Animal Welfare Institute

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American Veterinary Medical Association
1931 North Meacham Rd., Suite 100
Schaumburg, IL 60173-4360

Re: Comment on AVMA's Policy on "Pregnant Sow Housing"

Dear American Veterinary Medical Association Animal Welfare Committee,

Thank you for the opportunity to comment on the American Veterinary Medical Association's policy on "Pregnant Sow Housing" and related resources linked on the policy's webpage. I submit these comments as a long-standing AVMA member and practicing veterinarian, and on behalf of the Farmed Animal Program of the Animal Welfare Institute (AWI), for which I am a veterinary medicine consultant.

We share the AVMA's belief, articulated in its animal welfare principles, that "[a]nimals should be cared for in ways that minimize fear, pain, stress, and suffering," and that "[p]rocedures related to animal housing . . . should be continuously evaluated, and when indicated, refined or replaced."[1] In addition, we support several aspects of the current policy, including the statement that pregnant pigs should be provided with "adequate quality and quantity of space" that allows expression of "normal patterns of behavior" and the recognition of the importance of ongoing training for people handling and working with pregnant sows "to ensure that they are able to provide and promote good welfare."

However, we recommend substantial revision of the policy, as well as the supporting documents linked on the policy webpage, to reflect updated conceptions of animal welfare[2–6] and the latest scientific research regarding: (1) the physical, psychological, social, and welfare needs of pigs[4,7–11]; (2) the impact of different pregnant pig housing systems on physical and psychological health and well-being of both mother and offspring[12–19]; and (3) facility design and management practices demonstrated to mitigate animal welfare hazards associated with group housing systems.[11,20–22]

Most fundamentally, as described below, it is now a matter of settled science that gestation crates/stalls inherently prevent pregnant pigs from achieving a minimally acceptable level of animal welfare.[7,11,23–27] In addition, continued use of gestation crates does not align with societal ethics.[28,29] The Pew Commission recommended in 2008 that gestation crates be phased out within a decade.[30] American "[v]oters have banned close-confinement gestation crates every time the question has been put on the ballot, including in states that differ in their political composition"[31]; lawmakers in additional states have also enacted legislation or regulations to the same effect.[32] Research has consistently found that more than two-thirds of US consumers support a ban on gestation crates.[28,29]

Major pork producers, such as Smithfield, have already transitioned their company-owned farms in the US to group housing for all confirmed pregnant sows and have recommend that all of their contract sow farms do the same.[33,34] In 2012, 76.6% of large operations (500 or more sows) and 49.3% of medium operations (250-499 sows) utilized individual housing;[35] in 2021 (the most recent year for which data is available), these percentages had dropped to 61.3% and 18.3% respectively.[36] Concerns about the potential negative impacts group housing might have on productivity have essentially been laid to rest.[24,27,37–39] The Economic Research Service (ERS) noted that Canada and the European Union (EU), the

top two sources of pork imported into the US, have policies and pledges in place regarding gestation crates that position them to be able "to supply policy-compliant pork to States with retail sales restrictions on pork produced in gestation crate systems."[40] The ERS report also alluded to the fact that the US pork trade opportunities could be restricted in the future, as animal welfare considerations and livestock production practices are increasingly incorporated in bilateral or multilateral trade agreements.[40] Given these shifts, the AVMA should clearly indicate that gestation crates result in lower welfare outcomes than properly designed and managed group housing systems.

While gestation crates are inherently unable to provide pigs with a minimally acceptable level of welfare throughout their lives, the level of animal welfare in other housing systems, such as indoor group housing or pasture-based systems, is strongly influenced by factors such as layout, design, and management factors. Animal welfare can be good or poor in these systems, and there is a growing need for evidence-based recommendations on how group housing systems must be constructed and managed if animal welfare is to be protected. As such, we encourage the AVMA to shift its position from one of "there are advantages and disadvantages to any sow housing system" to one in which it explicitly encourages the transition from gestation crates to group housing and provides substantive, evidence-based recommendations regarding how to maximize welfare in group gestation housing systems.

Contents

I. Porcine Natural History, Mental Capacities, and Pregnancy-Associated Physical & Behavioral Needs

In order to evaluate animal welfare, it is necessary to consider not only physical health, but the natural history of the species and their cognitive and psychological capacities.[7,41] Furthermore, the physical and psychological changes that occur during pregnancy and impending parturition mean that pregnant animals have additional needs that must be taken into consideration if their welfare is to be protected.

Domestic pigs are descended from wild boars, whose genus appears in the fossil record during the Miocene era (5 to 23 million years ago).[41] Domestication occurred relatively recently (5,000 to 9,000 years ago in several different locations independently). Despite artificial selection for traits relevant to domestication and meat production, the cognitive and psychological characteristics and behavioral repertoires of modern pigs remain similar to their wild ancestors.[7,9,42] This is demonstrated by observing the behavior of pigs who become feral or are permitted to roam freely in a semi-natural environment. Research indicates that, in this context, pigs visit approximately five different areas in their home range daily, spend about 75% of their active time foraging (including grazing and rooting), and build communal nests to sleep in during the night.[41,43] Pigs raised under commercial conditions remain highly "motivated to investigate and explore their environment as an end in itself, independent from the goal of finding food."[44] Pigs urinate and defecate away from nesting sites.[7,41]

Research clearly demonstrates that pigs are cognitively complex animals.[8,9,45] Because of their evolutionary history as a social species reliant on foraging, pigs are highly inquisitive and have advanced learning abilities. Under natural conditions, they continually engage in exploratory behaviors in order to create a detailed mental representation of their environment, including the location, amount, and relative value of food items, an ability that has also been documented in research setups.[8,45,46] Pigs' highly innervated snouts allow them to both take in extensive information about their environment via touch and smell, and to manipulate it via rooting, carrying, scooping, pushing, and levering out thick roots.[7–9,43] Research also shows that pigs have long-term memory, experience the passage of time, and anticipate future events.[9] In fact, when required to choose a longer or shorter duration of a non-preferred activity (confinement to a small crate, in one experiment), they will typically choose the shorter duration.[47]

Recent research has found that, when kept in social groups under semi-natural conditions (barn with access to a pasture), domestic pigs develop social preferences, specifically "dyadic affiliative preferences," i.e., individual pigs with whom they prefer to rest, explore their environment, and engage in affiliative contact behaviors, such as social nosing.[48] (Such relationships would likely be referred to as "friendships" by laypeople or by scientists studying similar behavior in humans or in charismatic wildlife, such as chimpanzees or elephants.[49–51]) Pigs have a wide range of vocalizations with which they communicate with one another, and these vocalizations are "highly referential, giving detailed information on the identity of the caller, as well as [their] affective state (both arousal and/or valence), cause of distress, and physical status."[8] Similar to what we observe in canine patients, pigs can learn to

comprehend gestural and verbal symbols used by humans to represent objects and actions.[9] They can even comprehend a combination of such symbols, such as following the verbal cue "fetch the frisbee" to retrieve the intended object rather than another.[9] Research has demonstrated that pigs can learn to use a joystick to manipulate a cursor on a computer screen to achieve a given goal, and they perform considerably better than dogs.[9,52]

Since the AVMA last reviewed the literature on pregnant sow housing, there have been significant advancements in porcine research regarding affective states, including emotions (which are typically relatively intense and short-lived) and moods (long-term states that reflect the cumulative impact of many stimuli over time).[8] Affective states are understood to be comprised of behavioral, physiological, cognitive, and subjective components.[8] Means of evaluating the first three of these components in pigs have been developed, including judgement bias tests, attention bias tests, and open field- novel object tests.[8,53] Research indicates that pigs are capable of developing a depression-like state characterized by serotonin depletion, pessimism, anhedonia, and lack of motivation.[8,53,54] Additionally, pigs have been shown to understand and respond to the emotions of other pigs.[9]

Late in pregnancy, pigs, like other mammals, can face many challenges that potentially impact their welfare, such as general discomfort, difficulty maneuvering their enlarged bodies, and difficulty sleeping and resting.[55] The welfare needs arising from pregnancy are especially pressing for pigs because they have been bred for increased litter size, potentially making comfort in late pregnancy more difficult to achieve.[55,56] In addition, behaviors in the perinatal period are strongly mediated by the pregnancy hormones prolactin and progesterone, and motivations to perform these behaviors persist even under conditions of modern agriculture.[57]

When released from confinement to semi-natural enclosures, modern sows quickly revert to the behaviors of their wild boar ancestor, especially during pregnancy, parturition, and nursing.[10,41,43,57] The wild sow spends most of the year living in a small group of related females until, shortly before parturition, she increases her activity level and begins roaming away from the group, often traveling long distances in search of a suitable nest site.[57] Domestic sows kept in pens that permit locomotion have been documented to walk the equivalent of over 18 miles in the days leading up to parturition and choose farrowing locations that are enclosed or against a wall.[57] Wild sows build complex nests: they begin by creating a concave depression via digging and rooting, and then gather and carefully arrange a variety of grasses, leaves, and sticks; branches up to 6 ft. in length are even used to camouflage the nest.[41,57] In the agricultural context, research has found that sows experience "frustration or injuries when having difficulties in moving or expressing prepartum [nest-building] behaviour, resulting in an increase in stress levels and a decrease in maternal endogenous hormones."[58] Providing sows with nesting materials prior to farrowing decreases restlessness, stimulates maternal care, and decreases risk of aggression directed at neonatal piglets.[59]

II. Inability of Gestation Stall Housing to Provide a Minimally Adequate Level of Welfare

For most of human history, pregnant pigs were not intensively confined for any part of their life cycle. Gestation stalls were originally developed in the late 1960s as a means of temporarily confining pigs, however, they began to be widely used to permanently confine female breeding pigs in the 1980s and 1990s.[60] On average, pregnant sows weigh 529 lbs., though larger sows may exceed 790 lbs.,[61] yet gestation stalls provide only 14 square feet (sq. ft.) of space given their small dimensions: 6.5-7.5 ft. long by 1.8 to 2.5 ft. wide.[62,63] As such, pigs are limited to standing in one place, laying down, and sitting. Even transitioning between these three options is difficult because the crates are often designed around their static space requirement (i.e., the amount of space used by the sow when she is standing or lying stationary), which is significantly smaller than the space required to change posture normally from

standing to lying and vice versa.[42,64] When provided with sufficient space to turn around, research has found that sows will do so nearly 200 times per day.[65]

In operations that utilize gestation crates, sow typically spend nearly their entire lives, starting at 7 months of age, confined in either a gestation crate or a farrowing crate, both of which restrict movement to a similar degree. Research indicates that a sow has an average of 3.5 litters prior to being culled, though some sows may survive to have over a dozen litters.[66]

The AVMA policy and associated materials note that confinement to gestation stalls negatively impacts behavioral expression and contributes to stereotypies and confinement injuries. However, they understate the severity of harm associated with these disadvantages and fail to discuss numerous additional physical and psychological harms associated with use of gestation crates. These materials also presume an outdated conception of animal welfare that focuses almost exclusively on minimizing negative experiences, such as pain, rather than considering the potential of various housing systems to provide positive animal welfare.[4–6]

A. Impact on Psychological Health

Confinement to a gestation crate frustrates numerous highly motivated natural behaviors, including walking, running, rooting, foraging, exploring, wallowing, grooming, nest-building, playing, socializing, comfortable resting, adjusting posture and body contact with others for thermoregulation, and urinating and defecating in an area not used for resting or eating.[11,67] Pigs kept in gestation crates can do little besides eat, stand, sit, and lie in their own waste. Gestation stalls are unable to comply with the World Organization for Animal Health (WOAH) standards that pigs be provided with separate areas of eating, lying, and excreting waste.[68] Research has demonstrated that both sows and gilts are willing to "work" to escape confinement in a gestation stall for just three minutes, even to a non-enriched environment devoid of food (in one study, this work entailed pushing a button with their snouts dozens or hundreds of times).[67]

Gestation stalls prevent normal social interactions.[7] Despite claims that gestation stalls protect sows from aggression, research has found that while crated sows may not be able to compete for resources, group stress and aggressive interactions between neighboring pigs persist because a dominance hierarchy cannot be established and aggression cannot be resolved.[11,16,69] The average duration of fights between stalled sows has been found to be longer than fights between group-housed sows and aggressive interactions continued to occur for a longer period in stalled sows.[23] Sows are unable to engage in non-agonistic behaviors (i.e., behaviors not related to conflict or aggression) when they are housed in individual stalls.[16] A study published in 2014 found that, at numerous points during pregnancy, sows housed in individual stalls performed agonistic behavior (such as trying to bit one another) significantly more than socially housed sows.[16] In contrast, socially housed sows performed more non-agonistic social behaviors, such as nose-to-nose interactions, compared with sows in stalls, and the difference between the two groups increased as pregnancy progressed.[16]

As such, it is unsurprising that sows confined to gestation crates frequently exhibit abnormal behaviors. These may take the form of (1) stereotypies, which manifest as frequent, repetitive, functionless, and invariant movement patterns, or (2) a condition referred to as "apathetic" behavior, low-responsiveness, or even clinical depression, characterized by a low level of activity and decreased responsiveness to external stimuli.[70–73]

1) Stereotypies

Ever since the 1980s when the pork industry first began to confine sows in gestation crates, research has shown that stereotypies occur many times more often and with much higher intensity in stall-housed sows compared to those in group housing.[15,71,73–76] As mentioned in the 2005 *JAVMA* review of housing for pregnant sows, there is a "strong consensus" that "stereotypies are an indication of welfare problems."[77]

There are several different types of stereotypies. Stereotypies develop in response to welfare problems such as chronic hunger (discussed further below), immobilization, lack of environmental stimulation, frustrated behavioral needs, and inability to have normal social contact. The most common stereotypy is called "vacuum-, sham- or empty-chewing," and refers to continuous chewing behavior while no feed is present in the mouth. Some studies have documented sham chewing occurring hundreds of times per day, occupying 50% to 75% of the sow's waking hours.[54,78] Other stereotypic behaviors include bar-biting (literally chewing the metal bars of the crate for extended periods), trough-biting, rooting with the snout (in the absence of any substrate in which to root), head-weaving, and pressing drinkers without drinking.[15,71,78] Research has documented crated sows spending 5 to 30% of the day bar-biting and 35-38% of the day performing stereotypic rooting.[54,72] Recent research has also found that virtually all sows confined to gestation crates for a prolonged period will develop stereotypies, but their severity and frequency vary with how long the sows have been confined, their stage in pregnancy, and how many parities (pregnancies) they have endured in gestation crates.[54,78]

2) Low responsiveness, apathetic behavior, and anhedonia

The other type of abnormal behavior, "low responsiveness," was first described in the 1980s as "apathetic behavior."[70,71] Researchers noted that sows confined to gestation crates for a prolonged period reacted to environmental changes and novel stimuli in a very different way than sows kept in group housing.[70,71] For example, one experiment examined the reaction of awake, lying sows to the experience of having about 7 ounces of room-temperature water poured on their backs. While sows kept in group housing generally sat or stood up within 30 seconds and performed a range of behaviors such as vocalizing, shaking their bodies, and raising their heads, individually-crated sows failed to change body positions for a long period (median 12 minutes, with many sows failing to sit or stand up for over 20 minutes). They also performed far fewer normal behaviors in response to the stimulus. The authors concluded: "Lack of responsiveness is an indicator that the animal is having to modify its normal functioning considerably in order to cope with its environment so its welfare is bad."[70]

More recent research has utilized newer methods of evaluating mood and mood disorders. The pupillary light response has been investigated in various species, including humans, as a sensitive indicator of psychological states, particularly to measure autonomic function.[79] A study published in 2013 compared the latency of pupillary light reflex between pregnant sows housed in gestation stalls with that of sows housed in groups with just under 34.5 sq. ft. per animal.[79] Sows confined to gestation stalls were found to have a significantly longer latency (time until the pupil constricted to its minimum size) compared to group-housed sows.[79] Similar prolongations have been noted in humans with anxiety disorders.[80] Because the stall-confined pigs also performed more stereotypical behaviors, the authors suspected that the prolongation of the pupillary light reflex (PLR) was related to chronic stress or depression.

In 2022, another study, performed by a different research group, evaluated pupillary light reflex latency of gestation stall-confined sows of different parities (number of litters) and its association with the results of other tests intended to assess affective state.[54] They noted that sows with a weak pupillary light reflex took significantly longer to approach a novel object and explored it much less than pigs with

a strong pupillary light reflex, indicating increased fearfulness. In addition, the more pregnancies a sow had undergone, the more her performance on the novel object test indicated fearfulness. Further, parity impacted the results of the sucrose response test, a common means of assessing animals' reward stimulus response which can provide information about their affective state. Higher parity sows had a significantly lower response to sucrose solution (which typically causes enjoyment in pigs), and there was a tendency for sows with a weaker pupillary light reflex to also have a lower response to the sweet solution. Based on their results and research in other species, the researchers suspected anhedonia (inability to feel pleasure) and a depression-like condition had developed in many of the stall-confined sows and recommend use of PLR as a means of evaluating affective state in this species.[54]

B. Impact on Physical Health

It is clear that comfort is severely compromised by gestation stalls.[7] Lack of bedding and sufficient space to maneuver, combined with inability to adopt a normal lying position and avoid constant contact with feces and urine, prevent physical comfort. In addition, inability to perform thermoregulatory behaviors precludes thermal comfort when ambient temperature is too warm or too cold. The restrictions on movement and behavior imposed by gestation crates also lead to a range of physical health problems, some of which are not adequately discussed in the AVMA's policy and associated materials.

1) Musculoskeletal

Long-term confinement to gestation crates "affects muscular conformation and bone strength in sows, increasing susceptibility to fracture" and making it more difficult to change positions.[81] Osteoporosis leading to brittle bones can be related to lactation and lack of sunlight, and thus can affect sows in various housing systems; however, lack of exercise due to constant crate confinement worsens the condition.[82] Total bone mass of stall-housed sows has been found to be lower than that of group-housed sows.[14] Both the humerus and femur of crated sows have significantly lower breaking strength compared with those of group-housed sows, and the proportional weight of locomotory muscles is lower in the crate-housed sows.[81] When compared with group housed sows, "sows housed long-term in gestation stalls experience difficulty of movement with standing up quickly and lying down."[64]

In addition, the oral stereotypies exhibited by sows confined to stalls can be severe enough that they result in "asymmetric bone development causing protrusion of the lower jaw or mandibular misalignment."[83]

2) Urinary

Bacterial cystitis (bladder infection) is a painful condition that is frequently diagnosed in sows housed in gestation crates, who develop them more commonly than group-housed sows.[84] Crate systems do not permit sows to have a separate area for resting and for defection.[13] In addition, sows kept in crates adopt an abnormal "dog-sitting" position about 8 to 30 times more frequently than sows kept in social housing,[75,85] and, as described in the 2019 veterinary textbook, *Diseases of Swine*, "[t]he dog-sitting position helps to force fecal material into the vagina."[86]

In addition, stall confinement and inability to walk around can contribute to urine stasis/retention, another risk factor for urinary tract infection.[13,86] Lack of exercise is implicated in cystitis-pyelonephritis complex of multiparous sows, in which chronic infection of the bladder facilitates vesicoureteral reflux, the retrograde flow of infected urine into the ureters and ultimately the kidneys.[87] Because of the connection between prolonged confinement and urinary tract infections, *Diseases of Swine* recommends providing pigs with access to an exercise yard to increase frequency of urination.[86]

3) Gastrointestinal

Confinement to gestation stalls and the attendant lack of exercise causes constipation, a condition that is uncomfortable and/or painful for the sow, can prolong the duration of farrowing by creating a physical obstacle to birthing, and may increase risk of gastrointestinal torsion.[13,88,89] Constipation is also a risk factor for postpartum dysgalactia syndrome.[88] In addition, constipation is reported to play a role in causing rectal prolapses due to straining during defecation.[90]

Constipation may not be the only means by which gestation stalls increase risk of rectal prolapse. One study found numerous prolapses in sows confined to gestation stalls but none in group-housed sows on the same farm.[90,91] In the affected sows, there were no other identified risk factors for rectal prolapse, and the investigators concluded that the parallel bars of the back retaining gait applied pressure on the anus.[91] Gestation stalls with excessively sloped floors have also been implicated in rectal prolapse, due to the increased pressure on pelvic structures during more advanced stages of pregnancy.[92]

4) Integument

Numerous skin conditions are caused or exacerbated by confinement in gestation stalls. Research has found that "gilts show an intense behavioral reaction on first introduction to gestation stalls resulting in injuries," particularly wounds to their forelimbs.[11,93]

Because of the small size of crates, sows' bodies, which expand during pregnancy, are compressed against or often protrude outside the bars of the crate.[61] In addition to causing continuous physical discomfort, the constant pressure and friction with the bars can cause skin lesions, which are painful and prone to becoming infected. Skin lesions can include injuries from protruding cage parts or decubitus ulcers.[94] In one study of 267 sows in gestation crates, 126 had, at minimum, five to 10 superficial injuries and up to two deep (>0.5cm) wounds.[62] Limb injuries were determined to have been caused by the sharp edges of the crates' slatted floors and being stepped on by neighboring sows when attempting to adopt a normal side-lying position.[62] Lesions on the back were determined to be caused by pressing the back forcefully against the sides of the stall in an attempt to adopt a side-lying posture.[62]

In female pigs who have had more than one litter, skin necrosis and trauma are common conditions, often affecting the shoulder, hip region, and side of the jaw, which are caused in part by the pressure of lying for long periods on hard floors.[95] Frequent exercise is considered a means of prevention.[95]

5) Immune Function and Disease Risk

As the AVMA has noted in its 2005 review of pregnant sow housing, the stress response culminating in an increase in blood cortisol levels impacts immune response by various mechanisms, including inhibiting immune cell function.[77,96] A recent study supports this, documenting the in vitro inhibitory effect of glucocorticoids on porcine lymphocyte proliferation and on production of the pro-inflammatory cytokine, TNFα.[97] Other research has found that high glucocorticoid levels promote intracellular proliferation and recrudescence of *Salmonella* Typhimurium.[98]

When the AVMA's review was being written 20 years ago, the authors concluded that "stall housing is not more physiologically stressful to sows than group housing."[77] However, more recent research strongly suggests that, under current commonly-employed management conditions, pregnant pigs in group housing have lower stress hormone levels than in pigs kept in gestation stalls, and the difference in stress hormone level is even more pronounced when group housing includes enrichment and/or well-maintained deep straw bedding.[12,19,93]

For example, a 2021 study found that sows kept in crates had higher stress hormone levels (adrenocorticotropic hormone [ACTH] and cortisol) than sows in group housing systems with electronic sow feeders at all time points checked (41 days, 71 days, 101 days).[15] Statistical significance was noted for ACTH at 41 days.[15] A 2015 study comparing gilts in individual gestation stalls with those in group housing with an electronic sow feeder system found that the crated gilts had statistically significantly higher cortisol levels at 110 days of gestation compared with the group-housed gilts.[14] A study published in 2022 found that, in crate confined sows, stereotypies such as sham-chewing and trough-biting correlated positively with serum cortisol levels.[78]

In the past two decades, research has also brought to light the harmful impact of high catecholamine levels, not only on mammalian immune function,[96,97,99] but also on the virulence traits of specific pathogens and the pathogens' ability to inhibit mammalian immune function.[100–103] For example, when grown in the presence of catecholamines, *S.* Typhimurium exhibits enhanced motility and reduces porcine lymphocyte proliferation.[100,102] Research has found that the catecholamines epinephrine and norepinephrine affect gene expression (including many virulence genes) in the porcine respiratory pathogen, *Actinobacillus pleuropneumoniae*.[104] In the presence of norepinephrine, *Campylobacter jejuni*, a pathogen which causes serious foodborne illness in humans, exhibits increased virulence-associated properties.[105]

Catecholamine levels appear to be higher in pregnant pigs confined to gestation stalls, compared with those in group housing. For example, the 2021 study mentioned above found that adrenaline (epinephrine) levels were numerically higher for sows in gestation stalls, compared to those in group housing at all time points checked and reached levels of statistical significance at 41 and 71 days of gestation.[15]

Finally, in vivo research has documented a connection between housing and immune response. For example, research published in 2013 found that sows housed in groups had a more effective immune reaction to experimentally-induced insult, suggesting better ability to mount a response to primary infections compared with sows housed in individual crates.[106] A study published in 2011 found sows housed in individual stalls were 2.6 times more likely to shed *Campylobacter* in their feces.[107]

6) Cardiovascular

Sows' inability to exercise during the course of their lifetime reduces cardiovascular fitness, as demonstrated by a higher resting heart rate compared to sows in group housing.[108]

7) Reproductive

Crate confinement during pregnancy appears to increase the incidence of stillbirths, a phenomenon referred to as the confinement-stillbirth hypothesis.[109,110] When strongly motivated behaviors such as nest-building are frustrated, the sow's level of stress increases and levels of maternal endogenous hormones, such as oxytocin, can decrease, potentially having a detrimental effect on both mother and piglets by prolonging birth intervals.[58,89,109,111] Nursing performance and maternal characteristics can also suffer.[58]

Pregnant pigs confined to gestation crates have an increased duration of farrowing, a welfare concern for both the mother sow, due to prolonged discomfort, and her piglets, as longer farrowing increases the number of piglets who will be stillborn.[14,89] Research has shown that farrowing lasts an average of 1.5 hours (42%) longer in sows who are crated during the 2 weeks before giving birth compared to those who are able to walk and turn around during the same period.[112] In one study, the mortality rate for piglets whose mothers were permitted more space during gestation was significantly lower during the

early hours after birth, especially when deep straw was provided for pregnant pigs during gestation, compared to those whose mothers were confined to smaller areas.[12]

C. Impact on Offspring of Maternal Confinement to a Gestation Stall

In addition to increasing the risk of piglets being stillborn or dying soon after birth, confinement of pregnant mothers to gestation crates has now been shown to impact the health and welfare of their offspring long after birth, presumably through epigenetic mechanisms.[113] Research from as early as 2006 has documented a difference in behavior between piglets born to gilts in gestation stalls and those born to gilts in group housing, with the former group exhibiting more distress (increased grunting and squealing) when socially isolated and more difficulty with weaning.[114]

More recent research has identified various mechanisms by which prenatal stress impacts the immune function of offspring.[115] One study found that piglets whose mothers were kept in gestation crates during pregnancy had higher cortisol levels and other markers of physiological stress, and lower levels of lymphocyte proliferation, during the three weeks after birth compared to those whose mothers were kept in free-movement housing.[84] In another study, offspring of stall-confined sows were found to have lower resistance and resilience to disease as determined by a lipopolysaccharide (LPS) test, a model of the inflammatory response.[15] Compared with piglets whose mothers were confined to gestation crates during pregnancy, piglets born from group-housed mothers had lower levels of stress hormone (cortisol) in response to the LPS test, and their fever and other symptoms resolved more rapidly.[15]

Additionally, prenatal stress negatively impacts offsprings' emotionality and behavioral tendencies, including the ability to provide maternal care in the future.[18,113] Female piglets born to mothers who experienced stress in mid-gestation "have their brain development shifted towards a pro-anxiety phenotype."[18] When mothers expressed stereotypies during pregnancy, the amygdala, or emotional center of the brain, of male offspring exhibited extensive epigenetic changes.[113] In line with this finding, other research has documented that emotionality of offspring is impacted by whether their mothers exhibit stereotypies during pregnancy.[17] As discussed above, it is well documented that pregnant pigs confined to gestation stalls exhibited markedly more stereotypies compared to pigs in group housing, particularly when group housing is enriched. [15,71,73–75,116]

III. Group Housing: Animal Welfare Hazards and Mitigation

Group housing is widely recognized as a superior option for pregnant pig welfare because it has the potential to permit normal bodily movement, social behavior, locomotion, exploratory behavior, and separate areas for lying and elimination.[11,20,26,27,73,117] Of course, group housing does not automatically ensure a good or even minimally adequate level of animal welfare. Being provided with enough space to walk around, turn around, and lie down without impediment is a necessary condition for good animal welfare, but not a sufficient one. However, the possibility that welfare can be poor in group housing systems is not a reason to continue to support housing systems that rely on gestation crates. As explained in one recent paper, "while disadvantages … in the group system could potentially be overcome … it is not possible to address the inherent deficiency of stall housing."[26] Thus, as a science-based and animal-focused veterinary association,[118] the AVMA should advocate a transition to group housing, provide evidence-based information on how associated welfare hazards can be mitigated, and encourage legislation, policy, and practices that protect and promote pregnant pig welfare.

A. Potential Welfare Hazards

1) Social Stress, Aggression and Associated Injuries

Animal welfare can be negatively impacted by aggression and the injuries, pain, fear, and stress that can result from aggressive encounters.[119] Relative to other species, pigs are not highly aggressive. Under natural conditions, group structure consists of several related female pigs who synchronize their activities (including birthing), cooperatively defend their piglets against predators, and care for each other's offspring to allow one another to forage more efficiently.[41] Aggressive behavior within these groups is rare. Sows have a loosely linear dominance hierarchy within these stable groups, which is typically maintained by subordinates avoiding conflict, rather than frequent attacks by dominant individuals.[120]

Under commercial conditions, aggression is more common in part because groups are usually far larger than under natural conditions and are created by mixing unfamiliar, unrelated sows.[119] In addition, since the use of gestation crates became common, "breeding companies often largely focused their efforts on genetic selection based on individual production characteristics (e.g., litter size, piglets' growth, and meat quality) and traditionally ignored the social behaviors and the ability to establish a dominance hierarchy without exacerbated aggression."[121] Thus, increased aggression may have inadvertently been selected for in recent decades.

When unfamiliar pigs are mixed, fighting and other forms of aggression typically peak two hours after mixing and decrease significantly afterward due to formation of a hierarchy.[119,120] Once a hierarchy is established, aggression occurs primarily because of competition for limited resources, especially at feeding.[120,122] Frustration has also been shown to trigger aggression.[123] Once groups are established, aggression tends to involve little to no fighting, instead taking the form of a single "aggressive bout," such as a knock or bite, displacement, or display of a threat behavior.[119]

Aggression levels in newly formed groups of sows have been shown to remain elevated when access to feed is restricted,[119] which is likely related to the welfare problem of chronic hunger discussed below. Vulva biting in particular can be seen when sows must compete for limited feed or must queue while waiting to be fed.[94,117,122] Fortunately, as described below, extensive research has been performed that identifies means of mitigating aggression during mixing and after a dominance hierarchy has been established. Because aggression is a moderately heritable characteristics, producers, breeders, and their veterinarians have the opportunity to mitigate aggression via genetic selection.[121,124–126]

2) Nutritional Challenges and Chronic Hunger

The nutritional requirements of breeding female pigs may vary depending on a host of factors including body condition score, age, ambient temperature, and parity.[127] Meeting nutritional needs in group housing systems is possible through a variety of feeding strategies, though their effectiveness and welfare consequences may vary based on other factors. Regardless of feeding system, aggression and stereotypies remain a concern in group housing systems when sows experience chronic hunger due to restricted feeding.[126] Sows are typically provided a restricted amount of food, rather than being fed *ad libitum*, or "to appetite." This is because they have been bred for the rapid lean growth producers desire in their offspring and for large litter size, both of which have selected for increased appetite, so *ad libitum* feeding can result in obesity.[128] Excess weight gain can result in higher risk of lameness and early death or culling.[128] In addition, producers have a financial incentive to reduce feed costs.

Unfortunately, restricted feeding has long been documented to cause chronic hunger in sows and boars, as evidenced by behavioral observations and experiments that assess motivation to access additional food.[129,130] For example, pigs fed 60% of their ad libitum feed intake were willing to press a lever several

hundred times to access a small amount of additional feed.[130] Recent research has found that, given access to unlimited food, sows ate over twice their usual daily ration.[131] Given the percent of time sows would spend foraging and eating in a natural environment,[41,43] it is unsurprising that stereotypies can result when concentrated feed is rapidly devoured, yet sows remain hungry and lack foraging opportunities.[128] As described below, considerable research has been done on means of reducing hunger while restricting energy intake.[128]

3) Lameness

Higher risk of lameness is frequently cited as a potential disadvantage of group housing,[13,26,39] though some studies have found no difference[132] or even lower lameness rates in group-housed sows compared with those in stalls.[24] Lameness can result from a range of underlying pathologies; however, it is a serious welfare concern regardless of cause because of associated pain, other negative affective states, and higher cortisol levels,[116] as well as because it impairs pigs' ability "to compete for resources and increases lying time which may give rise to pressure injuries, e.g. calluses and bursitis."[11] Because lameness can result from injuries that occur during mixing and as a results of aggressive encounters, measures known to mitigate aggression are also means of mitigating lameness.[11]

Lameness rates can vary significantly with flooring type (solid, partly slatted, fully slatted) and properties of flooring materials (slip-resistance, abrasiveness, surface profile, and hardness).[13,133] Fully slatted floors are particularly problematic in terms of increasing risk of lameness.[11] According to a 2016 review of health impacts of group housing, "the odds of being lame on slatted floors is twice as high compared to nonslatted floors, 4.6 times higher compared to solid concrete floors with deep bedding and 4.8 times higher than in sows housed outdoors."[13] Slatted floor can be especially problematic as they become worn and chipped, but even when they are in good condition, they unevenly distribute pressure on the claws, leading to lameness-inducing claw lesions.[13]

An environment that is dirty with excreta and urine also contributes to lameness, as it is damaging to the hooves and acts as a reservoir for pathogens that can infect even minor wounds.[11,133] Poor drainage and insufficient cleaning can result in poor hygiene, as can insufficient bedding in areas of solid floors.[11]

Means of reducing lameness risks via the living environment are described below. However, incorporating early lameness detection and aggressive treatment into management strategies is also important.[134,135] For examples, precision farming technology, such as accelerometers incorporated into ear tags, can enable early, automated detection of lameness, while also monitoring other health- and welfare-related parameters.[136–138]

4) Insufficient Opportunities for Natural Behaviors, Positive Welfare and Agency

A final welfare hazard of group housing systems for sows and gilts is behavior restriction. That is, as commonly constructed and managed in the US, these systems often fail to provide sufficient opportunities for (1) expression of certain natural behaviors, (2) positive welfare, and (3) exercise of agency. Group housing systems are superior to individual stall housing in each of these regards, but improving their ability to provide such opportunities is nonetheless important.

Almost universally, modern animal welfare frameworks recognize the importance of natural behaviors or natural living. For example, in David Fraser's framework, one of three components of (or orientations toward) animal welfare is providing animals the ability to "live reasonably natural lives by carrying out natural behaviour and having natural elements in their environment."[139] The World Organization for Animal Health (WOAH), an intergovernmental organization in which the US participates, explicitly adopts as guiding principles the "Five Freedoms," which WOAH takes to describe "society's expectations for the conditions animals should experience when under human control."[140] One of these Freedoms is

the "freedom to express normal patterns of behaviour."[140] Similarly, behavioral expression is one of the domains in the Five Domains model for animal welfare assessment.[2]

Over the past 15 years, conceptions and frameworks of animal welfare have also advanced to incorporate "positive welfare" as a consideration.[3–6,141] While positive welfare is characterized in a number of different ways, it is generally understood to encourage moving beyond a conception of animal welfare that is limited to minimizing animals' pain, fear, and other negative affective states. Proponents argue that adequate animal welfare requires providing opportunities for positive emotions, moods, and experiences, as well as "positive affective engagement," or the rewarding experience of engaging in self-generated, goal-directed behaviors, such as play or curiosity-driven exploration.[6,141]

Related to both natural behavior and positive welfare is the concept of agency. An animal exercises agency when she "engage[s] in voluntary, self-generated and goal-directed behaviours," which helps to provide "a general sense of being in control."[2] As described in a recently published textbook on pig welfare, "agency enables an animal the ability to choose and actively influence its environment."[7] In addition to being incorporated in contemporary animal welfare frameworks,[2,3] exercise of agency or autonomy is increasingly explored in philosophical accounts of the ethical obligations that society or animal caregivers have toward animals who are under human care and control. Such accounts recognize the importance of "considering autonomy or something similar to it – exercising personal choice, exerting some kind of agency – an important capacity of many animals, one which must be given proper consideration and respect in any adequate moral framework."[142] For example, some conceptions of care ethics recognize that relying on a list of objective welfare standards is insufficient for ethical assessment, as doing so neglects the importance of respecting animal choice and what matters to individual animals.[143]

Under commercial conditions in the US, group housing often involves maintaining pregnant pigs in a relatively barren environment, devoid of substrate, bedding, and manipulable materials. As of 2012 (the most recent year for which this data is available), over 97 percent of breeding female pigs were housed in gestation facilities with no outside access, and thus no access to soil, wallows, or vegetation.[35] Such conditions largely preclude many natural behaviors such as foraging, wallowing, environmental exploration, rooting in substrate, grazing, digging, and building nests, both for routine rest and in preparation for farrowing.[7] Because group-housed sows are typically separated prior to farrowing and may be mixed with different gilts and sows after weaning or breeding, they often do not have the opportunity to maintain long-lasting relationships with their preferred social partners.[48] As described below, free-access crate systems with limited and/or poorly-designed communal areas effectively impose on many pigs a level of behavioral restriction similar to that of gestation crates. Thus, while typical conditions in group housing systems are not as restrictive as those of individual stalls, there is much room for improvement in terms of expanding opportunities for behavioral expression, positive affective states and engagement, and agency.

B. Means of Mitigating Welfare Hazards

1) Provide Adequate Space for Species-Typical Behaviors and Social Interactions

Numerous studies have found that, across various feeding systems, aggression, lameness, and number of injuries decline, and exploratory behaviors increase, as floor space increases.[21,119,133,135,144–146] In addition, minimum space requirements are higher when mixing unfamiliar pigs.[11,20] Providing more space allows for more normal social interaction patterns, including avoidance behaviors, which in turn reduce the time and level of aggression needed for hierarchy formation.[119] Because aggressive interactions are a potential cause of lameness, providing adequate space is also a means of reducing risk of lameness.[11,147]

a) Space Allowance During Mixing

In Sweden, "fixation" of sows in crates or individual stalls was banned in 1988.[20] In a paper describing Swedish producers' experiences and observations during the first 25 years of mandated group housing, the authors note the importance of providing enough space during the first one to two days after mixing sows, as this allows for the expression of "dominance and subordinate behaviour to establish a dominance hierarchy within the group."[20] Detailed ethological research on the behavior of newly introduced sows found very little aggression when they had sufficient space, including outdoor areas, to avoid resident sows.[148]

In 2013, *National Hog Farmer* published an article recommending 36 sq. ft. per sow for mixing pens in which unfamiliar sows will be introduced, based on European recommendations.[127] (These recommendations were recently increased to 37.5 sq. ft. per sow during mixing.[11]) The article also explains the benefit of a rectangular pen in helping to permit a greater flight distance.[127] Ensuring that a subordinate sow can escape from a higher ranking individual is considered "crucial to the rapid development of a stable dominance hierarchy."[11] Research has documented that it is rare for a dominant sow to chase a subordinate sow for more than 10 meters (32.8 ft) and the flight distance of a subordinate sow who is being chased is usually less than 16 meters (51.5 ft.).[148]

Research from Australia indicates that, during the first 2 days after mixing, providing 64.6 sq. ft. (6 sq. m.) per sow decreases number of fights and percent of time spent fighting and reduces injuries to low-ranking sows when compared with providing 21.5 sq. ft. (2 sq. m.) per sow.[149] Research comparing rates of lameness within the first days after grouping found that the odds of becoming lame decreased significantly when individual space allowance was increased from 18.3 sq. ft. (1.7 sq. m.) to 32.3 (3 sq. m.).[147]

b) Space Allowance After Dominance Hierarchy Has Been Established

Post-mixing, larger space allowance tends to be correlated with reduced aggression and injuries, and increases sows' comfort and exploratory behavior, regardless of feeding system.[13,135,144,150–152] In the European Union, sows and gilts in groups are required to have more than 2.25 sq. m (24.22 sq. ft.) per animal of unobstructed floor space, with the requirement being 10% lower for groups of more than 40 pigs and 10% higher for groups of 5 or fewer pigs.[13] However, research has found that this may be insufficient, at least for some feeding systems.[13] One study found that sows housed in dynamic social groups and fed by an electronic sow feeder had better welfare, lower aggression, and fewer injuries when 3 sq. m. (32.3 sq. ft.) per sow was provided.[153] A study using a four-times-per-day drop feeding method found that providing approximately 32.3 sq. ft./sow resulted in significantly less aggression during feeding compared to providing only 15 sq. ft. per sow.[144] Due to differences in feeding systems, it is difficult to assign a precise minimal space allowance that can be generalized across all types of group housing.

At present, many pork producers are transitioning to free-access crate systems, in which lockable stalls roughly the size of gestation crates are used to facilitate non-competitive feeding. However, because too little space outside the free-access crates is provided, pigs outside of the free-access crates must lie in thoroughfares and risk being stepped on or encountering aggression if they are blocking a penmate's access to a resource.[151,152] Dominant sows tend to monopolize available communal areas.[151,152] Thus, research has found that more than half of sows in these systems spend less than 5% of their time outside of the free-access crates.[152] This suggests that, to protect and promote sow welfare, minimal space requirements in communal areas must be determined based on factors such as ensuring there are sufficient protected lying areas for all animals to lie comfortably at the same time. Separate areas for dunging areas should also be provided. For example, based on minimal usage of communal areas in the

study cited above,[152] 11.6 sq. ft. per sow of loafing area, combined with ~ 14 sq. ft. per sow within the free-access crate,[154] is clearly insufficient, especially when the communal area is comprised solely of an alley running between two lanes of stalls. A similar study on free access crates reported low rates of use of communal areas when sows were provided 20 sq. ft. within the free-access crate and 14.9 sq. ft. in the loafing area.[151]

c) When to Group Sows

A recent analysis by the European Food Safety Authority (EFSA) – an expert panel that advises the EU and is comprised of scientists from throughout the continent – was tasked in its *Welfare of Pigs on Farm* report with developing recommendations on when to group sows relative to the time of inseminating them. Under EU legislation, female pigs can be confined to gestation crates immediately after weaning and kept in such a system for a maximum of 4 weeks after insemination.[11] Similar practices have been adopted in the US by higher welfare pork producers. The rationale is that mixing with other sows can cause stress and the associated cortisol release can prevent implantation or result in embryonic losses, thus confinement to individual stalls will "protect [sows] from stressors associated with grouping and social competition during the early phase of pregnancy and to promote embryo survival."[11]

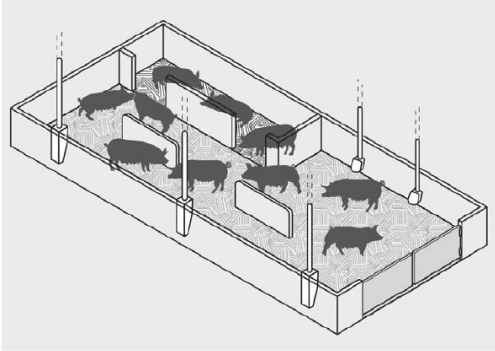
A recent systematic review found that the impact of housing welfare during the post-weaning and early pregnancy stage to be an understudied area.[155] However, after evaluating extensive research, EFSA concluded that sows should be grouped at the time of weaning and found that, under proper conditions, farrowing rates were equivalent to those seen in pigs confined to gestation crates for their entire pregnancy.[11] Grouping at the time of weaning ensures that highly motivated estrus behaviors (sniffing, flank nosing, mounting) are not frustrated by confinement to a stall.[11,23] The EFSA notes that this practice could risk the welfare of some sows, particularly those who are already somewhat weakened, thus it is necessary to take extra measures to protect their welfare.[11] In order to minimize welfare problems and embryonic losses, the EFSA recommends use of specialized mixing pens, forming subgroups which are later mixed, avoiding grouping compromised animals or animals of different sizes, maintaining good hygiene, ensuring good pen design and layout, providing a fibrous diet to promote satiety, and providing means of feeding pigs individually.[11]

Research carried out under conditions reflecting North American pig production has also found equivalent farrowing success (total piglets born, number of live born piglets, mean litter birthweight) when comparing sows mixed into a dynamic group immediately after farrowing and sows housed in gestation stalls for 8 days prior to mixing.[156]

2) Optimize Design and Layout of Pens

Pigs prefer to have separate areas for lying, feeding, and defecating, and these welfare needs require careful attention to design and layout of pens.[7,157] Aggression and associated injuries can also be decreased by appropriate design and layout. For example, partitions and other types of barriers can be used both to create "resting bays," ensuring pigs have a place to lie down that is not in a walking path, and to create escape routes that allow subordinate animals to avoid conflict with dominant animals.[119,127,158] Such barriers should be flexible or soft (e.g., straw bales) and without any sharp edges or protuberances.[11]

Use of communal space in a group pen can also be increased by ensuring that there are enrichment options, drinkers, and other resources in well-considered locations, maximizing the benefit of exercise enabled by group housing.[159] Care must be taken to ensure that location or perceived scarcity of resources do not contribute to conflict between penmates. The diagram below is included in the EFSA's 2022 analysis, Welfare of Pigs on Farm.[11]



Drawing representing a 'well-designed' mixing pen to allow sows to establish a dominance hierarchy in safety (based on a photo courtesy of Vermeer H)

a) Feeding systems

Several different types of feeding systems are available, and their impact on welfare can vary depending on factors such as group composition and size, unobstructed space allowance, and design and placement of feeders. Regardless of feeding system, chronic hunger due to feed restriction leads to increased stereotypies and aggression.[126,128,160]

In competitive feeding systems, feed is provided to the group as a whole, either by feeding pigs without any protection from their pen mates or with only partial protection, such as partitions; these may provide adequate nutrition when pigs of similar nutritional requirements are grouped together.[127] Especially if chronic hunger is mitigated, trickle feeding, in which feed is very slowly made available at multiple individual feeding stations over the course of about 15 to 30 minutes, is reported to be effective at minimizing aggression in small groups of relatively uniform pigs.[158] "Stealing" of food by fast-eating sows can also be mitigated by trickle feeding.[127]

Noncompetitive feeding systems involve use of electronic sow feeders (ESF) or free-access crates. In general, these protected feeding systems better prevent aggression.[119,128] ESF enable provision of individualized nutrition, but require animals to enter the feeder one by one. It is important that ESF be designed, located and managed in such a way that pigs are not required to queue often or for long periods, as this can contribute to aggression, especially vulva-biting.[117,127,161] Free-access crates, which have similar dimensions to gestation crates but allow the pigs to open a rear gate and exit at will, work best when pigs of similar nutritional requirements are grouped together. However, as discussed above, free-access crates can cause welfare issues similar to those caused by gestation crates if there is insufficient space in communal areas and/or if the design and layout of communal areas is inadequate, as lower-ranking pigs may spend >95% of their time within the crate.[151,152] In addition, there is a risk that producers will keep the back gate in the locked position when auditors are not present, essentially making the free-access crate functionally indistinguishable from a gestation crate.

Finally, there is some evidence that providing outdoor access or raising sows on pasture permits competitive feeding practices without significant increases in aggression, as sows rely on simultaneous foraging and grazing to meet some of their nutritional needs.[162–166]

b) Special pens for pigs with specific health needs

In order to protect the welfare of pregnant pigs, it is necessary for group housing systems to have a number of designated "relief pens" (also called "hospital pens"), which are pens designated for individual pigs or small numbers of pigs who may be injured, sick, or especially low-ranking.[158] Research in Europe indicates that producers most commonly rely on veterinarians to provide guidance on design

and management of relief pens.[167] These pens are best located in areas where they can be easily monitored by workers, ideally near the veterinary area of the barn.[158,168] They should be free of drafts, contain sufficient bedding, and provide supplemental heat as needed.[158] In Denmark, legislation specifies how pig hospital pens should be designed and may serve as a reference.[167] It requires, for example, that hospital pens be able to accommodate no less than 2% of animal spaces, that one free pen always be ready, that each pen have at least 38 sq. ft of unobstructed free area, and that pens containing two or three animals provide at least 30 sq. ft. of space per individual.[168] Ensuring adequate hygiene in hospital pens has been identified as a major area of concern by British veterinarians and management recommendations are available.[169]

3) Mitigate Chronic Hunger

Chronic hunger both contributes to aggression and is an animal welfare issue in its own right. Research has found that proving ad libitum feed reduces aggression during mixing.[120,170] Therefore, during mixing, feeding sows to satiety is a simple means of reducing aggressive interactions.[11,127]

Once a group is established, aggression associated with feeding can be minimized by adopting feeding practices that prevent obesity while also mitigating hunger; this includes providing formulated diets with increased levels of fermentable fiber or resistant starch and providing foraging material.[128,160] Research carried out 30 years ago found that vulva lesions, typically sustained via aggressive bites around feeding time, were much less prevalent when sows had access to additional roughage.[94] Since then, research has found that feeding higher fiber diets can stimulate mechanoreceptors in the stomach, enhancing satiation at the end of a meal, and may permit hindgut fermentation to release energy into the bloodstream several hours after a meal, stabilizing glucose and insulin levels and thus promoting satiety between meals.[128] Fiber-rich diets, especially those that rely on fermentable, soluble fiber sources, such as sugar beet pulp or potato pulp, result in reduced arousal, anticipation, and agitation of food prior to a meal, which may reduce aggression and vulva biting in association with feeding.[128] Some studies have found that if the energy density of food is sufficiently reduced, sows can be fed *ad libitum* without becoming obese.[128,171]

In addition to reducing aggression and mitigating the negative affective state of chronic hunger, fiber-rich diets tend to increase the amount of time sows spend eating, allowing a more natural feeding pattern, and decrease stereotypies such as sham chewing, bar-biting, and trough-biting.[128]

Providing straw bedding, soil, or other loose materials that permit normal feeding behaviors like foraging, rooting, and sniffing may also help mitigate the negative welfare impacts of restricted feeding, while also providing an outlet for environmental investigation and exploration.[128] One study found that the relative risk of injuries caused by vulva biting is 2.6 times higher when pregnant sows and gilts are not provided with roughage, with researchers noting that the animals provided with roughage "appeared to be less hungry than in herds with only concentrate feeding," and did not stand in line behind the feeding station as much.[94] Sows not provided with additional roughage had 1.7 times greater risk of body lesions compared with those in herds where additional roughage was provided.[94]

In the EU, it is required that pregnant sows and gilts receive "a sufficient quantity of bulky or high-fibre food as well as high-energy food" and that they have "permanent access to a sufficient quantity of material to enable proper investigation and manipulation activities, such as straw, hay, wood, sawdust, mushroom compost, peat or a mixture of such, which does not compromise the health of the animals."[128]

4) Provide Appropriate Flooring and Bedding

Flooring is important both for the comfort of the animal and because, depending on flooring characteristics and condition, flooring can injure pigs directly by causing claw lesions, and indirectly by increasing the risk of slipping and falling.[127]

Slatted floors are frequently utilized because they permit manure to be washed into a manure pit below the floor. However, fully slatted floors in particular negatively impact animal welfare due to their contribution to lameness and because they limit the use of straw and enrichment items.[11,150] One study that involved 646 group-housed female breeding pigs found that animals on slatted floors were twice as likely to be lame as those on solid floor, and 3.7 times as likely to be severely lame.[132] Another study found that, compared with straw-bedded floors, slatted floors dramatically increased the risk of leg disorders; specifically, 87.8% of farms with concrete slatted floors had major leg disorders, while only 8.8% of farms with straw bedding did.[133]

A number of European countries have either abolished or are phasing out the use of fully-slatted floors,[11] and there appears to be sufficient evidence for the veterinary profession to advocate for a similar transition in the US. Given the welfare benefits of solid (non-slatted floors), the EFSA recommends that "the maximum solid floor area that does not compromise pen hygiene should be provided in part-slatted systems."[11] Currently, when any slatted floors are used, the European Union has legal standards for the maximum opening between slats (20mm [0.79 in]) and the minimum width of slats (80mm [3.15 in.], with 120mm [4.72 in.] recommended).[127]

Provision of properly maintained bedding, such as straw or wood shavings, has numerous welfare benefits, including decreasing risk of lameness, permitting natural behaviors such as rooting, providing a comfortable resting area, improving thermoregulatory ability, decreasing stereotypies, decreasing skin damage, and reducing aggression.[12,13,93,128,150,172,173] Since bedding is typically made of manipulable materials, it may double as enrichment and improve opportunities for agency.[172] For example, providing straw also permits nest-building.[11] Some research has also found that having access to deep straw during gestation improves sows' maternal behavior and the early survival of their offspring. In mixing pens in particular, covering the floor with mats or straw is recommended to protect feet during fighting or other behaviors involved in establishing the dominance hierarchy.[11]

There are various means of providing straw, including providing straw on top of solid flooring, utilizing long-stem straw for a deep bedded systems, or a straw flow system.[174] With deep straw-bedded systems, bedding is left to pile up and compost/ferment, rather than being regularly cleaned out.[175,176] In Sweden, where sows are not crated at all during their lifetimes, deep litter straw systems are the norm for pregnant sows.[20] In the US, research has found that sows group-housed in deep-bedded, hoop barns had similar reproductive performance to sows kept in individual stalls.[173] In this study, the bedding pack was made of cornstalks, and individual feeders were used.[173]

Ammonia and odor are substantially lower in deep litter or deep straw bedded systems compared to conventional slatted floors.[177] In addition, when compared with pigs kept on slatted floors, pigs reared in deep litter systems have been found to have lower rates of diseases resulting in lameness.[178] It is essential that uppermost layer of straw bedding be kept fresh, clean, and dry through proper management.[172]

5) Maximize Use of Static Groups, Rather Than Dynamic Groups

Group housing can be managed either for static groups, in which only one breeding group is housed together at the same time, or dynamic groups, in which new pigs are continually added to the existing

group as other pigs leave for farrowing.[179] Maintaining static groups minimizes aggression because sows are only grouped once during each pregnancy cycle.[179] For example, in one study of 10 sow herds, static groups had lower lameness scores and decreased skin lesion prevalence at the end of pregnancy.[180] Another study found that total injury score was significantly higher in dynamic groups than in static groups both in general and two weeks after mixing, and the dynamic groups also had fewer non-aggressive interactions.[161] In static groups, sows are also better able to maintain longer term relationships with preferred social partners, improving their prospects for positive welfare, e.g., engaging in affiliative behaviors.[4,48] Finally, social stress in mid-gestation has been shown to shift brain development of female piglets towards a pro-anxiety phenotype, compared with piglets born to mothers kept in stable groups.[18]

If static grouping is not an option, the layout and design of groups pens can encourage formation of stable social structures, i.e., stable subgroups within the larger group. Research is ongoing regarding means of minimizing mixing-related aggression, particularly in large dynamic groups.[22,156] In general, gradual familiarization of unfamiliar animals is considered a key factor in preventing aggression.[13] Research has found that, if small groups of sows are able to interact freely with one another for as little as seven days prior to being introduced into a larger group, harmful aggressive behaviors are decreased and affiliative (friendly) behaviors are increased.[22] The option of subgrouping can be facilitated by the design and layout of group housing systems.[11]

6) Limit Group Size and Composition

Under natural conditions, mature sows live in small social groups called "sounders," comprised of two to four females and their piglets from the most recent breeding season.[41] On commercial operations utilizing group housing, group size can vary, but is typically much higher: dozens or even hundreds of sows per group.[181] Thus, it is unsurprising that, as group size increases and there are more hierarchy positions to resolve, there is increased risk of fighting and injuries.[11,122,150] A large study evaluating over 100 farms found that a risk factor for leg problems is housing sows in large groups.[133]

It is also generally recommended that sows of different sizes be grouped together to reduce the risk that smaller, younger subordinate sows will sustain serious injuries or be on-going targets of aggression.[11,150,152,182] First-parity sows housed with other first-parity sows and gilts were found to have fewer injuries, better weight gain, and higher farrowing rates compared with first-parity sows housed with multiparous sows.[182] In addition, when free access crates are used, housing younger sows with others of similar age and size allows the animals to be more confident in exiting the crates and using the communal space.[159]

7) Maintain High Level of Hygiene

Maintaining a high level of hygiene is important for protecting pregnant pig welfare. Wet, dirty floors increase the risk of slipping, falling, lameness, and claw lesions.[13] Flooring that is covered in excreta leads to softening and weakening of hooves and increases the risk that even small wounds will become infected.[11] During construction of housing facilities, provision of adequate drainage is essential.[11] Designing and laying out housing areas to encourage use of specific areas for specific functions (e.g., resting, elimination, feeding) can also help promote hygiene.[11] When given the opportunity, pigs will void outside of their lying area starting at six days of age.[157,172] Farm protocols must ensure adequate frequency of procedures such as cleaning and supplying fresh bedding.[11]

8) Provide Environmental Enrichment

Given pigs' high level of cognitive complexity, housing them in a barren environment with insufficient stimulation or opportunities for positive affective engagement is a welfare concern. A barren

environment may contribute to lack of use of communal areas in systems that utilize free-access crates, negating much of the benefit of group housing.[159] In addition to improving psychological well-being, environmental enrichment has been shown to reduce pigs' susceptibility to diseases,[7] improve immunological response and clinical outcomes in pigs experimentally infected with common pathogens,[183] and improve early neonatal survival of offspring.[12] The hippocampus and frontal cortex of piglets is affected by the maternal environment through epigenetic mechanisms; research has found neurodevelopmental differences between piglets whose mothers, during the final third of pregnancy, lived in a barren environment compared with those whose mothers received hay bedding as environmental enrichment.[113]

Environmental enrichment for pigs has been extensively studied, and a review chapter on the topic published in 2024 notes that good environmental enrichment is "designed in a way that enhances [pigs'] living conditions by facilitating the performance of their species-typical behaviours, whether to provide an outlet for explorative behaviour or to improve cognitive function or social behaviour."[184] Generally, pigs are most interested in enrichment items that they can investigate, manipulate, chew and ingest.[185] For gestating pigs in particular, recommendations for enrichment include providing an outlet for foraging behavior by ensuring that enrichment scores high on "edibility and chewability."[184] To prevent dominant sows from monopolizing enrichment, it should be provided in amounts that ensure access to all animals, e.g., providing straw throughout lying areas large enough to accommodate all animals.[184]

9) Provide Access to Outdoors or Adopt Pasture- or Silvopasture-Based Systems

There are a range of systems that provide pregnant pigs with outdoor access, from systems that are based primarily indoors but provide access to a concrete or soil outdoor run to fully outdoor systems in which pigs live permanently outdoors on soil with access to temporary or permanent shelter.[176,186] Outdoor production systems are widely acknowledged to promote animal welfare, provided that associated animal welfare hazards are well managed.[178,187] Access to pasture or other vegetative cover provides opportunities to engage in natural behaviors, such as rooting and grazing, as well as to exercise agency, for example, via roaming.[178] When outdoor areas are expansive enough and contain palatable forage, such as legumes, pigs can meet some of their nutritional requirements through foraging, which permits more natural feeding patterns and can mitigate chronic hunger.[166]

Particularly when it includes access to functional wallows and grass, roots, or other roughage, outdoor access can reduce pen-mate directed oral activity and aggression, including vulva biting.[164,165,186,187] Several studies have found that pigs housed in outdoor paddocks tend to have lower rates of injuries, lameness, and bursitis.[11,164,178,186,187] Ethological studies of sows during mixing have found that behaviors intended to diffuse aggressive interactions are much more effective when sows are mixed in large grassy paddocks rather than in indoor systems.[188]

In addition, pasture-raised pigs are typically treated with considerably less antibiotics than are conventionally raised pigs, and research has found that the prevalence of antimicrobial resistance genes is significantly lower in pasture-raised pigs compared with conventionally-raised pigs for nearly all antimicrobial classes.[189] This may be related to lower rates of bodily injuries and respiratory problems, such as pneumonia and pleuritis.[187]

Potential welfare challenges with pasture production, as well as management strategies to mitigate such issues, have been reviewed and continue to be studied.[162,164,178] Because environmental conditions may vary, providing protection from extreme weather takes on heightened importance. Ensuring access to a functional wallow is important for thermoregulation and to prevent problems with sunburned skin.[187,190] Mitigating predation risk by utilizing techniques known to deter the predator species of concern is also essential.[191,192]

a) Mitigating Parasitic Disease Risk

The AVMA cites exposure to parasites as a cause of "poor" welfare in free-range sows and a disadvantage group pens and free-range housing.[193] Helminth parasites are a concern in domestic pigs in all kinds of production systems, though "common porcine helminths very seldom cause clinical disease."[194] Financial considerations (e.g., increased liver condemnations and reduced growth rates) and zoonotic potential, rather than animal welfare, are typically the concerns related to helminth parasites.[194,195] However, pastures that are heavily contaminated with parasite eggs (e.g., *Trichuris suis*) can lead to morbidity and mortality,[194,195] and providing pigs with bedded lying areas in group housing may increase transmission of helminth parasites by better allowing eggs to survive.[194]

Fortunately, genetics, diet, and management practices allow the threat posed by parasitism to be mitigated such that welfare is not negatively affected. For example, the heredity of resistance to some helminth parasites is so high that breeding for resistant pigs may be an option.[194] Some helminth parasites may be at least partially prevented and controlled by feeding fermentable carbohydrates (pre-biotics).[194] Deep litter straw systems provide a microenvironment unsuitable for parasite development, such that eggs typically fail to become larvated or become infective.[196,197] Strategic pasture management, including pasture rotation with relatively long intervals between groups of pigs, can help prevent the accumulation of parasite eggs.[198,199] When possible, pigs can be included in crop rotation to increase the rotational interval.[187] Research also suggests that the free-living stages of multiple parasites (*T. suis*, *Ascaris suum*, *Balantidium suis*, and coccidia) can be penetrated in the environment by micro-fungi.[194,200]

Finally, medical treatments can be used to manage parasite problems. Deworming with appropriate parasiticides is an option and, with the exception of *Oesophagostomum* species, there is no evidence that anthelmintic resistance is a problem for common porcine parasites.[201]

IV. Recommended Language

In light of the information presented above, we recommend the following changes to this policy:

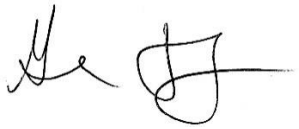
> **Pregnant ~~sow~~ pig housing**
>
> Pregnant pigs (sows and gilts) are kept in a variety of housing systems. ~~Sow~~ These housing and management systems ~~should~~ must:
>
> - Provide every animal access to appropriate ~~food and~~ water and sufficient food to prevent negative affective states such as chronic hunger;
> - ~~Promote~~ Ensure good air quality and a high level of hygiene ~~allow proper sanitation~~;
> - Protect ~~sows~~ all animals from environmental extremes;
> - Reduce exposure to hazards or conditions that result in injuries, pain, distress, fear, or disease;
> - Facilitate the ~~observation~~ monitoring of individual ~~sows~~ pigs, whether by direct observation or via precision farming technologies, to assess their welfare;
> - Provide ~~sows~~ every animal with adequate quality and quantity of space that promotes positive experiences and social interactions, and allows them to assume normal postures and express normal patterns of behavior, including walking, running, nest-building, rooting, and foraging.
>
> ~~There are advantages and disadvantages to any sow housing system and the benefits and harms to the animals of each should be considered by weighing scientific evidence~~

~~and veterinary professional judgment. For example, while gestation stall systems minimize aggression and injury, reduce competition, and allow individual feeding and nutritional management, they restrict normal behavioral expression.~~ The welfare harms associated with gestation crate housing systems are significant and can only be mitigated to a limited degree, thus transitioning to group housing systems is recommended. Group housing systems must be well designed and managed to avoid welfare problems including ~~are less restrictive, but could lead to increased~~ lameness and undesirable social behaviors, including injurious aggression and competition for resources (e.g., feed, water, space to lie down).

The AVMA encourages ongoing research to better understand and meet the welfare needs of gestating pigs ~~sows~~. Appropriate and ongoing training for people handling and working with pigs ~~pregnant sows~~ is critical to ensure that they are able to provide and promote good welfare within the management system being used.

Thank you for the opportunity to submit comments on this important policy. I would be happy to communicate about this issue further and/or share any cited references that may be of interest to the Animal Welfare Committee in its deliberations.

Sincerely,



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