently shifted towards cultivating positive welfare experiences and a life worth living, beyond just alleviating suffering. The Five Domain Model systematically evaluates animal welfare, considering both negative and positive aspects. Encouraging positive welfare states involves facilitating species-specific behaviours, such as exploration and play, and fostering positive human-animal interactions. In breeding boars, strategies promoting positive welfare include providing enriching environments, encouraging exploration, and cultivating positive interactions with caretakers. Thus, for an overall welfare improvement of breeding boars, not only should the absence of suffering be guaranteed, but also the promotion of positive experiences that make their lives worth living.

## 1. Drivers of improved animal welfare

In Europe, there is a long-standing tradition of animal welfare advocacy, supported by a well-developed network of animal welfare organizations, activists, and policymakers. This concern stems from cultural, ethical, and legislative frameworks that prioritize animal welfare. Between the early and mid-20th century, several European countries formulated animal welfare (AW) laws aimed at preventing cruelty and minimizing unnecessary suffering (Vapnek and Chapman, 2010). In the 1970s, the European Union (EU) initiated legislative measures to safeguard animal welfare (Veissier et al., 2008). A few decades later, in 2009, the Lisbon Treaty came into effect, acknowledging animals as 'sentient beings' and mandating EU member states to prioritize animal welfare considerations. EU member states have implemented comprehensive legislation and regulations seeking to protect the welfare of farm animals, as well as other regions in the world such as Chile (Ley N° 20.380 de 2009) or the United States of America (Animal Welfare Act, signed into law

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on August 24, 1966). The implementation of Directives and Regulations govern various aspects of animal husbandry, including farming, transportation, and slaughter practices. Development of new regulations are pushed by citizens' opinion towards a greater protection of farm animals (Eurobarometer, 2023).

Besides legislation, consumer awareness and demand for ethically sourced products have led to increased scrutiny of farming practices and a preference for products certified as meeting higher welfare standards. Consumer demand for ethically raised products necessitates adherence to welfare standards, based on a relationship of trust between consumers and certification bodies. Consumer awareness about animal welfare issues, such as confinement, stress, and cruelty, drives demand for products certified as meeting higher welfare standards. Labels such as "cage-free", "free-range", and "certified humane" indicate to consumers that animals were treated with care and respect, influencing their purchasing decisions. Consumers who expect higher standards than those imposed by legislation, have a choice of purchasing several options of labelling schemes ensuring improved welfare conditions (Stygar et al., 2022). Certification on animal welfare stands as a "pull strategy" in contrast to legislation, which is based on "pushing" standards towards better animal welfare. This "pull strategy" proposes the improvement of welfare conditions by attracting producers towards better welfare, and offering higher prices for the same product, if animal welfare standards can be certified.

Optimisation of animal performance is also a driver towards better animal welfare that attracts the interest of producers, which is based on several principles. For instance, in pigs, good welfare practices tend to correlate with better growth rates, feed conversion efficiency, and reproductive success (Henningsen et al., 2018). Some strategies aimed to enhance the welfare of pigs, such as reduction of stocking densities (Vermeer et al., 2014) or increased availability of environmental enrichment (Mkwanazi et al., 2019), have been demonstrated to improve growth rate. Providing suitable environmental enrichment and space for natural behaviours reduces stress and prevents harmful behaviours, ultimately improving productive performance (Averós et al., 2010). Stress reduction is crucial, as stressors like overcrowding and inadequate conditions compromise immune function and increase susceptibility to diseases, affecting overall health and productivity.

The positive interaction between higher welfare and performance is also prevalent in breeding boars, as welfare conditions influence their reproductive performance (Bernardino et al., 2022). As an example, the stress suffered during housing in individual crates adversely affects testicular physiology. This was evidenced by Tosky et al. (2013) who showed that boars housed in pens (1.8 × 2.5 m) had greater collection volumes and more total sperm per ejaculate compared with boars kept in stalls (0.9 × 2.1 m). Testicular thermoregulation is challenged in crated boars due to restricted movement, stress, and constrained physical space. Unfavourable thermal environment may compromise testis physiology and semen quality (Corcuera et al., 2002).

The importance of animal welfare to achieve the best outcomes (including those from breeding boars) is widely acknowledged, as evidenced above. The strategies to improve animal welfare have, nevertheless, been focused on reducing the negative experiences that could lead to stress or pain. In contrast, less attention (or none) has been given to improving life conditions from a positive perspective, not only removing sources of negative welfare states but promoting the positives, including all contexts or situations that may be rewarding for pigs, ultimately improving their positive welfare. Influential studies on animal welfare raises the importance of positive emotions to improve animal welfare, providing more strategies to make their life worth living (Boissy et al., 2007). Yet, the farming conditions of breeding boars, in what regards to animal welfare, remains largely unexplored, which opens an opportunity to explore ways to improve the welfare of breeding boars.

The goal is to review the welfare of breeding boars, defining the situations that can affect that welfare, either negatively or positively, advocating for a reduction of situations leading to negative welfare, and promoting those leading to positive welfare.

## 2. The welfare of breeding boars

Quoting the Council Directive (2008) 2008/120/EC, 'Boars' are male pigs after puberty retained for breeding. They are commonly bred in specialised 'nucleus' herds and arrive at the breeding centres or quarantine facilities when they have already entered puberty or are about to do so (approximately 6 months of age). They commence semen production at approximately 7–8 months of age. Some boars are employed as teaser boars to induce oestrus in sows, often positioned in the alley adjacent to sows during artificial insemination (AI) procedures. Outside of these activities, however, they are usually individually housed with minimal contact with other pigs. Breeding boars are commonly retired after 2–3 years of service, usually due to size-related health issues such as lameness, infectious diseases, lack of libido and low semen quality (Knecht et al., 2017a).

Breeding boars are typically housed in individual pens, with a minimum space allowance (a minimum of 6 m<sup>2</sup>), primarily to ensure staff safety and facilitate service management (EFSA, 2022a, 2022b). Despite legislation also requires that the space should be increased when necessary to ensure that boars have enough space to stand, turn around, and lie down comfortably, such housing conditions limit social interactions and exploratory behaviours due to isolation and scarcity of enrichment materials (EFSA, 2007). Service activities usually occur within the boar pen or a designated mating area. Breeding boars stationed in dedicated breeding facilities are only removed from their individual enclosures for semen collection purposes (EFSA, 2007). Housing boars in groups may lead to increased aggressiveness and higher risks for injuries and stress (Camerlink et al., 2022). Alternatively, to match the social behaviour requirement, in certain cases, the boar may cohabit with a group of sows and attend to their mating needs as they enter oestrus. In some outdoor systems, boars may be housed in groups, where one or a multiple boars live with a cohort of sows post-weaning, and occasionally, with pregnant sows to detect any returning to oestrus.

Breeding boars are trained to mount a dummy sow for semen collection, typically conducted once or twice weekly (EFSA, 2007). The sexual behaviour of boars is influenced by intrinsic and extrinsic factors, including genetic predispositions, seasonal variations, social dynamics, sexual stimuli, and psychological states (Hemsworth and Tilbrook, 2007). Animal welfare plays an important role in the sexual behaviour and performance of breeding boars. For instance, rearing practices that limit physical contact lead to diminished

sexual behaviour, whereas elevated temperatures exert an adverse effect (Hodel et al., 2021).

Many factors affect semen quality in pigs and the sexual behaviour of the boar (Flowers, 2015; Knecht et al., 2017b), including the design of facilities, the use of prostaglandins to increase libido (Levis and Reicks, 2005) and the environmental conditions (Kunavongkrit et al., 2005). Prior to the housing and management conditions that may influence boar welfare and its reproductive performance, semen production is also linked to the prenatal development of the animal and during the first weeks of life. Despite no evidence is available in pigs, in other mammals (i.e. humans), the quality of life in early life can affect the growth of testicular tissue, and therefore negatively impact the semen quality in the future (Hart et al., 2016) the nutrition being a notable factor (Crisóstomo et al., 2020). In pigs, the way they are handled in their early life has consequences for handling boars in their adult life, so, establishing a positive human-animal relationship since early life is crucial for handling boars and collecting semen later (Hemsworth et al., 1986).

Little information on boar welfare is available in breeding centres. Even in the official report from EFSA (2007) or those of the Farm Animal Welfare Council (2014), there are only a few recommendations on housing and nutrition regarding boars kept for breeding purposes. Hemsworth and Tilbrook (2007) published one of the first manuscripts specifically addressing the welfare of breeding boars. They included locomotory issues and penile injuries, as a result of mounting behaviour, as two relevant welfare issues in breeding pigs. In this regard, it is necessary to draw attention to the design and maintenance of accommodation and mating/semen collection areas to mitigate them (Heinonen et al., 2024). Regular claw trimming may also be necessary to prevent injuries. The EFSA panel on Animal Health and Welfare have recently published a report on pig welfare that includes breeding boars and recognises them as a crucial part of pig production (EFSA, 2022a, 2022b). As identified by the EFSA panel, the most highly relevant welfare consequences for breeding boars are 'restriction of movement, isolation stress, inability to perform exploratory or foraging behaviour, prolonged hunger and locomotory disorders (including lameness)'. Quoting EFSA (2022a), (2022b), however, 'the scientific information on the husbandry systems and the welfare consequences about boars are very limited'.

### 3. Welfare as the absence of suffering

There is scientific consensus that birds and mammals can feel negative emotions such as pain and distress and are hence capable of suffering (Gregory, 2004). In Western societies, the capacity to perceive feelings such as pain and pleasure is perhaps the single most important criteria for the moral status of an animal, according to Lund (2007). Hence, the confirmation of the capacity of an animal to suffer is the basis of the moral obligations of humans towards animals being used for human benefit.

In the recent past, definitions of animal welfare predominantly emphasized biological function, encompassing factors such as health, growth, production, and reproduction, with primary attention directed towards mitigating negative welfare outcomes (Ohl and Van der Staay, 2012). Notable historical definitions include Sandøe and Simonsen (1992) characterization of animal welfare as 'a state in which animals are free of pain and suffering'.

Based on the previous understanding of animal welfare, the prevention of suffering has been mainstreamed in animal welfare science, from the first report of the Brambell Committee in 1965 until now. Animal welfare science has been mostly dedicated to the detection of suffering, and to finding strategies to mitigate it, when possible (Dawkins, 2012). Possible sources of suffering have been investigated in all the phases of animal production, including breeding, rearing, transport and slaughter.

#### 3.1. The five freedoms

For identifying animal suffering it is necessary to develop reliable indicators that can objectively measure it. This has been one of the main focuses of animal welfare science since its conception. The first attempt to design a framework to assess animal welfare was developed by the Farm Animal Welfare Council (FAWC) of the British Government in 1993, by developing the Five Freedoms, a methodology to assess animal welfare using a systematic and comprehensive approach.

The renowned Five Freedoms articulated by the FAWC (1993) include:

- *Freedom from thirst, hunger and malnutrition* - By ready access to a diet to maintain full health and vigour.
- *Freedom from thermal and physical discomfort* - By providing a suitable environment including shelter and a comfortable resting area.
- *Freedom from pain, injury and disease* - By prevention or rapid diagnosis and treatment.
- *Freedom from fear and distress* - By providing sufficient space, proper facilities and the company of the animal's own kind.
- *Freedom to express normal behaviour* - By ensuring conditions that avoid mental suffering.

The Five Freedoms encompass both bodily well-being and psychological distress. They serve as a pragmatic and thorough tool for evaluating the merits and drawbacks of any animal husbandry approach. The objective is not to eradicate stress entirely but rather to avert suffering (not solely 'unnecessary suffering'). Suffering might arise when an animal struggles, or finds it challenging, to manage any potential challenge (e.g. thermal, social or immunological) that may lead to stress (Webster, 2001).

The Five Freedoms were probably the basis of the first objective animal welfare assessment protocols, as they integrated various factors related to the welfare of animals, including health, natural behaviour, and (negative) emotional states. Several methods for objective assessment have emerged in recent years, based on the Five Freedoms model. Among these, the Welfare Quality® (WQ) protocol stands out as particularly promising, primarily due to its focus on animal-based indicators. The evolution of WQ protocols underscores not only diverse interpretations of animal welfare but also prioritizes the feasibility, reliability, and validity of the parameters under consideration.

The Welfare Quality assessment protocol delineates four 'welfare principles', 'adequate feeding', 'suitable housing', 'optimal

health', and 'appropriate behaviour' (Veissier et al., 2011). These principles emphasize practical actions required to attain favourable welfare results, with terms like 'adequate' and 'appropriate'.

### 3.2. EFSA's welfare consequences

More recently, the EFSA proposed a methodology to assess animal welfare based on the consequences that conditions regularly met in animal production could have on the welfare of farm animals. The methodology to determine welfare consequences operates under the premise that the impact of an exposure variable, such as space allowance, on animal welfare can be assessed by comparing the expression of an animal-based measure (ABM) under conditions where the variable is not a factor (e.g., unlimited space) and under conditions of higher exposure (e.g., restrictive conditions). By evaluating the level of welfare through ABMs across various levels of the exposure variable (e.g., varying space allowances), quantitative recommendations can be derived (EFSA, 2022a, 2022b). Like the Five Freedoms approach, the EFSA's welfare consequences rely on negative effects and how they should be prevented to maximise welfare.

For breeding boars, the EFSA panel devised a list of five prominent welfare consequences. Among them, four are consequences derived from the housing conditions (restriction of movement, isolation stress, the inability to perform exploratory or foraging behaviour, and lameness), and one is associated with restriction of food (prolonged hunger).

#### 3.2.1. Restriction of movement

Movement restriction was deemed of utmost importance within individual indoor pens. Despite their substantial dimensions, boars are frequently accommodated in enclosures with restricted space (the minimum requirement of 6 m<sup>2</sup>), leading to significant limitations in their mobility. The prevalence of these conditions is common and boars is extensive and boars often remain in such systems throughout their entire lifespan, from 6 months of age until culling normally at 2–3 years old. Boars have minimal opportunities to gamble outside the pen, except when they are transferred to the service or semen collection areas. The restricted space impedes movement, which is vital for normal pig behaviour like defecation away from resting areas and exploration.

#### 3.2.2. Isolation stress

Confinement in individual crates, which is performed to reduce the risk of aggressions between entire males but also leads to isolation stress. Limited direct contact with other pigs, even if visual, olfactory, tactile, and auditory contact is possible, results in the restriction of social behaviour, which is of utmost importance for gregarious species such as pigs (Gonyou, 2001). This stress persists throughout the time boars are kept in individual pens, which is virtually their entire production life.

#### 3.2.3. Inability to perform exploratory or foraging behaviour

As a result of pen confinement, boars cannot engage in exploratory or foraging behaviours. Often featuring (partially) slatted floors and minimal bedding, these pens offer no chance for exploration or foraging, resulting in severe boredom and frustration. Again, this welfare issue persists over time, probably throughout their lifetime.

Exploratory behaviour is vital for pigs' welfare. The Council Directive 2008/120/EC mandates access to sufficient enrichment material for investigation and manipulation. Boars should have easy access to such material. It should be edible, chewable, investigable, and manipulable.

#### 3.2.4. Locomotory disorders

The limiting housing conditions of breeding boars in indoor individual pens, which normally are fitted with slatted floors and other hazardous surfaces, facilitate the appearance of locomotory disorders, including lameness. These pens typically feature slatted floors without bedding, increasing the risk of foot lesions and locomotory issues (Jørgensen, 2003). This welfare concern persists over time and shows a high prevalence among breeding boars.

#### 3.2.5. Prolonged hunger

Prolonged hunger is the only consequence that is not related to housing. In many occasions, boars receive concentrated diets that meet health and reproductive needs but fail to induce satiety (Pichler et al., 2020). Combined with inadequate provision of roughage or exploration material, this results in a persistent state of hunger for the majority of boars in this system throughout their entire production lifespan.

## 4. Welfare as a life worth living

As stated in the previous Section (3.1 Five Freedoms, and 3.2 Welfare consequences), animal welfare science has mainly focused on negative aspects, where good welfare is understood as the absence of welfare problems. This approach regarded physical health and biological function as the primary factors determining welfare status. This approach was prominent in the late 20th century, with scientific investigations emphasizing biological function yielding significant advancements in farm animal health, longevity, reproduction, and productivity (Fraser, 2008). Such research facilitated welfare improvements by identifying, for instance, suboptimal stocking densities and environmental factors contributing to injury or disease prevalence (Fraser, 2008).

More recently, animal welfare has incorporated aspects of positive welfare, addressing not only the absence of suffering but also a life worth living. In 2009, the FAWC, who - as aforementioned - was the architect of the Five Freedoms approach, acknowledged that 'One criticism of the Five Freedoms is their focus on poor welfare and suffering. This focus was undoubtedly appropriate at the time

they were devised but the requirement to provide for an animal's needs in the new Animal Welfare Acts implies that good welfare should be an ambition too' (FAWC, 2009).

In the intervening years, science has established clear links between biological function and affective state, and it is now recognised that biological processes give rise to affective states, and that affective states can in turn impact biological function (Mellor and Beausoleil, 2015). Unlike previous approaches, primarily centred on addressing negative welfare conditions, modern animal welfare science is placing greater emphasis on promoting positive states (Fraser, 2008), a shift that has garnered significant traction over the past 15 years (Yeates and Main, 2008; Lawrence et al., 2019). Consequently, conceptual frameworks initially devised to address predominantly negative welfare states have required adaptation or expansion of the current definition of animal welfare, acknowledging and fostering positive states (FAWC, 2009; Edgar et al., 2013).

#### 4.1. The five domains

In the context of incorporating positive mental states into animal welfare science, the Five Domain Model appears as a framework to systematically assess and understand the welfare of animals, considering their emotional states, including the negatives but also the positives. First proposed by Mellor and Reid (1994), the model consists of five domains: (1) nutrition, (2) environment, (3) health, (4) behaviour, and (5) mental state. By considering each of these domains, the model provides a comprehensive framework for assessing and promoting animal welfare holistically, taking into account the physical, behavioural, and emotional (including positive) aspects of welfare.

The initial four domains (1–4) focus on internal physiological and pathophysiological disruptions caused by nutritional, environmental, and health-related issues (domains 1–3), as well as external physical, biotic, and social conditions within the animal's environment that may constrain behavioural expression or present significant challenges (domain 4). Following the assessment of these internal and external factors, their anticipated affective consequences are allocated to the fifth 'mental' domain, ultimately shaping the animal's welfare state (Mellor et al., 2009).

The mental domain includes both survival-linked functional conditions and context-dependent behaviours that could be accompanied by positive emotions, thereby improving welfare. In other words, it delineates positive emotions linked to actions aimed at mitigating negative emotions (i.e. satiety as opposed to hunger); and secondly, positive emotions that may supplant negative ones when animals are afforded opportunities to express a wider range of behaviours (e.g., possibility to express natural behaviour).

The Five Domains Model enables a systematic and structured welfare assessment, drawing from current knowledge regarding the functional bases of negative and positive subjective experiences in animals. It is crucial to differentiate between these experiences, collectively termed affective states or affects (Duncan, 2005), and the resultant welfare states. The overall welfare of an animal, represented by its negative-positive affective balance, can encompass neutral as well as negative or positive states (Green and Mellor, 2011).

#### 4.2. Positive welfare

The Five Domain Model revolutionised the interpretation of animal welfare, raising the importance of positive welfare over negative emotions (Freire and Nicol, 2019). Scientific interest in 'positive welfare' gained traction through the review papers of Boissy et al. (2007) and Yeates and Main (2008), followed by the influential report by the UK Farm Animal Welfare Council (FAWC, 2009) outlining a framework for enhancing the quality of life of farmed livestock. Although the FAWC report did not explicitly mention positive welfare, it was influenced by the emerging scientific focus on this concept. After these foundational studies, there has been an ongoing review and advancement of the positive welfare concept (Lawrence et al., 2019; Rault et al., 2020).

Acknowledging positive affective states in animals finds support across various disciplines, including neuroscience and behavioural sciences, which have been examined in several influential reviews (Boissy et al., 2007; Burgdorf and Panksepp, 2006; Kremer et al., 2020). A detailed analysis of the assumption regarding animals' capacity to experience feelings and emotions in a manner akin to humans underscores the difficulty of interpreting the underlying evidence (Mendl and Paul, 2004). Emotions and moods serve to motivate behaviour and potentially guide animals in selecting behavioural strategies for survival and reproduction, and avoiding potential threats (Stankowich and Blumstein, 2005). Negative moods encompass states such as pessimism, anxiety, depression-like states, or boredom (Burn, 2017; Meagher, 2019), whereas positive moods include optimism, a sense of control, security, or competence (Špinka and Wemelsfelder, 2018).

Positive affective states occur when animals experience a favourable immediate condition related to homeostasis, and engage in rewarding goal-directed behaviours led by emotions (Mellor, 2015; Lawrence et al., 2024), and feel generally successful or satisfied, which results in moods (Špinka and Wemelsfelder, 2018; Kremer et al., 2020).

It is important to recognize that while achieving the behavioural objectives of negative motivational states, such as restoring water balance through thirst-motivated drinking, may result in transient positive states (such as the satisfying pleasure of drinking), mitigating survival-related negative affects typically only achieves a neutral welfare state at best (Mellor, 2017). Nonetheless, certain conditions within domains 1–3 may offer opportunities for repeated short-term positive experiences that could contribute to overall welfare. For instance, offering animals a variety of foods with different tastes and textures may lead to enjoyable experiences and prevent the onset of eating-related boredom in monotonous diets (Mellor, 2017). This may be particularly pertinent to pigs, given their omnivorous nature and their tendency to consume a diverse range of foods in natural conditions or when given the opportunity (Stolba and Wood-Gush, 1989).

Situations that hinder or limit the expression of agency-related behaviours, such as living in severely restrictive, oppressive, or



challenging environments, may be associated with various negative affective states, encompassing feelings such as anger, frustration, boredom, loneliness, helplessness, and isolation (Mellor, 2017). In contrast, environments that facilitate the expression of agency, such as an stimulus-rich environment, enabling species-specific motivated behaviours like exploration, hunting, various forms of bonding, or play, may be linked to a spectrum of positive affects, leading to sensations of engagement, pleasure, security, or excitement (Panksepp, 2005; Mellor, 2015). By diminishing or eliminating negative experiences, it may thus be feasible to transition an animal from an overall negative to an overall positive welfare state. This can be achieved by enhancing the physical environment that provides opportunities for voluntary and goal-directed behaviours that can be rewarding to the animal.

## 5. Breeding Boars deserve promotion of positive welfare

Several strategies exist to improve the positive (and global) welfare of breeding boars. These are related to the conditions that have the most notable negative impact, which - according to the latest EFSA report on the welfare of pigs - are the housing environment and nutrition (EFSA, 2022a, 2022b).

Contemporary production systems often feature confined and barren environments, with limited space and access to enrichment material, that offer limited opportunities for pigs to engage in natural activities like exploration and foraging. These behaviours are internally driven and inherently rewarding (Stolba and Wood-Gush, 1989; Boissy et al., 2007). The hindrance of motivated behaviour, or the obstruction of agency, may give rise to various negative affective experiences such as frustration and boredom (Panksepp, 2005). Conversely, by allowing pigs to engage in more species-specific behaviours and/or offering a wider array of behavioural choices may alleviate some negative experiences, and at the same time, potentially enhance their welfare (Mellor and Beausoleil, 2015).

Exploration and play are behaviours towards which pigs show high motivation to perform and that serve as indicators of positive welfare in pigs (Vigors et al., 2019). Play behaviour is nearly universal among mammals and is believed to have evolved as a mechanism for training or preparing animals for unforeseen challenges, aiding in their ability to cope with adversity later in life (Špinka et al., 2001). Furthermore, play is considered to be intrinsically rewarding, and encouraging a play-friendly environment for pigs may therefore improve their welfare. Notably, play behaviour is typically observed in environments where there are no imminent threats to fitness, making it a promising marker of positive welfare (Held and Špinka, 2011). Experimental findings suggest that pigs engage in more play under enriched environmental conditions. For instance, in piglets, play behaviour was heightened by the provision of straw in farrowing and weaning pens, the use of free-farrowing pens instead of crates, maintenance of birth litter composition (rather than fostering), and the addition of straw, bark, and tree branches to barren pens for prepubertal gilts (Lawrence et al., 2019).

Despite the process of domestication, domestic pigs retain much of their 'wild-type' or 'natural' behaviour, as noted by Stolba and Wood-Gush (1989), and there is an increasing body of evidence showcasing their cognitive and affective capabilities. The majority of contemporary pig farming practices, however, continue to significantly limit pigs' behavioural and psychological capacities. Stimulating exploratory behaviour in confined systems can be achieved by providing rooting materials. Several studies have examined the welfare advantages of various types of rooting materials or objects, including straw, peat, sawdust, hanging ropes or chains, tyres, and plastic toys, among others (reviewed by Godyn et al., 2019). A consistent finding across these studies is that materials that are ingestible, chewable, and deformable tend to induce more exploratory behaviours compared to simpler hanging objects like chains or tyres (Godyn et al., 2019; Ocepek et al., 2020). Although straw is often considered the optimal enrichment material for promoting exploratory behaviour, some evidence suggests that a combination of materials (such as straw, silage, peat, or sawdust) may be more effective than a single substrate (Ocepek et al., 2020).

Other than play and exploratory behaviour, affective experiences also emerge from interactions with humans. The quality of interactions between stockpeople and farm animals significantly impacts animal behaviour and welfare (Hemsworth and Coleman, 2011). Negative or aversive handling practices (e.g., hitting, slapping, pushing, shouting) have been demonstrated to heighten fear of humans and are associated with both acute and chronic stress responses, indicative of diminished welfare (Hemsworth and Barnett, 1992). Conversely, positive human-animal interactions characterized by low fear levels and a high degree of trust in humans may inherently reward animals (Hemsworth and Coleman, 2011). Several factors influence the quality of such interactions, including the attitudes, skills, or experience of stockpersons, as well as the tactile aspects of the interaction (e.g., whether it is punishment- or reward-oriented) (Hemsworth and Coleman, 2011).

Integrating regular positive tactile interactions into standard management practices could potentially benefit pig welfare by mitigating the fear towards humans. Consistent gentle contact with humans has been shown to diminish pigs' fear of humans in subsequent encounters and to mitigate negative reactions to future aversive situations. For instance, piglets that receive regular stroking or patting sessions during early life exhibit reduced fear of humans later on (Hemsworth and Barnett, 1992). Piglets gently stroked during suckling on their first day of life display reduced responsiveness to tail docking the following day (Muns et al., 2015). Regular positive handling can establish a bond between the animal and handler, potentially evoking positive emotions upon approach and contact with familiar human handlers (Tallet et al., 2024). Incorporating positive tactile interactions such as belly-rubbing, patting, scratching, or stroking into routine management practices may thus promote short-term welfare through positive experiences, while also offering long-term benefits such as stress resilience (Rault et al., 2020). These practices may impose risks for the stock workers if performed by hand. To minimise risks when interacting with adult boars, they should be performed using objects. Further research is necessary to develop effective tools to positively interact with breeding boars. Additionally, if interactions with familiar humans are predominantly positive, pigs may generalize this positive response to unfamiliar humans as well (Rault et al., 2020).

The impact of positive welfare on such male reproductive measures as libido, semen quality and amount and longevity in the breeding barn is poorly investigated and more research is recommended. Similarly, the economic trade-offs of implementing strategies promoting positive welfare should be explored, as there are no evidence in the literature about the impact of the promotion of positive

welfare to the economic return in the breeding of reproductive boars.

## 6. Conclusions

The Europe's progressive legislative framework and the growing consumer demand is pushing for ethically sourced farm animal's products. Besides, the association between animal welfare and performance makes the improvement of animal welfare attractive also for producers. To improve the welfare of breeding boars, there are still some sources of suffering to alleviate, notably restricted movement and prolonged hunger. The evolution of animal welfare science, however, has expanded beyond the traditional focus on alleviating suffering to encompass promoting positive states, reflecting a shift towards acknowledging animals' emotional well-being and a life worth living. The Five Domain Model offers a systematic approach to assessing welfare, emphasizing the importance of considering both negative and positive affective states. Strategies to enhance the positive welfare of breeding boars involve improving housing and nutrition, facilitating exploratory behaviour and play, and promoting positive interactions with humans. For an overall improvement of the welfare of breeding boars, the prevention of suffering must go aligned with the prioritisation of positive welfare outcomes by implementing proactive measures, such as enriching environments and fostering positive human-animal relationships.

## Ethics statement

Not applicable

## Competing interests

The author declares that there are no competing interests.

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## Declaration of Competing Interest

None.

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