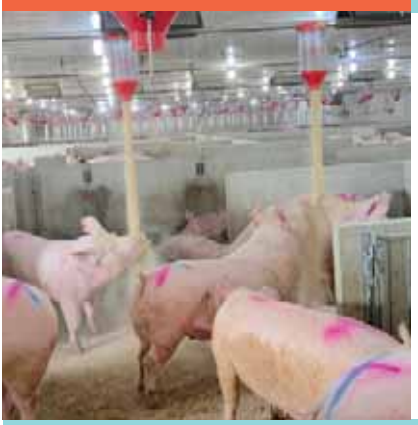
PRAIRIE SWINE CENTRE

MASTERING GROUP SOW HOUSING

A DECADE OF SCIENCE AND KNOWLEDGE



Science OF Ethology

VOLUME 2

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Foreword

Prairie Swine Centre is celebrating our 35th Anniversary in 2026; over the last 35 years, the Centre has evolved into one of Canada's premier swine research facilities, delivering practical, industry-focused research that improves production efficiency and strengthens the financial position of pork producers while advancing animal welfare and environmental sustainability across the Saskatchewan and Canadian pork industries.

Animal welfare has been one of the core research programs since dawn of the centre. Prairie Swine Centre is recognized for its leadership in providing the Canadian swine industry with practical results to improve the welfare of the pigs in our care - results from PSC research have been incorporated into the Code of Practice for the Care and Handling of Pigs, the nationally developed guidelines for rearing swine.

Our mandate to produce and distribute knowledge we derive through original research is supported through our Knowledge Transfer Program using various means, including publications such as this book. Group housing is now the standard for gestating sows and will become mandatory in 2029; to give producers direct access to the best information on group housing of sows, Prairie Swine Centre has summarized the best practices based on our research and that of other researchers and present them here. Research into sow group housing has been carried out at Prairie Swine Centre for over 25 years, and we will continue to lead the development of best management practices for group-housed sows in the years to come. It is our hope that you find the information in this book useful for your operation as you continue to make decisions on the management of group housed sows.

I would like to thank the authors who contributed to this handbook and all the researchers and students who created the information it contains. Prairie Swine Centre remains committed to serving the swine industry in Canada, and if you would like further information, you can find us here: www.prairieswine.com

Murray Pettitt, Ph.D.
CEO, Prairie Swine Centre

Introduction

This collection of work reviews scientific evidence on the different options available to pig producers using group housing. This second edition (produced in 2026), follows on the first edition produced in 2011 by the Prairie Swine Centre. Fifteen years have passed since then, with significant progress made on our understanding of the management of sows in group housing.

Sow research is a challenging area of research. While earlier studies focused largely on comparisons between stall versus group systems, more recent studies focus specifically on group housing, drilling down on the finer details - defining the art of managing sows in groups.

Unlike stalls, group gestation can be done in many ways, from floor feeding and short stalls to free-access stalls and precision management with electronic sow feeding, automated weighing and heat detection. Each system has different options (e.g. flooring type, space allowance, group size, time of mixing) and a quick look at the science tells us there is no 'best way'.

Similar research studies, such as those on floor space allowance or optimal group size, will frequently give different answers. The impact or effectiveness of a system often depends more on 'how' the system is managed, the daily decisions and human-animal interactions, than the system itself. These more subtle management factors can be lost in research, and when combined with differences in genetics, diet, measurements, interpretation or scientific bias, result in different (sometimes opposite) conclusions from otherwise similar studies. However, these challenges are not insurmountable, and as more and more producers have made the transition to groups our understanding has grown.

The issues in this manual have been prepared by leading swine researchers and review specific areas of management. Each issue covers a specific topic related to group housing, giving an up-to-date review of research on that area. Many important research questions remain, from basic aspects such as floor space allowance and pen design to mixing practices and environmental enrichment. With experience comes knowledge; as producers have gained knowledge they have passed on that information, sparking future research.

We thank the many swine producers who have shared their insights and opened their doors for research. Our hope is that continued study, innovation, training and experience will lead not just to better welfare for sows, but to improved productivity, greater job satisfaction for barn workers and increased returns to producers.

Jennifer Brown, Ph.D.

A Comprehensive Approach to Animal Welfare Science

Abigail Tillotson, M.Sc., Martyna Lagoda, Ph.D., Yolande Seddon, Ph.D., Harold Gonyou, Ph.D., and Jennifer Brown, Ph.D.

Greater emphasis and understanding of animal welfare is critical at every level of swine production. From producers and industry to society and consumers, concern for animal welfare can take several forms. Individual producers aim to ensure good welfare through daily decisions on the basic care of animals – from feeding and general management to the quality of health checks and the human-animal relationship. Within the pork industry, concern for animal welfare takes the form of codes of practice and quality assurance programs designed to define acceptable industry standards for the care and management of animals. From a societal perspective, concern for animal welfare is shown in laws governing major issues such as humane slaughter and housing practices, as well as in the purchasing choices of individual consumers.

Few consumers know, or are able to select, the farm from which they obtain their food. Their satisfaction relies on their confidence in the industry which produces it. As such, the importance of animal welfare has increased, and with it the need for producers and the livestock industry to provide good care. The field of animal welfare science arose alongside these changes as a tool to help address questions related to management practices that affect the well-being of animals. This article describes general perspectives in animal welfare science, explores measures used in welfare science, and how management practices are evaluated.

The most well known framework to understand animal welfare may be that of the Five Freedoms, originally developed by Brambell in 1965 (Figure 1). This framework predominantly centralizes the reduction of negative experiences. As understanding and perspectives shift, there is greater attention to positive experiences and their importance in facilitating a good life for animals. Furthermore, while the Five Freedoms outline the eradication of discomfort, stress, etc., it is important to acknowledge that it is not possible nor desirable to fully eliminate negative emotions due to their evolutionary functional development.

The Five Domains aim to more accurately represent the aspects that determine the welfare of an animal. Similar to the Five Freedoms, there are five domains identified. However, in contrast to the list of freedoms, there is an integration of domains (Figure 1).

The four domains of Nutrition, Physical Environment, Health, and Behavioural Interactions integrate into and influence the final domain: Mental State. Rather than explicitly stating that freedom from negative experiences will result in positive welfare, the Five Domains allow for a more holistic understanding of how the lived experience shapes the psychological health of animals. Each domain represents a facet of life that can have positive or negative implications, thus defining the welfare of an animal. The first three domains (nutrition, physical environment, and health) describe internal conditions that shape physiological function and can give rise to sensations such as hunger, thirst, pain, or discomfort, which are experienced as emotions (e.g., anxiety, fear, frustration, or apathy), and drive survival-related behaviours to restore physiological stability. For example, food deprivation produces hunger and related distress that motivates seeking and feeding behaviour (Mellor et al., 2020).

The fourth domain (Behavioural Interactions) focuses on how animals interact with their environment, other animals, and humans, their ability to have agency - the capacity of an individual to influence their life through actions and choices - and their ability to pursue goals that are important to them, i.e., express motivated behaviours such as exploration, social contact, play, foraging, rooting, nest-building, maternal care, and resting in

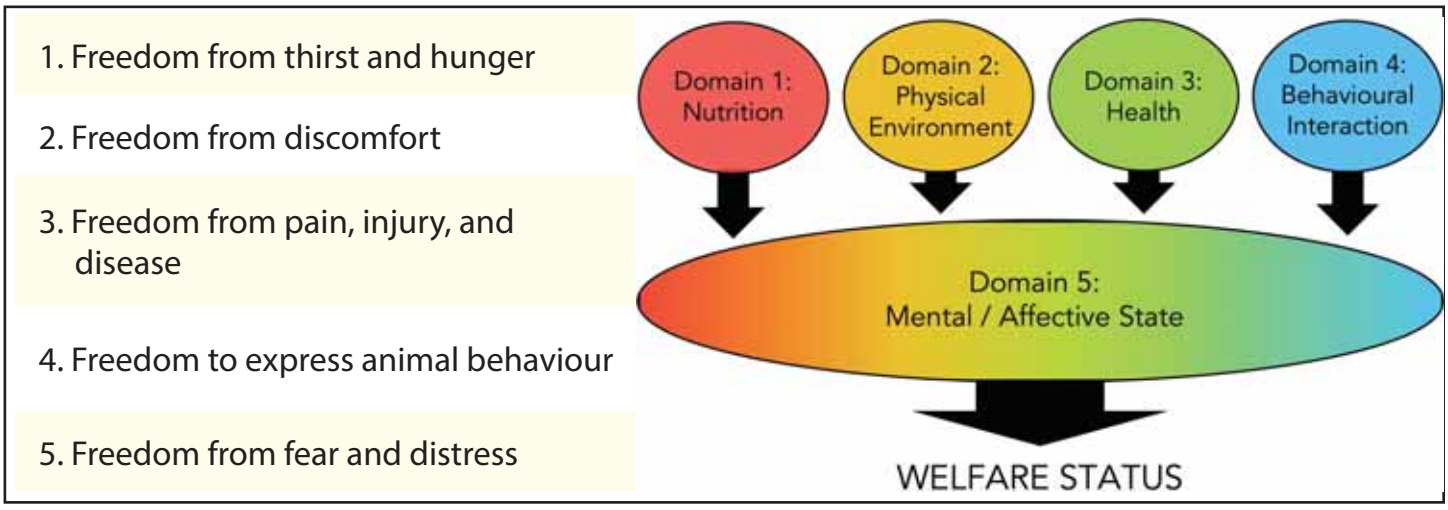

Figure 1. The Five Freedoms defined by the Farm Animal Welfare Council (FAWC, 1979) and The Five Domains (from "Review: The Five Domains model and promoting positive welfare in pigs" by N.J. Kells, 2022, Animal 16, 100378. CC BY 4.0.

Rather than placing our emphasis on any one component of animal welfare, we should look for systems that meet a comprehensive definition

preferred areas. These behaviours are biologically driven and reflect important survival and reproductive needs, meaning that successful expression is rewarding for pigs, and generates positive emotions such as comfort, pleasure, and social satisfaction, while behavioural restriction can lead to frustration, boredom, or distress (Mellor et al., 2020).

Recognizing these behaviours as expressions of fundamental biological needs rather than optional extras highlights the importance of providing opportunities for pigs to engage in them. The fifth domain (mental state) integrates the effects of the previous four domains to assess the animal's overall emotional state. The integration of the previous four domains into the fifth emphasizes that the physical conditions are not welfare outcomes; rather, welfare is defined by the animal's emotional state. For example, lameness is not the welfare outcome; pain, discomfort, reduced confidence, and associated frustration, despair, or anxiety are the welfare outcomes (Mellor et al., 2020).

On-farm assessments of animal welfare are also more practical with the use of the Five Domains. Historically, the assessment of animal welfare placed greater emphasis on health, physiology and production measures, as these were more familiar and easily measured. However, current understanding recognizes that measures of affect (emotional state) and normal behaviour are important components of welfare assessment. The Five Domains Model enables animal welfare assessment to reflect the balance between positive and negative states that are found in real-world conditions and supports the goal of animal management to minimize the negative states and promote positive states to predominate (Mellor, 2016).

Welfare assessments aim to balance measures of health and productivity with other measures, including the absence of pain, distress and hunger, and the ability to perform a range of normal behaviours (such as rooting, positive social interactions) which can promote positive emotions. This is reflected in the WOAH (World Organization for Animal Health) definition of animal welfare: "Animal welfare means how an animal is coping… An animal is in a good state of welfare if it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and is not suffering from unpleasant states such as pain, fear, and distress…" (WOAH, 2023, Chapter 7.1).

The Five Domains model also recognizes that complete freedom from, for example, fear and distress, is unattainable. The inherent nature of intensive farming (including normal life experiences) will result in some level of fear and/or distress (during moving or mixing events, castration and other painful procedures, or during weaning). Therefore, by evaluating each domain as a spectrum as opposed to a binary, there allows for a realistic assessment of welfare in a given environment.

These standards are used around the world to evaluate the welfare of all livestock species. In the case of stall housing for sows, the requirements related to 'freedom of movement' and 'the ability to express innate behaviour' are not met due to the restricted movement of sows in stalls, and these criteria are central to welfare arguments against the use of stalls.

Sows rest in a bedded area behind gated free access stalls. Photo courtesy of the Egli farm.

Another framework for assessing animal welfare is described by David Fraser in his book, Understanding Animal Welfare (2008). The Three Circles generally views three philosophical perspectives, with each perspective emphasizing different components of welfare (Figure 2). The first perspective examines how well animals function in their environment. The 'functional approach' assumes that if animals are healthy and productive, their welfare must also be good, and uses measures related to growth, reproduction, and health (or absence of poor health) to demonstrate good welfare. Physiological measures indicative of stress are also used to demonstrate how well animals are functioning in their production system.

A second perspective within the Three Circles relates to 'affective states', or how animals feel. This approach emphasizes the importance of emotional states and the feelings of animals, using measures such as pain, fear and discomfort (or alternatively, positive emotions) as indicators of well-being.

The third perspective of the Three Circles is known as the 'natural approach'. Through thousands of years living in the wild, our now domesticated animals have relied on their natural responses to cope with environmental challenges. When they encounter similar challenges in our production systems, they will attempt to use these same natural responses to attempt to cope. The coping mechanisms used by wild animals are largely the same as those used by domesticated animals, as coping mechanisms

are genetically ingrained and stable through evolution and domestication. Among other things, our animals will use exploratory behaviour to become familiar with their environment, to adapt their social behaviour to alleviate competition, and use thermoregulatory behaviour to avoid cold or extreme heat. If animals are unable to express these behaviours, they will become frustrated and stressed. They may be able to express the behaviours but be ineffective in coping because a critical part of the environment is missing, for example, a wallow (cooling device) in hot conditions. The natural approach considers how well the system accommodates the responses of the animals; think 'fit the farm to the animal, not the animal to the farm'.

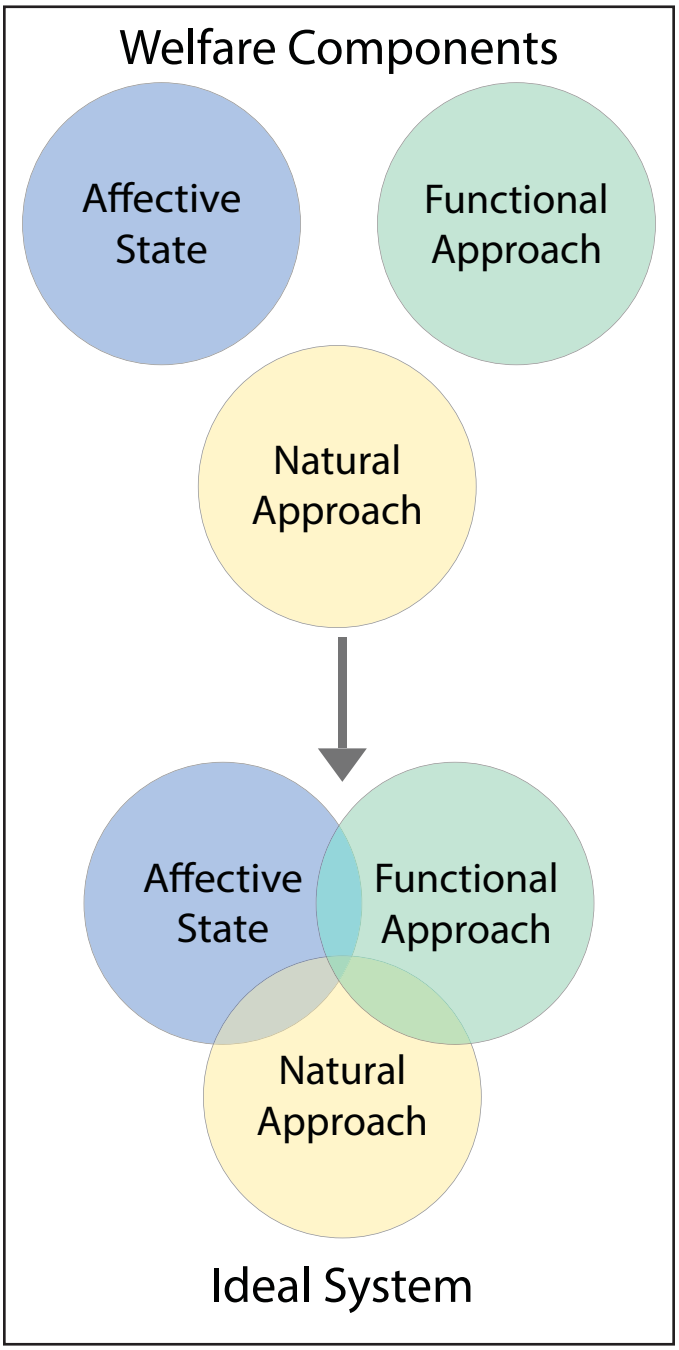

Figure 2. Components of animal welfare and the comprehensive approach

While these three perspectives – 'functional', 'affective states' and the 'natural approach' - can be used separately, when used alone they run the risk of jeopardizing other components of animal welfare. Rather than placing our emphasis on any one component of animal welfare, we should look for systems that overlap (Figure 2) and meet a comprehensive definition: a system in which animals can function well, in which positive feelings outweigh negative, and in which they can express their natural behaviours in an effective manner that truly satisfies their needs.

Both the Five Domains and the Three Circles integrate physical and behavioural aspects to then draw conclusions on the welfare of an animal. These comprehensive definitions of animal welfare meet the approval of most members of society. The challenge to modern producers is to achieve these goals in a production system that is also efficient and profitable. From a research perspective, the challenge to scientists at the Prairie Swine Centre is to identify management practices that can optimize animal welfare while at the same time maintaining or improving productivity, efficiency and profitability. This book will use animal welfare science to address production issues as Canada fully transitions to welfare-friendly and productive group sow housing.

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Social Behaviour of Group Housed Sows

Arielle Sabourin, M.Sc., Yolande Seddon, Ph.D., Fiona Rioja-Lang, Ph.D., Harold Gonyou, Ph.D. and Jennifer Brown, Ph.D.

Group housing is being adopted because it gives sows freedom to move and allows expression of species-relevant behaviours. From a public perspective, allowing sows more choice in how they spend their time can cast a positive image of the industry leading to greater social license. However, it also poses new management challenges. Pen resources such as food, space, enrichment and lying areas are always limited to some extent, and sows will naturally compete to gain access or control them. Competition can result in damaging aggression, with subordinate sows suffering the consequences in particular.

Understanding the social nature of sows can give us clues for better management to promote positive behaviours, such as lying together and grooming, while minimising negative ones such as fighting. Three main approaches to promoting positive social interactions are discussed in this issue; first, focusing on sow behaviour and causes of aggression; next, the pen environment and thirdly, through genetic selection.

PIGS IN THE WILD

In the wild, wild boar sows live in social groups. There are three types of social groups among wild pigs: a group of several sows with their offspring, a boar with sows, and a peri-parturient sow with her offspring. The primary social group of wild pigs is called a sounder, which consists of several sows and their adolescent offspring. Sows in a sounder are likely to be closely related, and will live together their entire lives with the exception of the period when they separate to give birth (Graves, 1984; Mauget, 1981). Boars are solitary and only join a group of sows during the breeding season. The third group consists of an isolated peri-parturient sow and her litter. Separation from the primary social group lasts from a few days before farrowing until about ten days after the birth of the piglets (Andersson et al., 2011; Jensen, 1986). The sow remains in close proximity to the farrowing nest and rejoins the main group as the piglets become mobile. Wild sows rarely come together to form a new social group, they remain with their littermates or other females from their mother's sounder, for their entire lives. The only time that they 'join' a new group is when their mother rejoins her sounder when they are 10 days of age, and aggression is rare (D'Eath, 2002).

In commercial production, new groups of sows are artificially formed many times during their life cycle (in dynamic group housing, as much as every two weeks), leading to increased group aggression. Many other species live in social groups of closely related individuals and try to exclude any unrelated newcomers to the group. However, Stookey and Gonyou (1998) demonstrated that for swine, it is not the lack of relatedness that results in aggression among newly mixed pigs, but lack of previous familiarity. Therefore, one method to reduce the aggression that occurs when forming groups of sows is to recombine animals that were together during their last gestation. Unfortunately, complete familiarity within a group is impractical to achieve as we must bring in new gilts and incorporate sows that have changed breeding groups due to failed breeding. Complete integration of a group of unfamiliar animals often takes several weeks, although aggression usually subsides within a couple of days (Moore et al, 1993).

Wild pigs around a watering hole. Image courtesy of Harold Malamion via Unsplash.com. Accessed September 9, 2026.

AGGRESSION AND DOMINANCE

Aggression is an issue with sows in intensive production. It is often said that sows are naturally aggressive; however, in a sounder or group of wild pigs, fights are rarely seen. Competition, on the other hand, is a characteristic of the social system within a group of animals. In its simplest form, we have dominant/subordinate relationships among the animals. The definition of dominance is that it results in priority of access to limited and defendable resources, including feed and lying patterns (Spoolder, 1998; Spoolder et al., 1996; Krauss and Hoy 2011). Alternatively, it has been proposed that instead of a dominance order, the relationship among group members could be considered an avoidance order, which we will discuss in this issue (Jensen, 1982).

Aggression in sows in commercial production is due to the frequent mixing of groups leading to unnatural social shifts and restricted feed causing increased competition. Moreover, in the case of sows, aggression and loss of feeding opportunities not only causes physical damage but also disrupts ovulation, conception and pregnancy. The vast majority of aggressive fighting in group-housed sows occurs either at the time of re-grouping, or during daily feeding. Fight participants are at risk of suffering severe skin damage, abscesses, lameness, increased heart rate, and cortisol levels (Burfoot et al., 1995; Svendsen et al., 1990; Marchant et al.,

2001; Mendl et al., 1992), where the losing sow is most at risk. Often, the majority of fighting will occur within a couple of hours after mixing. Once a sow's dominance status has been established by aggression, it is often maintained by very subtle agonistic behaviours. These behaviours include threats through head movements and body posture by the dominant animals, and, for subordinate sows, moving in such a way as to avoid dominant animals. This reinforces the idea that the social order among sows in a group to be one of 'avoidance' rather than overt 'dominance' (Jensen, 1982).

Although we often attribute the aggression of newly mixed pigs to the need to establish their dominance order, that is likely a secondary aspect of the aggression. Subordinate animals cannot just submit and accept a low position in the dominance hierarchy; they must also find a way to be tolerated within the group. New pigs in a group are more likely to fight than established sows (Kraus and Hoy, 2011). This is also why, when managing sows in a dynamic group, the constant introduction of unfamiliar sows into groups typically results in ongoing aggressive interactions as sows establish a new dominance hierarchy.

FAMILIARITY AND SOCIALISATION

It is well known that familiar pigs spend less time fighting than unfamiliar ones. In general, larger and older animals are dominant to smaller and younger ones (Meese and Ewbank, 1972). We can understand that being with familiar pen mates is less stressful as each sow knows her place in the social order (Arey, 1999).

Depending on group management strategies, animals within a group may be familiar with each other from their previous gestation period. Sows are able to remember previous pen-mates even after several weeks of separation during farrowing and nursing (Arey, 1999). Consequently, when sows are grouped for a subsequent gestation period, the group consists of previously acquainted sows (an established group) and a number of new animals. Thus, the challenge often associated with younger animals, being the least dominant, is confounded by the fact that they are also new.

When gilts were introduced to sows through a barrier before mixing, there was a significant reduction in aggression compared to no introduction period (Kennedy and Broom, 1994). This implies that gilts gained familiarity and learned social skills from the older sows without being subjected to the consequences of their aggression during introduction. One way to reduce aggression at mixing could therefore be to have an introductory period.

Early socialization is another approach to reducing aggression that has been well studied in nursery pigs but not in sows. Numerous studies found that nursery piglets fought significantly less when mixed at 12-14 days of age (when a wild sow and her piglets would rejoin the group) instead of mixing litters at 21 days or later, when commercial weaning normally takes place (Camerlink et al., 2018; Fels et al., 2021; Luo et al., 2025). Because social learning takes place early on, producers may be missing an important 'window for socialization' that could have lifelong consequences. As noted, this concept has not been proven in sows but is a promising topic for future studies.

OPTIMAL GROUP SIZE

When it comes to defining optimal group size for pigs, there is no clear answer. Originally, it was thought that larger groups would result in greater aggression. However, the opposite has been found. Pagel and Dawkins (1997) explained the effect in economic terms; as group size increases, the cost of being a dominant individual goes up. Large groups are analogous to humans living in cities, where more socially tolerant behaviour is adopted.

Several researchers have investigated the idea that putting pigs in large groups results in less aggression. One study found that pigs became less aggressive and shifted to a low-aggressive social strategy in larger groups compared to small groups (Samarakone and Gonyou, 2009). Similarly, Turner et al. (2000) concluded that pigs alter their strategy for negotiating social encounters as group size increases, possibly because they fail to recognize all individuals. In large groups, grow-finish pigs were less likely to engage in aggressive interactions and showed more avoidance behaviour (Turner et al., 2000). When observing sows as opposed to grow-finish pigs, researchers have found similar results. Generally, sows in larger groups with larger and more varied space had less aggression (Broom et al., 1995; Mendl, 1994). These studies help us to understand the success of large dynamic groups. The positive impact of having a large social group and complex pen area help to balance the negative impact of frequent mixing of new animals into the group. Clearly, a facility's grouping practice can influence the level of aggression displayed in a pen. In later issues of this book, we explore the impact of familiarity among sows and practices to reduce aggression at mixing.

SPACE ALLOWANCE

Having sufficient space is an essential resource. Space allowance can be considered in three ways; first, there is physical space: the amount of space taken up by the animal's body. Next, there is kinetic space, the space needed for animals to stretch their limbs and move around a little. Commercial space allowance guidelines are often based on kinetic space, for example all animals should have enough space to allow separate feeding, drinking and dunging areas within the pen. The third concept of space is social space, which considers animals 'personal space'. When given adequate social space, subordinate sows can avoid dominants and access feed and water without being driven away.

Insufficient space limits the ability of sows to escape agonistic encounters and worsens the consequences of those interactions. Increasing space allowance will typically reduce aggression and injuries within a pen (Barnett et al., 2001; Docking et al., 2001; Remience et al., 2008). In general, small groups require more space per pig than large groups. This is because larger groups allow for a degree of 'space sharing'.

PEN DESIGN

In addition to space allowance, pen design is important for reducing aggression and promoting positive welfare. Barnett et al. (2001) compared sow aggression in square versus rectangular pens. They found that aggression was less frequent in the rectangular pen and concluded that this was due to the longer distance sows can travel. Sows escaping an aggressor were more able to move away and end the conflict. Free-access stalls are also good for minimising aggression, as subordinate sows can enter a stall to escape or avoid aggression.

GENETIC SELECTION

As group housing becomes the norm, genetics companies have begun selecting for sows that 'get along' and perform well in groups. Temperament, unfortunately, is highly variable, as it is highly influenced by factors such as housing, environment, and group dynamics, and weakly heritable, but aggression is one of the more heritable traits (O'Malley et al., 2019; König von Borstel et al., 2018). Currently, researchers are starting to use AI to observe and quantify aggression to aid in selecting against it (Wei et al., 2023).

Muir (2005) questioned whether genetic selection of highly competitive individuals with positive production values, as opposed to individuals with the ability to thrive in a group, has led to lesser productivity of the group as a whole. He argued that in competitive systems (e.g. poultry, swine) more aggressive animals are often more productive, and that over time we have inadvertently selected animals for greater aggression, which has been shown in sows (Brajon et al., 2020). Muir conducted an experiment on Japanese quail where he followed two genetic lines for six-week body weight, where one line used conventional selection based on production values and the other used an optimal index incorporating production values and group dynamics. Over 23 generations, the line using the optimal index saw increased body weight and decreased mortality, indicating that selecting for positive group dynamics can have a positive impact on production.

Producers must use caution however, as selection for one behaviour trait such as reduced aggression may affect other behaviours like maternal care or fearfulness (Løvendahl et al., 2005; D'Eath et al. 2009). So, while genetic selection for temperament in group housing is an important concept, traits to select for are still being identified.

CONCLUSION

Studying pigs in both wild and domestic situations gives ethologists clues on how to understand and better manage sows. We know that while sows in the wild may not have a dynamic social group, sows in our commercial barns do, which leads to increased social stress, competition, and aggression.

Many practices are known to reduce aggression in social groups, such as keeping familiar sows within the same breeding cycles to ensure similar gestation groups, introducing gilts to sows through a barrier or pre-mixing dynamic groups prior to introduction. To reduce the consequences of aggression, designing pens with appropriate protections, especially when performing competition-inducing activities (such as feeding or lying in preferred spots), and considering appropriate space allowances are recommended. For breeding, selecting sows with positive temperament traits such as lower aggression could reduce the genetic components associated with aggression. However, temperament has low heritability compared to production traits and selecting for behaviours may not be as simple as we think.

In conclusion, understanding sow behaviour in combination with management practices, appropriate housing and genetic selection can all contribute to improving social behaviour of sows in groups. The science of group sow housing is constantly evolving, and we still have much to learn.

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Beyond the Group-v.s.-Stall Comparison: Lessons from Housing Transitions

Yolande Seddon, Ph.D., Jen-Yun Chou, Ph.D., and Jennifer Brown, Ph.D.

The Canadian swine industry is moving away from housing sows in stalls throughout gestation, with all facilities required to group house mated sows and gilts by 2029 from at least 28 days (+7 days) gestation (NFACC Code Technical Panel, 2020). The decision to move to group-gestation housing was based on evidence that viable housing alternatives and husbandry strategies have been developed to manage sows in groups, and that sow welfare and performance can be maintained or improved in groups compared to stalls, when correctly managed (Pig Code of Practice Scientists' Committee, 2012). This issue reviews the current scientific evidence on sow welfare and performance in groups versus stalls, and what is understood about the risks and opportunities for maintaining sow welfare and performance in group-housing systems.

Several scientific studies and reviews have compared the welfare outcomes of group housing versus stalls for gestating sows (Jang et al., 2022; Kemp and Soede, 2012; Verdon et al., 2015). The conclusions of these studies vary because welfare assessment involves a variety of measures, and the conclusions reached will vary depending on the emphasis placed on different measures and the group housing systems selected. The key measures and results of studies comparing sow welfare in stalls and groups are summarised below under the headings: Sow Health and Performance, Stress Physiology, Sow Behaviour, and Sow Aggression. Evaluation of the welfare of sows must consider all of these factors, and the results show that there are advantages and disadvantages to both stall and group housing systems.

Based on the current knowledge, sows in groups typically show physiology indicative of less chronic stress, greater muscle mass and tone and improved locomotion, less oral stereotypic behaviour, a shorter parturition time and shorter wean to oestrus interval. However, sows in groups also have higher skin lesion counts, a lower farrowing rate and higher embryonic mortality (EFSA AHAW Panel, 2022; Kemp and Soede, 2012; Jang et al., 2022). However, the management of group-housing, including the space (quantity and quality), grouping strategies (static or dynamic composition, Issue 7; timing of mixing, Issue 6), feeding regimes (feeding system, dietary fibre level, feed drop frequency, etc.) and sow genetics can all greatly influence the outcomes in group housing (Verdon et al., 2015). No one system is perfect, and there are trade-offs between the two housing systems.

Researchers at the Prairie Swine Centre (PSC) recently conducted a retrospective data analysis across a 3-year span comparing the performance between commercial farms operating ESF-groups and stalls (Luo et al., 2026). Twenty-seven key performance indicators (such as conception rate, repeat percentage, stillborn, etc.) were synthesised using Principal Component Analysis (PCA) and major production patterns were identified. Significant parity by housing interactions were driving the performance differences between group and stall housing. Group housing showed potential for improving sow longevity and creating more favourable farrowing outcomes in older parity sows, whereas stall housing had more favourable fertility (more piglets weaned lifetime and shorter wean-to-oestrus interval) and pregnancy-retention patterns (higher farrowing and pregnancy rate), especially in lower parities (Luo et al., 2026). It is important to note that there are management measures to mitigate some of the negative welfare consequences of group sow housing such as aggression; however, for the negative consequences incurred by stall housing, the only mitigation is moving animals out of the stalls (EFSA AHAW Panel, 2022).

From a management perspective, individual animal care and detection of health problems can be more challenging in groups than stalls. Nevertheless, with increased numbers of producers now operating group housing, there is a consensus among adopters that group housing can be successfully operated, but an enhanced emphasis must be placed on good stockmanship, good group-housing system design and grouping management to prevent adverse effects arising for animal welfare and performance (Tuyttens et al, 2011).

Sows loaf on solid concrete flooring with solid walls providing some separation. Photo courtesy of the O'Neil farm.

WELFARE ASSESSMENT

In the following sections, we will draw upon the Five Domains framework (see Issue 1) to comprehensively compare sow welfare in group and stall housing. However, when evaluating group housing, a problem arises as there are many different forms of group gestation housing. Group housing can range in feeding and flooring systems, pen designs and grouping strategies, with some systems pointing to being likely easier to manage for better welfare in terms of consistent feed access, lower aggression and increased sow comfort. More in-depth management of the different aspects of group sow housing systems will be covered in the following issues. Here we provide an overview of comparison as a prologue.

There are both advantages and disadvantages to housing sows in stalls and in groups

Sow Health and Performance

The 2012 Scientific Committee Report for the Canadian Code of Practice for the Care and Handling of Pigs (Pig Code of Practice Scientists' Committee, 2012) summarised the scientific research comparing the welfare of sows in stalls and group housing systems. Their conclusions are similar to those of the latest EU report (EFSA AHAW Panel, 2022) related to sow health and performance. Group-housed sows often have higher skin lesion scores due to post-mixing aggressive interactions, whereas stall-housed sows experience more joint and limb lesions due to pressure on joints and limbs when space for movement and postural adjustment is limited (Anil et al., 2005; Gjein and Larssen, 1995). Lameness occurs in both group- and stall-housed sows. There has been a higher reported incidence in group-housed sows (Anil et al., 2005; Chapinal et al., 2010), and this may be partly due to the ability to detect lameness more easily in groups. The quality of the flooring, sow genetics and nutrition play key roles in the leg health of sows. On the other hand, compared to sows in stalls, sows housed in groups have been found to have increased muscle mass, greater bone strength and improved physical fitness, (Bartlett et al., 2001; Karlen et al., 2007; Marchant and Broom, 1996), including cardiovascular health (Marchant et al. 1997) due to the ability to express natural locomotion and exercise.

In terms of reproductive performance, studies report that sows in groups perform equal to, or superior to that of sows in stalls, in terms of back fat, sow weight gain, farrowing rate, litter size, piglet birth weight, piglet weaning weight and the wean to oestrus interval (Barnett et al., 2001; Min et al., 2020; Rhodes et al. 2005). Mummification and stillbirth can be caused by various biological factors and cannot be simply attributed to housing types; therefore, inconsistent reports exist (Choe et al., 2017; Min et al., 2020). In the recent PSC research analysing commercial farm reproductive performance longitudinally over a 3-year period, it was found that housing effects were strongly parity-dependent (Luo et al., 2026). ESF-group-housed barns maintained a relatively low and stable farrowing mortality (i.e., piglet loss during birth and stillborn piglets) across parities whereas for stall-housed barns this increased significantly in later parities. There were no parity-based differences in mummifications between housing types. Stall housing did show advantages for gestation retention both at early (higher pregnancy rate at D35 and D72 and conception rate) and late (higher pregnancy rate at D105 and farrowing rate) stages, especially in young females, which may be partly linked to the mixing-induced social stress in groups affecting these metrics. This highlights the importance of careful management of low-parity females in group housing who may benefit the most from better mixing strategies (See Issue 7) and monitoring of feed access and body condition. In the long term, group housing enhanced sow longevity within the herd which provides both economic and sustainability benefits.

Stress Physiology

Plasma or salivary cortisol concentrations have been commonly used as a measure of acute (short-term) stress, capturing the level of cortisol circulating in the body at the time of sampling. However, the results are not always clear as both positive experiences (excitement and arousal) and negative experiences (fear and distress) can result in acutely increased adrenal activity and elevated cortisol levels (Von Borrell et al., 1997). When evaluating accumulative stress over a longer period of time, measuring the concentration of cortisol in a length of hair is increasingly being used as a measure of chronic (longer-term) stress, as cortisol is deposited into the hair as it grows. Cutting the hair and measuring the cortisol within can provide a view of cortisol levels over the specific period in which the hair growth took place.

Dinner time with an ESF. Photo courtesy of the O'Neil farm.

Sows in stalls.

Comparing hair cortisol in group (ESF fed, static groups) versus stalled housed mixed-parity sows revealed young females (parity 0-1), housed in stalls had higher hair cortisol concentrations compared to both young and older sows in either housing system. These results suggest gilts and parity 1 sows experience a greater level of stress during stall confinement than those in groups, and sows that have possibly habituated to stalls following several parities (Everding et al. 2026).

Whilst the stress for sows in stalls is prolonged confinement and lack of control over their environment, group-housed sows can experience acute stress from aggressive social interactions upon group formation and competition for resources. Consequently, group-housed sows have been found to have higher levels of salivary cortisol during their first week in groups compared to stall housed sows (Karlen et al. 2007). This difference was not present in late gestation, suggesting that group formation was stressful for sows (Karlen et al., 2007). Such acute stress can turn chronic if the group-housing systems result in changing social structures, and the dynamics over resources are not managed. The increased activity of animals in groups can also lead to increased cortisol levels. Consequently, studies have identified group-housed sows can have higher levels of cortisol at mixing and throughout gestation (Gjein et al., 1995; Geverink et al., 2003; Vieuille-Thomas et al., 1995), compared to sows in stalls, but other studies have found that levels may also not differ (Pol et al., 2002; Zanella et al., 1998).

The stress experienced by sows in gestation can also influence the behaviour and stress physiology of piglets (Lagoda et al. 2022). Limited studies have compared stress in group versus stall-housed sows for the prenatal effects on offspring. Tokareva et al. (2022) observed that piglets from stall-housed sows showed increased movement in a social isolation test, compared to piglets from sows in small static groups. However, such data could be interpreted as showing reduced or increased fear, and thus more studies are warranted. Given the evidence for prenatal stress effects on offspring (Miguel-Pacheco and Seddon, 2021), consideration to ensure sows can appropriately cope in the gestation housing, and there are not negative consequences for offspring is important, given the need for healthy and viable piglets and the consequences of prenatal stress for their welfare.

Sow Behaviour

A central concern related to gestation stalls is the restriction they place on the movement of sows. In welfare assessments sows in stalls are consistently rated below sows in group-housing when evaluating freedom of movement and the ability of sows to perform normal behaviour. Whether freedom of movement is important to the sow has been debated, leading to this being explored in research. Research by Tokareva et al. (2021a; 2021b) measured the motivation of stall-housed sows and gilts for freedom of movement outside of their stall, requiring the animals to push a button repeatedly for an increasing number of times to measure the strength of their motivation to leave the stall. Results found sows and gilts were motivated to have daily access outside of the stall, but the strength of the motivation was influenced by prior experience in the stall (Tokareva et al., 2021a) and satiety (Tokareva et al., 2021b). Once out of the stall, animals immediately showed a pronounced burst of movement, a rebound response to the restriction of movement imposed by confinement of a stall. Gilts locked in a stall for 60 minutes repeatedly pushed on the back gate in an attempt to escape, pushing, up to 41 times and with 645 newtons (145lbs of force) (Ede and Parsons, 2025), and when given a choice gilts in groups of 3 preferred to remain in a pen than a stall (Ede et al., 2024). Collectively, this evidence suggests sows value freedom of movement and the choice to not be confined to a stall.

Some have considered it more important that the sow has an outlet for behaviours she is strongly motivated to perform, such as rooting, rather than pure freedom of movement. Therefore, another important measure in assessing sow welfare is the incidence of abnormal behaviours, such as stereotypies. Stereotypies are repetitive behaviours that have no apparent function, and are an indicator of poor welfare. Bar-biting, sham-chewing (vacuum-chewing), drinker-pressing, head-weaving, repeated patterns of trough nosing and tongue-rolling are recognised stereotypies that sows perform. Stereotypies seem an inappropriate behaviour as they have no apparent function (Vieuille-Thomas et al., 1995). Unmet feeding motivation (hunger) is recognized as an important factor contributing to stereotypic behaviour due to the common practice of restrictively feeding sows during gestation to control sow weight. But stereotypies are also present at higher levels when animals are housed sub-optimally where all their needs are not met, especially for expression of motivated behaviours. Oral stereotypies are observed in both group and stall-housed sows. However, comparing sows in unbedded gestation systems fed the same diet, group-housed sows show lower levels of stereotypic behaviour compared to stall-housed sows (Chapinal et al., 2010; Tokareva et al. 2022). The performance of oral stereotypies also increases as duration of time in stalls increases, but this is not seen in group-housed sows (Broom et al., 1995; Tokareva et al. 2022). Therefore, while feed restriction in gestation can contribute to the development of oral stereotypies (Whittaker et al., 1998), stall housing increases the amount of stereotypies, suggesting increased stress from a lack of control in the environment, which is alleviated by the housing of sows in groups.

Aside from stereotypies, welfare is also assessed by the sows' response to different stimuli. In this case, reduced welfare can be identified in individuals that are abnormally inactive, or unreactive to stimuli which would normally elicit a reaction. Sows housed in

groups have been found to be more responsive to novel stimuli than those housed in stalls (Broom, 1986). Tokareva et al. (2022) found stall-housed sows showed increased sitting behaviour, which may be a space saving behaviour due to restriction in the stall. In comparison, group-housed sows showed reduced sitting, and increased lying behaviour, suggesting greater comfort due to increased space (Tokareva et al. 2022). The prolonged restriction in stalls may also make postural adjustments difficult for sows; with sows housed in stalls taking significantly longer to lie down than group-housed sows (Marchant and Broom, 1996).

Sow Aggression

The introduction of unfamiliar sows into groups typically results in aggressive interactions while sows establish a dominance hierarchy. In group housing, sows can cause considerable injuries to one another when they fight, and the welfare of sows will be reduced if they experience fear, injury or pain (Von Borrell et al., 1997). However, the amount of aggression experienced by sows in groups at mixing varies greatly depending on the management of groups. Aggression can be controlled by previous experience and through the provision of sufficient pen space and hide areas. This is discussed in more detail in Issue 2: Social Behaviour of Group Housed Sows. Significant aggressive behaviour is also observed between stall-housed sows, and although through physical separation by the stall, it rarely results in injury, it can result in frustration due to unresolved aggression. Comparing aggressive behaviour between group and stall-housed sows, Broom et al. (1995) found the proportion of agonistic interactions which resulted in aggression were greater in stall-housed sows than in sows housed in groups. This is believed to be due to the fact that, unlike a group situation, the stall prevents the aggressive interaction being resolved, and also prevents sows from performing submissive or avoidance behaviour. While little injury occurs to stall housed sows as a result, sows are likely to feel fear and frustration (Von Borrell et al., 1997).

A gilt approaches research officer Abby Tillotson for a treat.

SUMMARY

Clearly, there are trade-offs when transitioning from stall to group housing. The advantages of group housing are that sows have the opportunity to perform a broader range of behaviours and thus receive more exercise, with a range of associated health benefits. The main drawbacks of group systems are the increased incidence of sow injuries related to mixing aggression, limitation in some systems to provide individual nutrition and care to sows, and competition at feeding which can result in uneven feed distribution. Many of the concerns related to group housing (such as aggression and injury) can be resolved with good system design and stockmanship. However, the restriction of sow activity in stalls greatly limits sow freedom of movement and the ability to perform a variety of behaviours, and this cannot be rectified unless sows are let out of the stalls.

If freedom of movement and the ability to perform a range of behaviours are considered important aspects of sow welfare, the overall conclusion is that better welfare can be achieved when sows are not confined to stalls. However, it must be noted that in order to realise the benefits of group housing, only systems resulting in minimal aggression or injury should be used. This can be achieved when sows are fed using systems that ensure each individual can obtain sufficient food without being displaced. Providing opportunities to escape or avoid aggression, such as through generous space allowances or well-designed pens with partitions, are also important, especially for younger animals and when sows are newly introduced to a group.

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Unprotected Feeding Systems: Floor Feeding and Short Stalls

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UNPROTECTED FEEDING SYSTEMS

Previously, the term Competitive Feeding System has been used to describe feeding systems in which an animal can gain access to more food by winning a fight. These systems include floor feeding and trough feeding with non-gated stalls or shoulder barriers. Realistically, there can be competition for feed in pretty much all feeding systems, but to different degrees. Competition is reduced as the degree of protection increases, and is also influenced by the ratio of feeding stations to animals. Consider a barn using electronic sow feeders (ESF) in their pens, with one walk-through feeder per every 50 sows. While a sow is protected while she eats, there could still be competition at the entrance of the feeder, with dominant sows acting in a way that leads to avoidance by subordinate sows. Because of this reality, there has been the suggestion to start referring to Competitive Feeding Systems as Unprotected Feeding Systems, and Non-Competitive Feeding Systems as Protected Feeding Systems. For the remainder of this article and the rest of the book, the terminology of 'Unprotected' and 'Protected' will be used.

Fighting mainly occurs in the first hours after mixing, while the sows establish a hierarchy. Social order could be considered to be established by avoidance versus dominance. Dominant-subordinate relationships are the simplest form of competition as a characteristic of social groups. At a base level, dominant individuals exert greater influence over the group and obtain greater access to limited and defendable resources i.e., feed and space in a pen.

One major challenge for competitive feeding systems is the inability to limit feed access. Unlike for finishing pigs, most sows are not fed ad libitum to maintain good body condition. Modern genetics have brought larger litter sizes and leaner carcasses, but have also changed the body composition and metabolism of the sow; the energy requirement for maintaining body condition and supporting fetal growth is less than what the sow may wish to eat. Limited feeding may also increase competition, as sows often want to eat much more than what they are given. Much of the management of competitive systems revolves around reducing the ability of dominant sows to monopolize resources. This can be done through social management and physical engineering.

FLOOR FEEDING

Floor feeding is the most competitive approach to feeding in group sow housing systems. With this system, feed is dropped onto the floor of the pen via feedlines. This set-up increases the amount of free space in the pen, does not require any training, and uses a limited amount of technology and mechanization. However, careful management is needed to ensure that the sows are grouped properly and that all the sows are in good condition. This approach is popular for those opting for a low-investment renovation; conversion generally requires the removal of gestation crates, alteration of flooring (increasing the area of solid flooring), and alteration of feedlines and feed drops.

System Layout

Floor feeding lends itself to a simple pen layout. The major considerations for floor feeding include the area of solid flooring, the location of feed drops, and the use of solid walls or partitions. It is suggested to allow for a minimum of 1.9-2.3 m^2 (20-25 ft^2) of space per sow in mixed groups (National Farm Animal Care Council, 2014), with at least 1.4 m^2 (15 ft^2) of available feeding space per sow (Manitoba Pork, 2024).

Feed drops should be arranged so that the feed ends up being as spread out as possible. Spreading out the feed helps ensure that dominant sows do not guard large piles; it has been found that dominant sows will spend the majority of their feeding time directly under the hoppers (Verdon et al., 2018). Subdominant and submissive sows will eat further from the drop, with submissive sows having the most reduced access (Verdon et al., 2018). Strategic placement of solid walls can help reduce competition by separating animals, and provide a safe place for sows to rest against; this is especially important for larger groups of animals. These walls should be structurally sound, as animals will bump into them and are likely to rub up against them. The feedlines and feed drops should be well maintained, to make sure that they are releasing the correct amount of feed.

Management Approaches

Careful management is the key to making floor feeding work well; this includes mixing strategies, feed allowances, and observation of behaviour and body condition. When transitioning sows into floor feeding pens, animals must be selected by size, body condition score, age, and parity. Because access to feed in floor feeding pens is unprotected and highly competitive, groups of sows should be as uniform as possible to ensure that any competition is fair. In addition to sows being more evenly matched, they will also have similar feed requirements. Groups are generally quite small, with 6-25 animals per pen. To reduce pressure in the pen, it is suggested to provide the upper limit of suggested space allowance.

To ensure the most even feed intake among a group of sows, the sows should be as similar as possible, making them equally competitive

These groups should remain relatively static once an order of dominance has been established. Adding sows once an order of dominance has been developed is likely to lead to excessive bullying. If a sow is removed to a hospital pen due to injury or illness, or to an isolation pen due to aggressive behaviour, reintegration must be done carefully. Placing hospital or isolation pens adjacent to (sharing a fence with) the main pen can maintain familiarity between the removed sow and the main group, and make it possible for the sow to re-enter the group once the issue leading to removal has been resolved.

It can be advantageous to ensure that all animals entering the same pen are confirmed pregnant and have a similar level of back fat, so housing in breeding stalls for around 28-35 days post-breeding is suggested. This also acts to reduce competition and ensure adequate feed intake during the implantation phase of the reproductive cycle. Though mixing at 28-35 days post-breeding provides some security, it has been found that mixing within 4 days of artificial insemination does influence evidence of aggression or reproductive performance (Galli et al., 2022).

Feed formulation is another important factor to consider when floor feeding. Using a 'bulky' high-fibre feed will lengthen feeding time through increased mastication, but it may also increase aggression due to frustration. Whittaker et al. (1999) reported that while dietary fibre did not influence aggressive interactions, increased dietary fibre resulted in increased non-contact aggression or 'threatening' behaviours. In contrast to these threatening behaviours, the groups fed a higher fibre diet showed less evidence of vulva biting specifically. Jensen et al. (2015) reported that provision of more fibrous feed did not reduce feeding motivation, though it did reduce redirected oral behaviours, such as manipulating flooring or excessive drinking. It is important to note that in this study, feed was delivered in troughs in gated free access stalls. In an alternative study, feeding a higher fibre diet was seen to decrease stereotypic behaviours, decrease the severity of vulva lesions, and showed increased reproductive performance compared to those fed a standard diet (DeDecker et al., 2014).

Feeding on a strawed floor will also extend feeding time, and increase activity; it is important to note that this may be perceived as aggression, but can reduce unwanted manipulation of pen fixtures or vacuum/sham chewing (Whittaker et al., 1999). Further from Whittaker et al., 1999, sows in pens provided with straw were noted to be more active and 'aggressive' than sows in pens without straw, but there was no difference in the number of skin lesions counted between groups. In another study by Jensen et al. (2015), it was found that the ad libitum provision of straw in the common pen area led to an increased amount of time spent laying compared to pens with minimal straw provided.

Sows enjoy a feed drop. Image courtesy of the DeVries' farm.

Stories of Success: Dave DeVries

Dave DeVries runs a 350-sow farrow-to-finish operation near Drayton, Ontario. The DeVries' gestation room has eight group pens, which each house 25 to 30 sows, depending on the size of the animals in the group. Each pen is equipped with 8 drop feeders that drop feed 6 times a day on an automated schedule. The pen floors are 2/3 solid and 1/3 slatted; drinkers are situated above the slatted portion to avoid wetting the solid area. Dave has seen that most dunging is kept to the slatted area, and the solid areas tend to remain clean and dry. The pens are also set up with concrete walls that provide separation.

DeVries moves his sows into group gestation four days after breeding, making the move in the afternoon. He has found that dropping feed before the sows move in can reduce aggression, and that moving in the afternoon ensures that the sows have eaten that day.. Dave has also found that a high-fibre diet can reduce aggression; he feeds a diet that includes 30% wheat shorts that he mills on farm. To complete heat checks with a boar, there is a gated area at the front of each pen, but Dave has found that it is easy to identify which sows are in heat based on their behaviour while he walks the pens. Dave's farm maintains an 85% farrowing rate, just under 12 weaned per litter, which he expects to see increase as he switches genetic lines.

For Dave, the three factors of success to group sow housing are being open-minded, watching the animals while walking the pens, and good genetics. Read about more about Dave and other producers at www.SowHousing.com/producer-profiles/

Floor Space for Floor-fed Sows

The floor space allowance for floor fed sows should be fairly easy to define in terms of productivity, incidence of injuries, and level of aggression. The system is essentially an open pen with the condition that sufficient solid floor area is provided for feeding. However, few studies have examined the question of floor space allowance. Sequin et al. (2007), reported no advantage in any of these measures among space allowances starting at 2.3 m^2/sow (24 ft^2) and going up to 3.2 m^2/sow (34 ft^2). Salak-Johnson et al. (2007) reported problems at 1.4 m^2/sow (15 ft2) compared to 2.3 m^2/sow (24 ft2), but did not examine intermediate levels. From these studies we know that 1.4 m^2 is insufficient and 2.3 m^2 is sufficient; the optimal amount of space is yet to be determined.

Looking to grower/finisher pigs, there are detrimental effects on productivity below a space coefficient of k=0.034 (Gonyou et al., 2006) and changes in lying posture when k drops below 0.038 (Averos et al., 2010). Using weights from our facility for females near the end of gestation, gilts are observed at 220 kg and mature sows (3+ parity) at 310 kg. Applying the k values given above, gilts require between 1.24 and 1.39 m^2/gilt (13 to 15 ft^2) and sows between 1.56 and 1.74 m^2/sow (17 to 19 ft^2). The European Union specifies increased floor space for gilts (1.6 m^2/gilt; 18 ft^2) and sows (2.3 m^2/sow; 24ft^2) (Mul et al., 2010).

Additional research is required on floor space allowances in the range of 1.4 to 2.3 m^2/sow (15 to 24 ft^2). Until further research has been conducted, 1.4 – 1.6m^2/gilt (15 – 18 ft^2) and 1.7 – 2.3 m^2/sow (19-24 ft^2) is the suggested amount of floor space. It is necessary that there is sufficient solid floor area to feed sows without excessive aggression.

Scheduling several (3-8) feed drops a day can also assist in reducing the frequency and degree of aggressive behaviours. In literature, Schneider et al. (2007) found that feeding 6 times a day versus twice a day reduced skin lesions, vulva lesions, and structural issues (foot and leg issues, hoof issues) but did not influence sow growth or farrowing performance. These findings indicate that increasing the frequency of feed provision can reduce feed aggression. In an alternative study, it was found that four feed drops reduced aggression following the first drop, but dominant sows still monopolized the centre of the feed pile (Verdon et al., 2018).

Keys to Success

1. Sort sows by parity, size, and body condition
2. Utilise the time spent in breeding stalls to recover and even out body condition
3. Spread feed as evenly and equally as possible
4. Install solid dividers within the pen
5. Remove sows if they are losing body condition

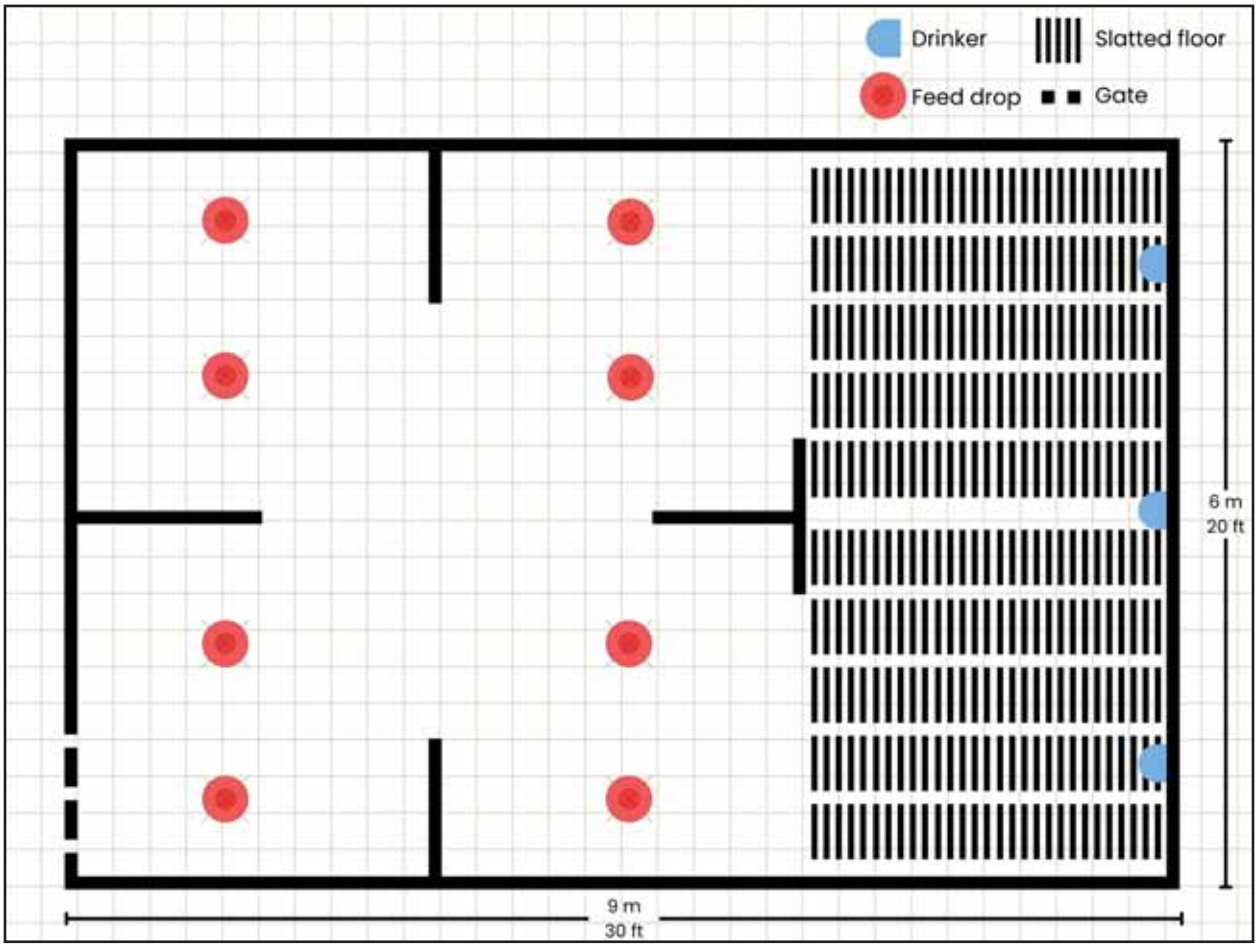

Figure 1. Example of a floor feeding pen layout

NON-GATED STALLS

Non-gated stalls fall somewhere between floor feeding and gated free-access stalls. This feeding system may also be referred to as short stalls or shoulder stalls, and sometimes the word stanchion may be used in place of stall. Often, the stalls for this system are recycled from existing gestation stalls, shortening the dividing bars to about shoulder length – stalls are suggested to be 60-90 cm (24-36" long). This allows for feeding with some degree of separation from other sows. While there is more division of feeding places to allow subordinate sows to defend their ration, there is very little protection, and dominant sows may push them out to obtain more feed; longer stalls can reduce competition and aggression.

System Layout

The layout of short stall systems can vary greatly. Often, a pen will have two long parallel sides with troughs and short stalls, with slatted flooring between each side (Figure 2). Depending on the size of the pen/group, there may only be stalls on one side, with more solid flooring. Some farms will utilise a cafeteria system, where adjacent pens utilise a common bank of short stalls, with animal access to the trough being controlled by a herdsperson. Having feeding troughs on one side can be advantageous as it allows for the use of one or a few central feed lines versus numerous parallel feedlines. Some systems may extend slatted flooring through the entire pen, but it is advisable to have solid floor under the trough and stalls to reduce food waste and provide a comfortable space for the sows to feed or loaf after eating.

Management

The management of sows in non-gated stall systems is very similar to that of floor feeding systems. This system does not require any animal training, as there is no true barrier to entry. When developing groups, characteristics such as size, parity, and temperament must be considered. Groups for stall feeding should be relatively small, in the range from six to 25 animals, and remain static; adding new animals after the group has stabilized will lead to the new animals being bullied in an attempt to drive the 'intruder' away. The same may occur if there is an attempt to reintroduce a sow after she has been removed for individual treatment in a hospital pen; even though the remaining group should be familiar with the removed sow, she may have lost her position in the group. Positioning isolation pens, such as hospital pens, directly adjacent to (sharing a fence) or within the group pen may ease transition back into the group as contact between the removed sow and the main group is retained.

As with floor feeding, animals should be allowed the upper limit of the suggested space allowance for group housed gilts and sows. It has been suggested to transfer sows into groups at 28-35 days after breeding to allow for implantation and to ensure good body condition, though there is evidence that transferring sows as soon as 4 days post-breeding can be successful.

Short stalls allow for a greater level of control over the rate of feed delivery compared to floor feeding. Trickle feeding, where feed is released slowly over about 30 minutes rather than dropped all at once, provides a degree of biological fixation as it keeps sows busy as they feed (Hulbert and McGlone, 2006). If possible, it is recommended to adjust the trickle rate to that of the slowest eater in the group. Adjusting the trickle rate is also advisable based on the season (slower in warmer weather) and stage of gestation.

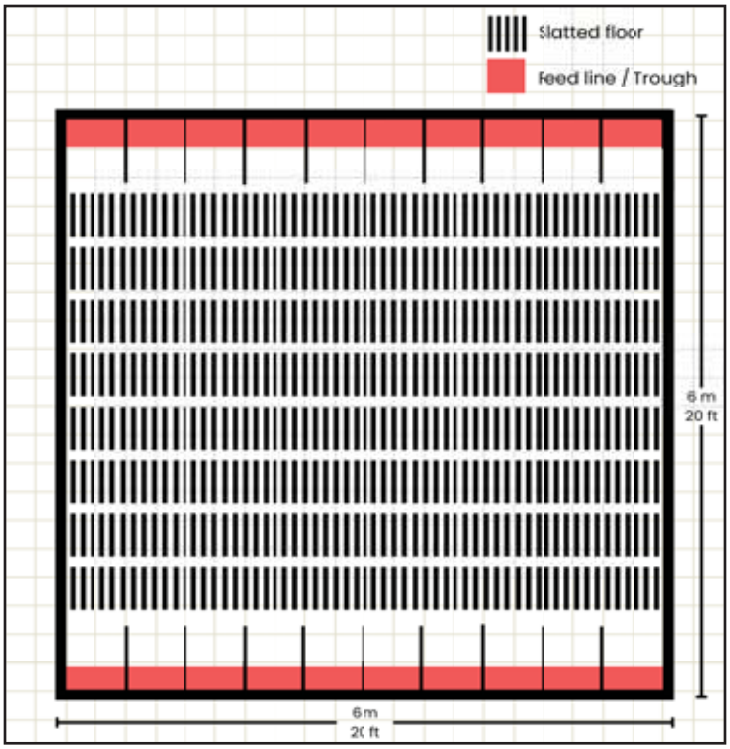

Figure 2. Example of a short stall layout

It must be noted that trickle feeding requires additional augers to deliver food in a continuous manner, which are likely to require more upkeep and adjustment compared to drop feeders. Whether trickle feeding or not, feed is usually delivered 2-3 times a day.

Feed-related aggression can also be addressed by using wet feed, either delivered in a slurry or wet by the addition of water to the trough. Wet feed increases eating speed, so subordinate sows can finish their meal before a dominant sow attempts to push her out of her stall. Unfortunately, because these meals are consumed faster, problems related to short meals such as non-nutritive oral stereotypies (sham chewing, tongue rolling) may occur.

Keys to Success

1. Longer stalls provide more protection and can reduce feed aggression
2. Wet diets take less time for sows to consume, and can thus reduce frustration and aggression related to leftover feed
3. Trickle feeding can reduce feed accumulation in front of slow-eating sows and provide a degree of biological fixation

THE BOTTOM LINE

Choosing Between Floor Feeding and Non-Gated Stalls

Both floor feeding and non-gated stalls are economically attractive, but one must be prepared to accept more aggression between sows and loss of control over feed intake. If choosing floor feeding, social management is paramount to the success of the system, so a good understanding of the herd is necessary. If more protection for the animals is desired or there is some concern about social management, non-gated stalls are the way to go. Deciding between these systems also takes a good understanding of what barn staff are able to manage, as a careful eye is needed to ensure the health and well-being of animals housed in these systems. As with any system, cheap or expensive, better management will result in better production.

Two Types of Problems

If the performance of your sows in a competitive feeding system is below your expectations, it is easy to blame the feeding system. However, feeding system design is not always the problem. Two types of stressors can affect animals in groups: competitive and general. To determine which stressor is most likely within your system it is important to determine the demographics of the problem. If the problem affects younger, smaller animals more than larger, older animals, it is likely a competitive issue.

A common problem in competitive feeding systems is the fat sow/ thin sow syndrome, in which smaller sows get thinner and larger sows get fatter. In this case you should attempt to reduce competition during feeding. However, if your problem is as common among larger sows as it is among smaller ones, then it is likely a general stressor that affects all of the pigs similarly. Examples of general stressors would include high temperatures, poor flooring, poor air quality or space restriction. The solution to these problems is quite different to that of a competition problem . In some instances, the problem may involve both general and competitive stress. For example, if poor flooring results in 10% of the sows becoming lame, evenly distributed across all sizes, the smaller lame sows may be at a greater disadvantage when trying to compete for feed. If you can identify that lameness was the initial problem, and improve the flooring, you will be more successful in correcting the subsequent problem caused by competition.

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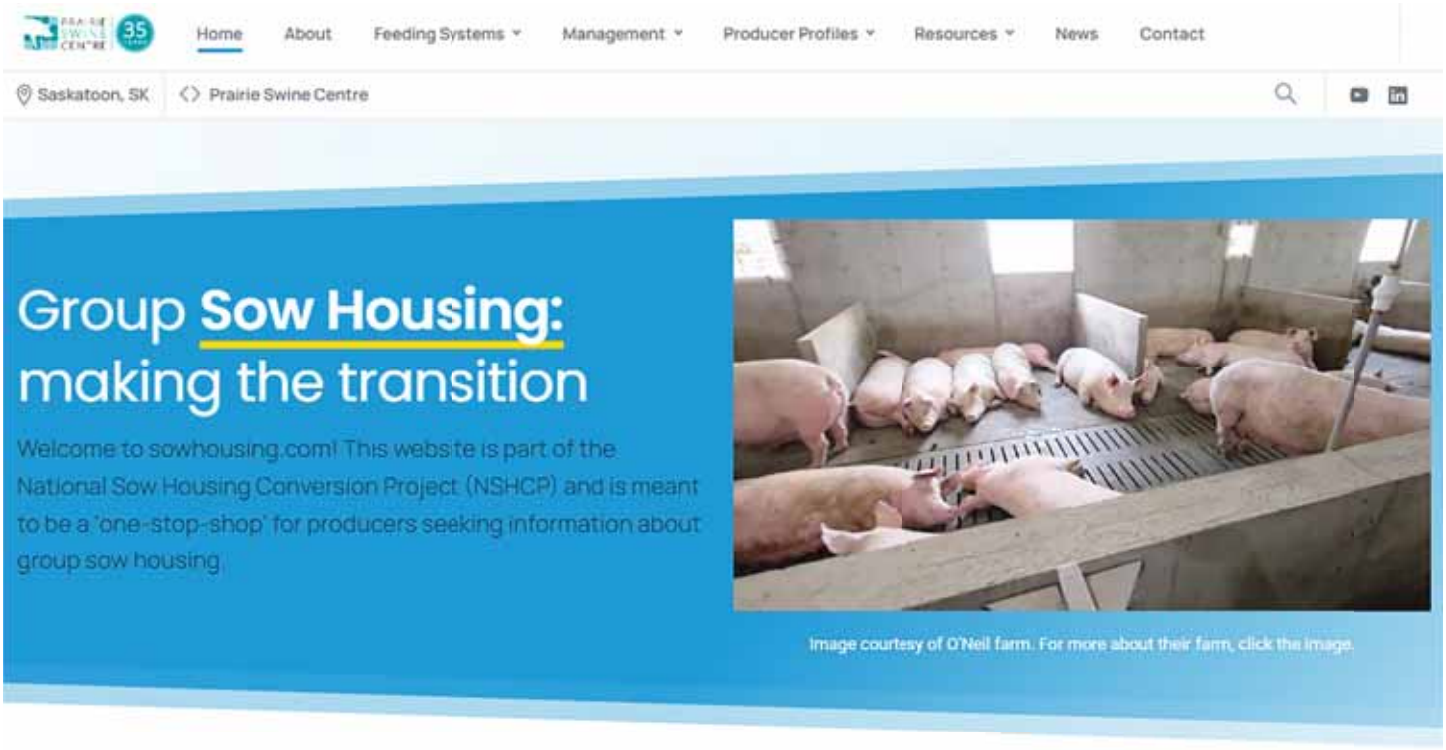

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Group **Sow Housing**: Decision Tree

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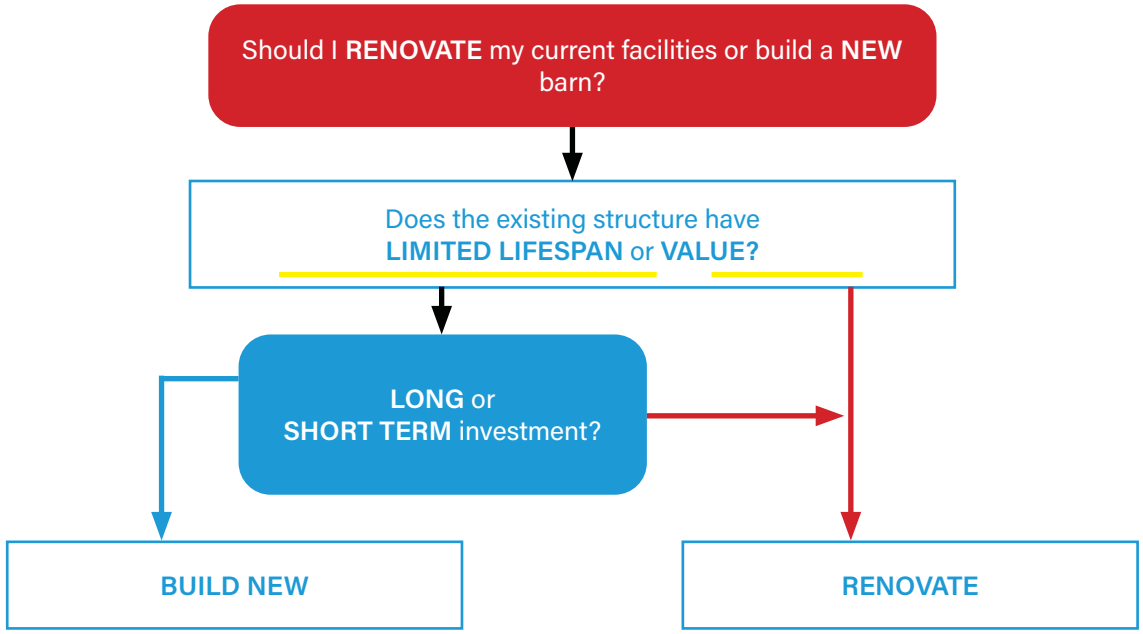
Decision #1



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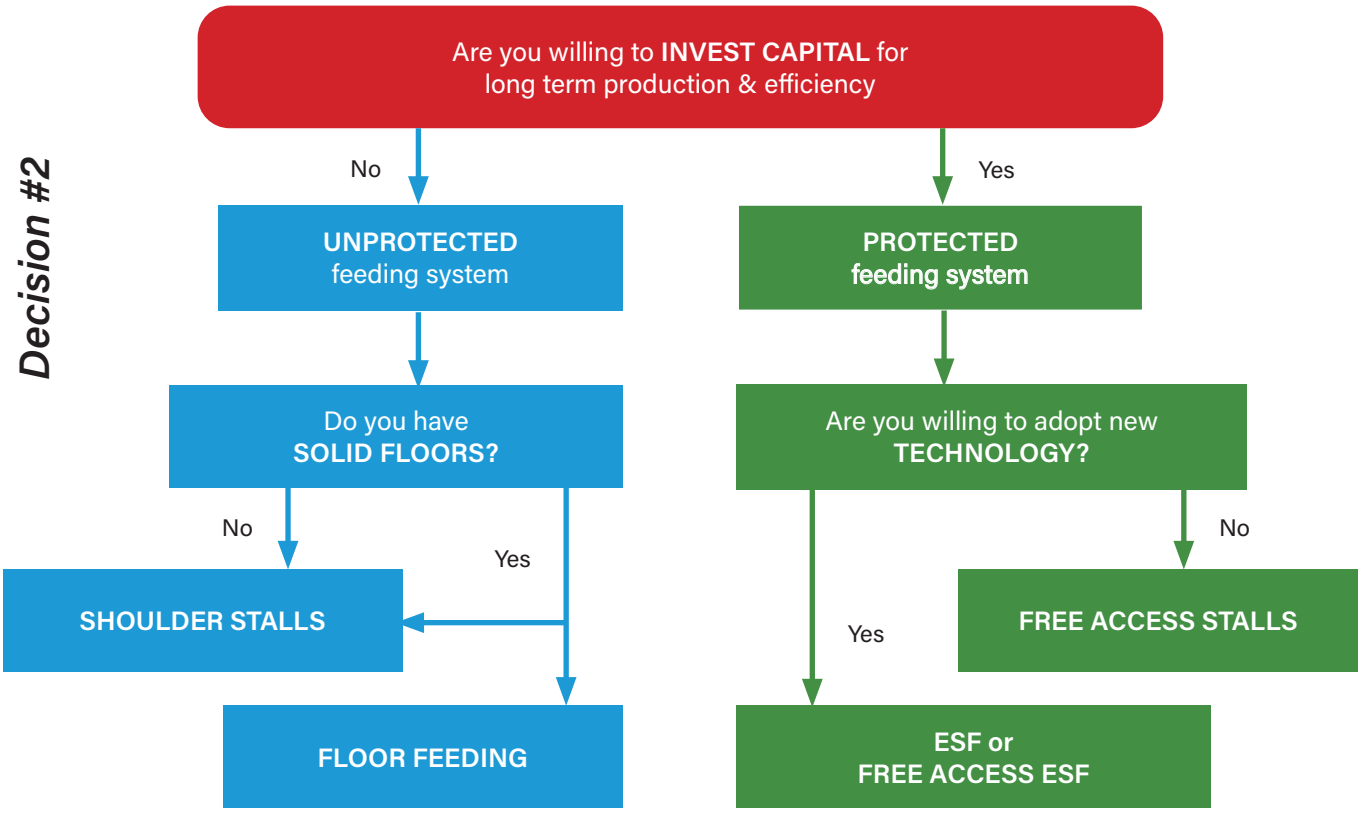

Protected Feeding Systems: Gated Stalls

Hannah Burlet, M.Sc., Harold Gonyou, Ph.D., Fiona Rioja-Lang, Ph.D., and Jen-Yun Chou, Ph.D.

This issue will focus on gated free-access stalls, which are a protected feeding system. This approach to group sow housing utilises individual stalls for feeding, which sows are generally permitted to leave to explore and socialize in the communal alley and loafing areas. The use of gated stalls predates the use of gestation stalls; originally, the gates were manually operated to lock the sows in during feeding times, then opened after the animals finished eating and left open to allow the sows to move in and out throughout the day - this operation of the system is sometimes referred to as a lock-in system. Lock-in systems require more labour than the more commonly used free access stalls.

Free-access stalls, sometimes referred to as walk-in/lock-in stalls, reduce the amount of human labour needed during feeding compared to lock-in stalls. Generally, this system requires a lower ratio of sows to feeders (1:1), but it still is a popular option for those making changes to their barns. When free-access stalls are vacant, the gate is held in an open position. When a sow enters the stall, a cantilever mechanism is engaged and closes the gate behind the animal. The sow can then leave the stall as she desires, with the gate opening as she pushes it while backing out (Figure 1). The gate cannot be opened by other sows from outside of the stall but can be opened by humans using a lever. The major advantage of gated free-access stalls is the degree of protection they provide – since sows are highly protected during feeding times, feed-related competition can be virtually eliminated.

Manual operation of gated stalls allows for controlled cycling of feeding animals. A modern approach to lock-in systems is the cafeteria system; multiple groups of sows are cycled through a bank of gated stalls, allowing for a higher ratio of sows to feeders and reducing the amount of space needed for the system and the cost associated with purchasing the stalls. A group of sows is moved in, allowed to eat, moved out, and another group is moved in. Instead of buying and using space for 100 stalls to feed 100 sows, this system could use 20 stalls to feed 100 sows divided into 5 groups. While this system significantly reduces initial costs, there is a continuous labour cost associated with it, as a skilled stockperson is needed to move the animals. This system also ensures that sows cannot sequester themselves in stalls for an extended period.

System Layout

The width of gated stalls used for free-access systems generally range from 0.56m to 0.71m (22" to 28") with 0.60m (24") stalls being standard, as this width allows for most sows to lay comfortably. The typical length for free-access stalls is 2.13m (7'), though some designs may be longer. Considering the standard length and width of gated free-access stalls, 1.3m^2 (14ft^2) is available for sows when they are in the stall.

Figure 1. Photo of sow exiting free access stall. Pressure against the back gate releases the lock and allows it to be pushed back and upwards to an open position.

Gated free-access stall systems can be set up in various layouts, such as 'I', 'T', and 'L' configurations, with each letter referring to the general shape of the pen (see Figure 2, Diagram of a 'T' pen). Of course, additional layouts could be constructed as space permits.

In 'I' shaped pens, there are two banks of stalls with an alley between the backs of the stalls. The alley behind the stalls should be sufficient for the sows in stalls directly across from each other to exit without maneuvering around each other, hopefully avoiding aggression. For this purpose, the alley is generally 3m (10ft) wide. Often, the center alley of 'I' shaped pens is completely slatted and does not provide sufficient space for all the animals housed in the pen to be out of their stalls at the same time. The loafing space provided in 'I' pens is considered the minimum for gated free-access systems, as the standard 3m alley allows only 0.9m^2 of loafing space per sow, assuming a 1:1 sow to feeder ratio. Typically, it is considered that mature sows require at least 1.8m^2 (19ft^2) of loafing space, meaning that only about 50% of sows would be able to enjoy the open space at a time. Further, in rooms with partially slatted floors, the Canadian Code of Practice for the Care and Handling of pigs suggest a space allowance of 1.4-1.7 m^2 per animal for gilts, 1.8-2.2 m^2 per animal for sows, and 1.7-2.1 m^2 for mixed groups. To increase the width of the alley to accommodate 2.1m^2 (24ft^2), an alley of 7.3m is required. These issues call attention to the greatest drawback of gated free-access stalls, which is the high space requirement.

In order to eliminate the need to have someone present during feeding, gating systems have been developed that can be controlled by the sow herself

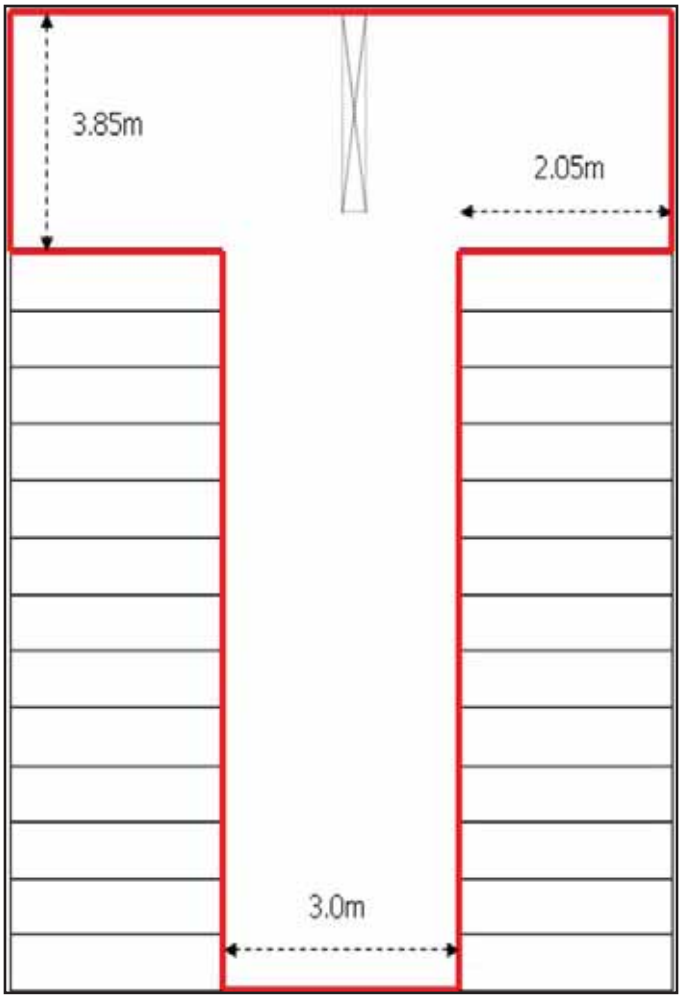

Figure 2. Diagram of a 'T-pen' showing feeding stalls with an alley between two rows of stalls and a solid floor loafing area at the end of the pen. An 'I-pen' is identical except it does not have a pen-wide loafing area at the end.

For 'T' and 'L' shaped pens additional loafing space is represented by the arm of the letter, and should add about 3m (10ft) to the total length of the pen area. In the loafing areas of 'T' and 'L' pens, adding solid partitions may aid in providing protection for resting sows without them having to isolate in their stalls outside of feeding time. These layouts also provide additional area for sloped solid floors for loafing, drinkers, comfort materials such as rubber mats or straw, and other enrichment materials; maintaining a space that sows enjoy being in is paramount to the use of the open loafing space. Nielsen (2008) states that a farm with 'T' pens saw 50-75% of sows in the common loafing area during resting times (i.e. feed is not present). In a study from Rioja-Lang et al. (2013), it was found that sows housed in 'T' pens spent significantly more time in the loafing area than sows housed in 'I' pens. In the 'T' pens, sows gravitated towards areas with walls to lean on rather than open space. This study does note that larger sows spent more time in the open areas in both pen styles, and that in both pen styles middle-parity sows spent the most time out of the free access stalls; these findings indicate that mixing decisions must be made carefully.

Training

Training gilts and sows to use gated stalls generally requires very little input. If a gilt or sow is hesitant to enter the stall, often the only encouragement needed to have them enter is a small amount of feed sprinkled at the entrance, or low-stress animal handling techniques such as gentle pressure from behind. A good time to assess if animals are having issues with entering the stalls is when the feed lines drop rations.

Issues with exiting the gated stalls are more common, as pressure is needed to open the gate. To help the sow exit, the stockperson may partially open the gate. If that does not work, moving a paddle around the sow's head or applying gentle pressure may encourage her to back up – once she begins to push backwards on the gate, the paddle should be moved away from her head. If the stall design allows, placing a board over the head of the sow to create a shadow can also encourage the sow to reverse.

Management Approaches

Group gestation housing can be managed with static or dynamic groups; static groups are preferable, but dynamic grouping can be used if sows are added and removed in a regular manner. Sows should be grouped by parity/age, weight, and body condition score. Uniform grouping ensures that the social hierarchy is not overly stratified; in free-access stall systems a submissive sow may choose to isolate herself in a stall, missing out on the benefits associated with loose sow housing such as exercise and increased social interaction. An isolated sow will have further issues integrating into the group, so this should be addressed as soon as possible. If there is continued or excessive aggression resulting in injury to multiple sows, it is best to identify the most aggressive sow and remove her, rather than removing the submissive sow(s). It is important to note that a sow using a stall to lay undisturbed is not uncommon, but if a sow is never seen in the open loafing area, there is cause for concern. Though the degree of involvement needed from stockpersons is relatively low for this system regarding feed provision, careful daily observation of sows is non-negotiable.

Free-access stalls can also make routine management practices such as vaccination, pregnancy checking, and creating groups to move to the farrowing rooms easier. Many systems will allow for individual stalls and rows of stalls to be locked, ensuring the sow does not back out of the stall before the stockperson is ready.

How much Space?

There is limited research data on the amount of space required per sow for free access stall systems. Leaving how much space is needed up to estimation, but in this regard the system is more complex than most other group housing. Free access stalls can be considered as having two parts: the feeding stall and the loafing area. Feeding stalls are generally designed to accommodate the animal for both feeding and resting. In order to allow large sows to rest comfortably in the stall, they are provided with a minimum of 0.60m (24 in) width, and 2.10 m (7 ft) length for a total of 1.3 m^2 (14 ft^2) per sow (Nielsen, 2008). Comparatively, cafeteria systems, in which the sow only uses the stall for feeding, a narrower and shorter stall that is wide enough for her to stand in but not wide enough to lie down can be used. The 'I' configuration, with only a slatted floor between two rows of stalls, is seen as the minimum loafing area. It is generally 3 m (10 ft) across to facilitate sow movement, which provides an additional 0.9 m^2 (10 ft^2) per sow when using 60 cm (24 in) stalls. This provides sufficient area for approximately 50% of the sows to use at one time (assuming a need for 1.7 m^2 or 19 ft^2 per mature sow), but it is unlikely that 50% of sows would be in the loafing area at once, in particular as slatted floors are relatively uncomfortable and discourage sows from using the loafing area. For producers who simply want to provide sows the opportunity to leave the stalls, the 'I' configuration with about 2.2 m^2 (24 ft^2) per sow would be sufficient.

However, if the intent is to provide a more comfortable loafing area, in order to encourage sows to use it for an extended period, both quantity and quality of space should be increased. In order to allow all sows to use the loafing area simultaneously, approximately 3.0 m^2 (33 ft^2) of space is needed for both the stall and loafing. To achieve this level of use, the loafing area would have to be more comfortable than the stall, requiring solid floor and bedding (or rubber mats).

The cafeteria system, in which several groups of sows share a bank of feeding stalls, has the potential to reduce space needs. If six groups of sows share a set of 'feed only' stalls, the stall requirement is less than 0.2 m^2 (2 ft^2) per sow. Providing a loafing area of 1.7 m^2 (19 ft^2) per sow would result in 1.9 m^2 (21 ft^2) per animal for the stall and loafing area combined. However, a cafeteria system also includes extensive alleys to move sows to and from the feeding stalls. Some of the space savings would be lost to these alleys.

Even at its minimum, a gated stall system requires more space than most other group housing. Achieving high usage of the loafing area would require even more space. The high space requirement is the greatest drawback of gated stalls, and producers should consider using low-cost buildings for this system.

Controlling Feed Intake

Controlling the feed intake of sows is a significant area of concern regarding group sow housing. In gestation stalls, feed intake is closely controlled as animals have completely protected access to their ration and it is very easy to see when it is or is not consumed. In free-access stalls, the initial quantity of feed dispensed into the trough of each stall should be the same. Stockpersons must carefully observe sow body condition, giving extra food to any under-conditioned sows. When a thin sow is identified, it is good practice to mark her back with a stock marker, so that it is easy for all stock people to identify that more feed needs to be added to her trough when she is in the stall. The lack of control over individual feed rations highlights once again the importance of carefully considering how sows are grouped; if possible, forming groups based on desired feeding level can help reduce issues with animals being over- or under-fed. The reality of sorting animals based on desired feeding level is complicated by the size of the group, the total number of sows in the system, if dynamic or static grouping is being practiced, and batch-farrowing schedule. Free-access stalls can provide more control over feed intake than floor feeding or short stall systems, but less control than systems utilising electronic sow feeders.

Sow Motivation to Access and Leave Gated Stalls

There are two major areas in the typical gated stall system – the individual stalls and the greater pen area, sometimes referred to as the loafing area. With each area, there is a motivation for the animal to interact with it. The greatest motivation for sows to enter the gated stalls is feed access, followed by the protection that the stall provides to lay undisturbed. The sow will be motivated to leave her stall to explore and socialize when she is finished eating her ration or done resting; in crate-housed sows, motivation to explore has been more greatly associated with a search for additional feed than for movement alone, as sows are generally feed restricted and have maintained an innate exploratory drive (Tokareva et al., 2021a). A further study associated sow satiety with the motivation to exit the stall, with sows fed a lower satiety diet being more motivated to exit their stall in search of additional feed (Tokareva et al., 2021b). Regardless of diet, all sows were motivated to leave the stall to roam, evidence that exercise is instinctive.

In a study on the behaviour of crate-naïve gilts when confined to a stall, it was observed that all animals tried to back out of the stall, and when confined for an hour the minimum number of attempts to back out was 41, and that most animals attempted to exit for almost the entire hour (Ede and Parsons, 2025).

Figure 3. A gated stall system with rubber mats installed over the slatted floor of the loafing area.

Rubber Mats

One way to increase the comfort of the loafing area is with the addition of rubber flooring. Rubber flooring has been extensively used in agriculture, particularly in dairy barns to increase cow comfort. It has been suggested that comfortable flooring may impact many aspects of an animal's state of well-being, including lying behaviour and ability to change position, as well as the incidence of lameness and skin and foot lesions (Boyle et al., 2000; Rushen et al., 2007; Tuyttens et al., 2008).

A past study completed at the Prairie Swine Centre investigated whether it is possible to increase the amount of time sows spend in the communal area by adding rubber mats to increase comfort, and by grouping sows by age to reduce fear in younger sows. The results indicate that in both 'young' and 'old' sow groups, pigs spent significantly more time in the free space areas with rubber flooring than concrete flooring, in both pen configurations (I-pens and T-pens). Sows housed in pens with rubber flooring were also significantly cleaner than sows housed on concrete flooring. Grouping sows by age was found to increase the amount of time that young sows spent in the common area.

A more recent study, also completed at Prairie Swine Centre, studied the influence of perforated rubber flooring in the gestation room. Results from this study suggest that the perforated rubber mat flooring is more comfortable for gestating pigs to walk on. This is evidenced by faster walking speed, improved overall locomotion, and improved specific aspects of locomotion including stride length, fluidity, and reluctancy. Additionally, sows housed in pens with rubber mats displayed better locomotion scores than those without when moving to farrowing.

From the same research group, it was found that most gilts tested (n = 21/29) preferred to spend time in an open pen rather than a stall. Animals were housed in a pen with feeders in an open area as well as gated free-access stalls in a 1:1 animal to feeder ratio. The study found that the number of animals that preferred the stall increased over the 7-day experimental period, with personality and time of day influencing preference (Ede et al., 2024).

These studies show that gilts and sows are both motivated to leave stalls to roam, interact with their peers, and display innate behaviours such as searching for feed. Preference for time spent in the stall or in the group pen area can be associated with previous exposure to stalls, individual personality, and factors associated with feed and satiety. Gated stalls provide protection while feeding and the ability for stockpersons to increase feed when needed, which may also reduce aggression associated with feed access.

Enrichment is an important aspect of loose sow housing. Rotating enrichment materials and providing an auditory cue before switching enrichment materials can increase the amount that sows interact with those materials (Roy et al., 2022). Suggestions for sow enrichment include ceiling-mounted three-stranded cotton rope, straw, suspended soft-wood planks, salt blocks, rubber mats (hung or placed on the floor), and positive human interaction.

KEYS TO SUCCESS

1. Maintain the gates so that they are easily opened by all sows when exiting the stall. Training of new sows may be helpful.
2. Make the loafing area as conducive to sow use as possible, by providing adequate space, water, fibre, and comfortable floors.
3. In large herds, sort the sows by age so that younger animals use the loafing area as well.
4. Remove despot sows that constantly attack other animals in the loafing area.

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Non Competitive Feeding Systems Electronic Sow Feeders

Jen-Yun Chou, Ph.D., Fiona Rioja-Lang, Ph.D., and Harold Gonyou, Ph.D.

The electronic sow feeder (ESF) system is considered a modernized way to manage group-housed sows with potentials for better nutritional management and animal care at the individual level (Parsons, 2016). The use of electronics to control all aspects of the system is a major shift in the management of sows, somewhat akin to the use of robotic milkers for dairy cows. Although it requires a significant shift in our approach to managing animals, the daily routine of the barn and staff training, it presents new opportunities for managing medium to large group size of animals while maintaining a level of individual monitoring.

HOW THE SYSTEM WORKS

An ESF system generally provides a single (or few) feeding station(s) for a large group of sows (ranging from 20 to 60 sows/station depending on the system). The sows must eat sequentially, one after the other per feeding station. The sows are usually identified by RFID (Radio Frequency Identification) ear tags, which triggers the gate opening or feed dropping. Once a sow enters the station, the entrance gate locks behind her. The computer-controlled feeder allots her a specific amount of feed, dropped into the feed bowl over a limited period. During the feed drop, and for several minutes afterward, the entrance gate remains locked so that other sows may not enter, which is why the system is a protected feeding system. The sow may leave at any time, ending the dispensing of feed and unlocking the entrance for the next sow. The computer records the amount of feed that has been dispensed to each sow (not the amount actually eaten) and allocates any un-dispensed allotment to a subsequent entrance by the same sow that same day, or to her next day's feed. The system typically cycles on a daily basis, with a new allotment of feed being made available to each sow every 24 hours. As the stockperson will not be present while each sow eats, the system must provide feedback on any sows that fail to eat their allotment each day. This feedback is in the form of an 'attention' list available every 24 hours and is used to identify animals that may need additional care.

There are currently two main types of ESF. One is the conventional ESF, a walk-through system where the system has a separate entrance and exit. The animals go through the system in a one-way traffic. The other, also known as the free-access ESF system, has only one shared entrance/exit, so the animal needs to back up when exiting the feeder, which forms a two-way traffic. It combines aspects of gated free-access stalls (see Issue 5) and ESF. Feeders are usually arranged side-by-side as in a gated free-access system, but they are equipped with electronic drop systems. To account for the cost of the ESF equipment, two-way ESF systems are placed at a higher ratio, usually about 20:1. This ratio is lower than what is often seen in one-way ESF systems and may reduce competition at the feeder entrance while facilitating side-by-side feeding. Many features are shared between the one-way and two-way ESF, and where differences occur, it will be specified in the sections below.

Automation of Sow Management

ESF is the only group housing system that currently allows for true control over individual feed intake. When a sow initially enters the system (pen), the manager enters a personalized feed program for her into the system. This will set the amount of feed the sow will receive each day and allows for adjustments as gestation progresses. The manager can base these levels on the sows' age, weight, body condition score (visually assessed or using a caliper, Li et al., 2021) or direct back fat measurement. Other group housing systems try to achieve equal feed intake for every sow in the group, but in ESF systems, sows can be programmed to receive more or less than the pen average. It is also possible, with many ESF systems, to program different diet compositions for sows within a pen, allowing sows to receive a specific diet, or a blended diet to achieve the appropriate protein and energy combination for individual sows. With the advance of technology, some ESF systems incorporate automatic weighing scale during sows' daily feeding to allow individual condition tracking and dynamically adjust feed delivery to optimise sows' body condition across gestation (Parsons, 2013). Some modern ESF systems also save labour by incorporating electronically controlled pig sorting with automatic spray marking for heat detection, pregnancy check, vaccination and animal movement.

How Sows Behave

A common observation of people when first observing a group of sows in an ESF system is that the animals are quiet and restful. Because the sows eat sequentially, rarely is the entire group active at the same time if the animal to feeder ratio is optimal. Typically, only a few sows are standing, even when stock people enter the pen and move about the animals. The greatest activity occurs immediately after the station initiates a new day of feeding (Hodgkiss et al., 1998). Several sows will approach the entrance and compete to be among the first to feed. Towards the end of the feeding cycle, only timid, subordinate animals will be left to eat (Strawford et al., 2008).

Sows gather in front of shared ESF. Image courtesy of the Ahrens farm.

Electronic Sow Feeding systems are the only group housing system that currently allows for true control over individual feed intake

If the feeder permits, sows will enter approximately three times per day (Cornou et al., 2008), and if there is multiple stations in the pen, they show preference for one of the stations (Eddison, 1992). Under moderate stocking rates, most sows will eat all of their food allowance on their first visit to the feeder (Cornou et al., 2008; Ornelas et al., 2026). When in the feeding station, sows eat quickly and if feed is not falling at their desired rate, will show impatience by banging the dispenser with their head. Upon exiting the station, a sow typically goes for a drink and may urinate or defecate before moving to the loafing area, depending on whether dry or wet feed is provided. For the two-way ESF systems, as water is not provided in the feeder, it is essential to place sufficient drinkers in the pen for improved accessibility. Recycling through the station many times during the day is characteristic of a few sows, particularly if the feed bowl is designed such that a small amount of feed falls on the floor or remains in the bowl. A recent study with one-way ESF recorded more than 60% of total ESF visits were non-nutritive, meaning that the sows did not record any feed intake during these visits, and each sow on average performed 2.5 non-nutritive visits per day (Ornelas et al., 2026). In gilts, these non-nutritive ESF visits were positively associated with the frequency in oral stereotypic behaviour and higher skin lesion counts (Lagoda et al., 2025).

Competition is evident among sows. Dominant sows will enter the station earlier in the feeding cycle and occupy the feeder for longer (Sommer et al., 2023). This may involve some aggression in the entrance area, and in late gestation, may result in vulva injuries (Rizvi et al., 1998). A recent PSC study on a one-way ESF commercial barn showed that longer waiting time at the entrance increased the frequency of aggression (Luo et al., unpublished).

KEYS TO MANAGE ESF SYSTEMS

Other sow housing systems will continue to function well if staff are negligent in inputting data into the system. This is not the case with ESF systems. Management of sows, in terms of feed distribution, monitoring intake etc., is heavily reliant on the electronic identification system and computer programming. It is critical that animal information be updated in the computer whenever animals are added to or removed from a pen. In addition, lost or failed electronic ear tags must be replaced promptly if the sow is to continue to be fed. Information on the animal, in terms of the appropriate feeding curve and due date, allows the system to provide the correct amount of feed and schedule the animal for sorting when necessary. Failure to keep up to date and accurately input information can be a major problem with ESF management.

The output from the system, in the form of the daily attention list, is also a key component of electronic management. For the feeder itself, keeping a good maintenance record and regular inspections is critical, as the animals cannot eat if the ESF is not working well. This usually means ensuring there is staff knowledgeable of basic mechanical maintenance (Parsons, 2017). It is not ideal to fully rely on ESF vendor technicians to provide rapid response to service requests. Having important spare parts inventoried on the farm also greatly reduces downtimes. Failure of the equipment must be addressed promptly, and a back-up plan must be in place.

Failure to train animals to the system will result in many missed meals and eventually require the removal of these animals (Bressers et al., 1993). For a barn just transitioned from stall housing, it is essential to assign the gilt training task to specific staff, as this is a new duty in an ESF barn (Parsons, 2017). Training is not particularly difficult with a well-designed training pen and protocol because pigs are smart and motivated to eat. It does require the training staff to remain patient, gentle and calm during the training process, because the last thing that should happen is to make the animals associate the feeder with an adverse experience. Gilts should be trained by housing them in small, separate groups and ensuring that each animal passes through the station each day. The gilts need to learn to enter the feeder to eat and learn to eat their daily feed allowance at once (Parsons, 2017). Once trained in a small group, the animals should be incorporated into a moderately sized group before eventually entering a large group. The more thorough the training, the fewer days of missed feed will occur. Because feed intake can be variable during training, it should be avoided as much as possible during the first month of gestation. Gilts ideally should be trained 4-5 weeks before first planned breeding. Some report no training is required for some two-way ESF systems, but on-farm experience suggests variations in whether a basic level of training may be required.

One of the worst problems with ESF management is the tendency to overstock feeding stations. The more sows being fed from a station, the less time is left at the end of the feeding cycle for young, timid sows to enter and feed. Overstocking results in competition to access the feeder, evidenced by increased aggression at the station entrance and frequent missed feedings by subordinate sows. The key to achieving a high stocking rate on a station is to decrease the amount of time spent in the station by each sow. Early studies often used stocking rates of 40 sows per station, but many farms are now successfully feeding 60. However, this level could be problematic if managed incorrectly. Overstocking will result in uneven body condition and poor performance by the thin animals.

Converting to group housing is not just an infrastructural or technological shift; it is a human resources shift. Maximising the welfare and production benefits of group housing requires investing in staff training and prioritising stockmanship (Parsons, 2017), which will prove tremendous returns in the long term.

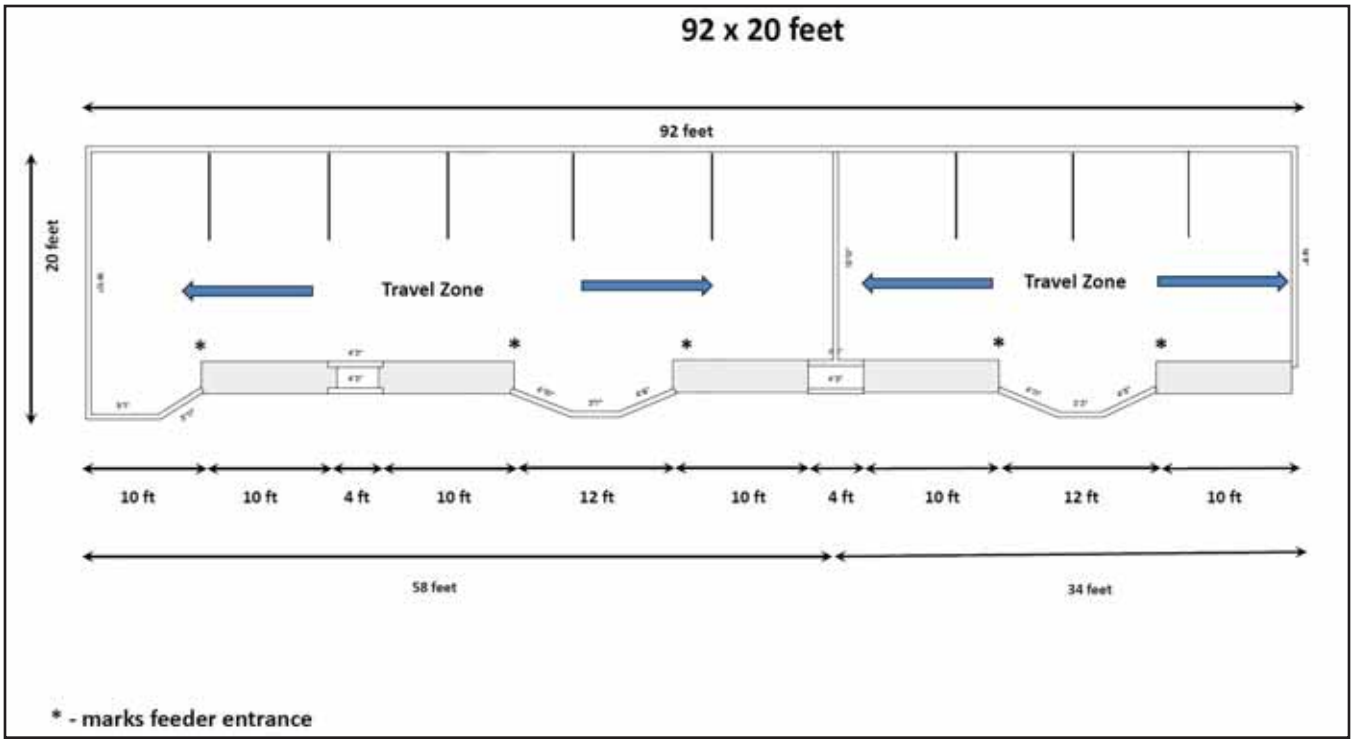

Figure 1. Pen design for a two-way ESF system. From Dr. Tom Parsons.

Pen Layout

Because it does not need to involve a row of feeding stalls, or even a long feeding trough, an ESF system can be more flexible in terms of pen design. However, many report that the system is more efficient if the pen is seen as three distinct areas: entrance, exit and loafing (or two areas for two-way ESF systems).

The entrance is the area in which sows await their opportunity to enter the station. The animals are hungry and this is the area of greatest aggression. There should be room for animals to flee from more aggressive sows, and any dead corners should be avoided so that animals won't be trapped in them (Parsons, 2016). Some form of roughage (e.g. straw in a rack) can be provided in this area to help alleviate hunger (Stewart et al., 2008).

In two-way systems, it is recommended that at least 3 meters of buffer space reserved on both sides of the entrance to prevent dominant sows from guarding the entrance and causing more aggression (Parsons et al., n.d.). Figure 1 is an example of pen design for a two-way system.

In one-way systems, animals should pass through the exit area quickly, but they may want to drink additional water as they have just finished eating. Many pen layouts allow sows to move directly from the exit back to the entrance area, though this contributes to recycling. Better flow is created if sows pass through the loafing area before returning to the entrance.

The loafing area is often a large open area for the sows to rest. If any area in the pen is to be solid floor or bedded, it should be the loafing area. Although an undivided area is common, it may be helpful to provide barriers that divide the loafing area into several bays. This is particularly important if a dynamic grouping system is in place, as sows that enter the pen at the same time will generally move into the bay or bays vacated by the group that recently left.

Although there are many variations of the three-zone system, Figure 2 illustrates the principle well. Sows enter the station from one zone, exit into another, and then move to the loafing areas before returning to the entrance. Figure 2 also illustrates the use of gates that can be used to separate the group into pre- and post-feeding to reduce competition. This can be helpful in training or for caring for problem animals that have failed to cope with the competition around the entrance. However, this would only be used in a few pens within an operation.

If pen layouts are well designed, ESF systems can operate well at space allowances of 18-20 ft² per sow. However, aggression and skin injury scores can be reduced by providing more space (Remience et al., 2008)

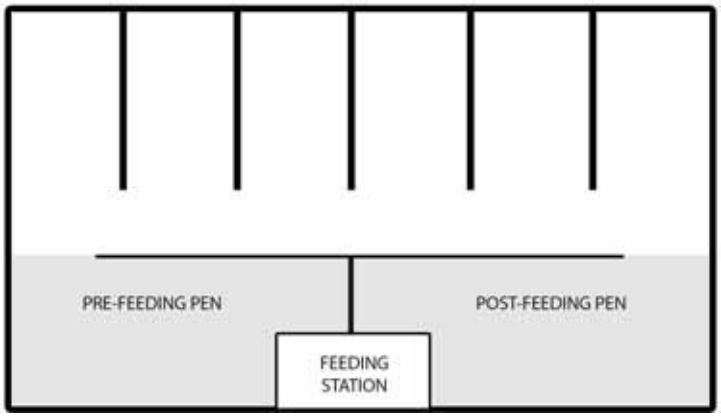

Figure 2. Diagram of a single pass system.

POTENTIAL FOR ELECTRONIC-BASED MANAGEMENT

An ESF system identifies animals as they pass through critical points in the pen each day. This information can be used to help manage the animals; in dynamic systems it is common to have to vaccinate or sort for farrowing a number of animals on a given day. Most systems have a sorting system incorporated in the station exit to move these sows into a holding area. If a few sows should be marked for attention within the group, their ID can be flagged within the system, and they will be sprayed with paint as they feed.

Electronic ID of sows can also facilitates oestrus detection. If there is a boar pen located near the pen, in-oestrus sows will spend a great deal of time in the area; sensors mounted to the boar pen can identify sows and record duration in close proximity. In addition, the system could also be set to monitor the time at which sows enter the station, the amount of time spent eating, and the occurrence of low-feed intake days. Sows generally show repeatable patterns for these measures, and a deviation may be indicative of a change in physiological state such as oestrus, illness, or injury (Cornou et al., 2008), but this needs to be utilised alongside daily visual inspection of individual animals, which should still be carried out routinely in ESF barn.

An interesting approach to reducing recycling of sows through the ESF and the associated aggression is to program the system to call individual sows to the station (Mantenffet et al., 2011). The computer is programmed to allow sows to eat during a specific time and initiates a voice call just prior to the station accepting them. Recent research also demonstrated that sows could learn individualised sound cues for feeding, which reduces aggression at feeder entrance (Blanc et al., 2024). Although not yet in commercial application, this approach illustrates the type of potential that exists with electronic-based management.

Figure 3. A sow examines a boar through a 'peep hole' equipped with an RFID scanner, which records her interest. Photo courtesy of Hog-Tied Farms.

KEYS TO MANAGING ESF SYSTEMS

1. Ensure that all sow IDs, breeding dates and feeding levels are entered into the system whenever a sow joins a group.
2. Check all animals daily to ensure no RFID tags are lost. Replace lost tags immediately when found.
3. Train animals well so that they are confident in using the feeding system before entering a large group.
4. Base your daily management on the attention list generated by the system at each daily reset.
5. Create a good flow of animals with your pen design that promotes movement from entrance, to exit, to loafing areas.
6. Avoid overstocking the station. Every animal should be able to eat easily each day.
7. Prioritise staff training for a new mindset for managing ESF systems and the importance of good stockmanship.
8. Daily checks on all animals should still be part of the routine in ESF barns even with the level of automated operation.

Reducing Time Spent in the Feeding Station

Overstocking of an ESF occurs when there is not enough time during a feeding cycle for all sows to pass through the station and consume their ration. This problem can be resolved by either reducing the number of sows/station or by reducing the amount of time spent in the station by each sow. One study reported that sows spent an average of 25-30 min/day in the station (Edwards et al., 1988). However, there are a number of ways to reduce this time to make the system more efficient.

Sows eat faster if water is provided in the feeding stations. Including approximately 50% water with the feed (e.g. 50 ml per 100 g) will increase rate of eating by as much as 35%. If water is added, there is little difference in the eating speed for mash versus pelleted diets. Water should be added with each drop of feed. Most manufacturers make provision for this in their equipment, but managers must ensure that it is working well and maintained.

The feed drop rate can be set to keep up with the fastest eating sows. Sows differ considerably in the time required to consume their daily ration, even if all are fed a wet diet. Older sows may finish their feed in as little as 10 minutes, while gilts will often take longer than 20 minutes. By setting the station to dispense the diet over a 10-minute period, faster eating sows can finish and be out of the station within 12-15 minutes. Slower eating sows and gilts will need to have the entrance gate locked for up to an additional 10 minutes for them to consume their feed and leave. One problem with this approach is that a slow eating animal that leaves after 15 minutes will leave a significant portion of her ration in the feed bowl, and this will be recorded as feed consumed - she will not have access to it the following day. Therefore, it is not recommended to set the feeding time limit per animal too short, in case animals do not have sufficient time to finish their meal, which may create more recycling, incomplete daily feed intake, and subsequently more animals that miss feeds and need to be pushed.

Total time spent in the station is reduced if sows are discouraged from multiple entries (recycling). Some feeder design retracts/closes the feed bowl after a sow leaves and only reopens if the next sow has not already consumed her daily ration. The only feed available to a sow that recycled is whatever falls on the floor around the bowl. Another feeder design reduces recycling by having an identification at the entrance to the station that only unlocks the entrance gate if the sow has not previously consumed her entire ration. Sows quickly learn that there is no point in attempting to re-enter the station. In one-way ESF system, pen layout can also be used to prevent sows from recycling too easily, by separating the entrance and exit area.

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Re-Grouping and Timing of Re-Grouping

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One of the greatest objections to group housing of sows is the fear of aggression among the animals. The vast majority of aggression in groups of sows occurs either at the time of re-grouping, or during the daily feeding. Re-grouping aggression may be intense, but is generally short-lived and contributes to acute stress. Feeding aggression is repeated daily and can be considered a chronic source of tension and stress within the group. The issue of feeding aggression has previously been addressed in our discussion of feeding systems. In this article we will examine re-grouping aggression and its impact on management and productivity.

Why do Sows Fight when Re-Grouped?

Our reluctance to keep sows in groups seems somewhat misplaced as, in the wild, pigs live quite harmoniously in groups of numerous sows and their litters (Gonyou, 2001). The difference between commercial production and living in the wild is that sows in the wild rarely, if ever, incorporate new sows into their group. If any sow attempts to join a group, she will be attacked by the resident sows and forced to leave. That is really what happens when we mix sows in commercial conditions: the resident sows attempt to drive away the intruders. Difficulties arise because the new animals cannot leave (Mendl and Held, 2001). Although we often attribute the aggression of newly mixed pigs to the need to establish their dominance order, that is likely a secondary aspect of the aggression. Subordinate animals cannot just submit and accept a low position in the dominance hierarchy; they must also find a way to be tolerated within the group. The key to remaining in the group is to stay on the periphery. Moore et al. (1993) and Kraus and Hoy (2011) studied the lying position of sows after new animals were added to an established group. The new animals slept together, apart from the resident animals for several weeks after being introduced. Gradually they were able to integrate into the main group. Once established, the stability of a group of sows is maintained more by avoidance than by aggression (Jensen, 1982). Maintaining separate sleeping areas contributes to this avoidance.

Within a well managed group housing operation, many animals within a group will be familiar with each other from their previous gestation period. Sows are able to remember previous pen-mates even after several weeks of separation during farrowing and nursing (Arey, 1999). Consequently, when sows are grouped for a subsequent gestation period, the group consists of previously acquainted sows (an established group) and a number of new animals. The new animals will generally be gilts or first parity animals recently added to the breeding herd. Thus, the challenge often associated with younger animals, being the least able to dominate, is confounded by the fact that they are also new. Younger animals (Strawford et al., 2008) and newly introduced animals (Moore et al., 1993) end up sleeping in the least preferred areas of the pen.

How Much do Sows Fight, and How Severe are the Injuries?

Re-grouping aggression is described as intense but short-lived. Fighting is greatest during the first three to four hours after mixing, and decreases to very low levels by 3-4 days after re-grouping. Reports differ in how aggression has been defined, but the average number of fights during the initial three hours is generally less than three per animal (Moore et al., 1993, Strawford et al., 2008, Kraus and Hoy, 2011). Extrapolating the data of Kraus and Hoy (2011) we estimate that new sows added to a pre-existing group of familiar animals will fight less than 30 times during the first four days.

The length of fights have been found to range from eight to 420 seconds but average at around 70 seconds (Arey, 1999). In the first three hours after mixing, the average time spent fighting by sows was reported to be 68 seconds by Strawford et al. (2008). Moore et al. (1993), reported similar value for new sows in a group, but new gilts fought for a shorter duration. In general, new sows are involved in more aggression (Kraus and Hoy, 2011), and older animals fight more than younger ones (Moore et al., 1993).

Fighting is sometimes assessed by the degree of injuries received over a period of time. Hodgkiss et al. (1998) reported that only 0.16% of injuries received (when studying sows in an ESF system) were considered severe, and of the severe injuries, half were to the vulva. The vast majority of injuries due to aggression are in the form of surface scratches to the skin, generally on the neck and shoulder. However, the incidence of scratches is greater for younger, smaller animals (Hodgkiss et al., 1998) even though they are involved in less fighting than older sows (Strawford et al., 2008).

It needs to be recognized that most reports on aggression and injuries report average values for either the entire group of animals, or particular sub-groups (such as gilts or newly introduced animals). The extremes in terms of number of fights, time spent fighting and severity of injuries may not be reported. Nevertheless, it can be said that the majority of sows in a group are involved in few fights and for a short period after regrouping.

Re-grouping aggression is described as intense but short-lived. Fighting is greatest during the 3-4 hours after mixing, and decreases to very low levels by 3-4 days after re-grouping

Reducing Aggression at Re-Grouping

We want to approach this challenge from a behavioural perspective, and will categorize methods to reduce re-grouping aggression according to the behaviour of the animals. The first approach is to reduce aggression by increasing familiarity among the sows. Whenever sows are grouped following breeding, you will have some sows that were housed together during their previous gestation and those that were not. Gilts will usually be unfamiliar with the older sows in a breeding cohort. In a study at the Prairie Swine Centre, we formed groups entirely of familiar animals or groups that included a number of unfamiliar sows (not housed together previously). The familiar sows did fight, but the fights were very short and produced few injuries. Fighting decreased rapidly over the first few days together. We observed the same pattern among sows that were grouped at weaning and then stalled for breeding. When placed into gestation groups they appeared to re-familiarize themselves with each other quickly and then aggression stopped (Rioja-Lang et al. 2011). Pre-mixing unfamiliar sows in a specially dedicated mixing pen can see levels of aggression reduced after 1-2 days together. These mixing pens tend to be larger, and more complex (contain dividers) thereby allowing individuals to retreat. Durrell et al. (2002) reported that pre-mixing unfamiliar animals to be added to an already familiar group reduced aggression in the post-breeding mixing. However, because most of the aggression is directed towards the unfamiliar animals, it appears that adding just a few new animals to a group is detrimental (O'Connell, 2004). The conclusion is that if unfamiliar animals are part of a group, they should make up more than 10% of that group.

The second approach to reducing aggression at re-grouping is to control the amount and layout of the space and allow animals a means to escape from an attacking sow. We found that providing escape stalls within the pen greatly reduced the injuries due to fighting. Free access feeding stalls will provide such an escape. An intermediate means of providing separate space for new sows is to divide the pen into subsections so that unfamiliar sows will claim one of them as their own (Sequin et al., 2006). Unfamiliar sows in a large group tend to form a new group of their own for lying. However, these sub-sections must be large enough to allow several sows to lie together. Small sub-sections may become a form of trap as animals flee from a fight. Finally, providing more space is a means of allowing animals to avoid an unfamiliar animal, flee from a fight, or rest on the periphery of the group. The shape of the pen may help in allowing sows to avoid one another, and flee from a fight. Rectangular pen shapes appear to be more useful than square pens in allowing sows to avoid one another, meaning that pen shape could play a more important role than space allowance (Barnett et al., 1993).

Figure 1. Mild, average, and severe injuries from post-grouping aggression

A third approach to reducing aggression is to attempt to create a stable social structure. Small groups (less than 8-10 sows) will form stable, linear hierarchies but mid-sized groups are less stable. However, pigs in large groups (over 40-60) develop a different social strategy in which they tolerate other animals rather than having to try to dominate them (Turner et al., 2001; Samarakone et al., 2009). Replacement gilts previously housed in large groups may be better prepared for group housing as sows. An alternative means of preparing gilts for life in groups is to frequently re-group them during development. Such animals are less likely to

be aggressive once they join a sow group (Bolhuis et al., 2004; van Putten and Buré, 1997). Generally, groups made up of a range of body weights will form a more stable social hierarchy, but the subordinate animals may be at too great a disadvantage in a competitive feeding system. Several studies have examined using one or more clearly dominant animals in a group to try to suppress aggression. Our attempt to do so with large, higher parity sows in a group of younger animals did not reduce aggression. Reports on the use of a boar to suppress aggression in a group of sows have produced mixed results (Luescher et al., 1990; Sequin et al., 2006).

Miscellaneous methods have been used to reduce aggression when re-grouping. Barnett et al. (1994) reported that it was best to group animals late in the day just before the lights are turned off. Feeding the animals a double portion of their diet just before mixing can also be effective. Hemsworth et al. (2006) and Strawford et al. (2008) reported that sows that are several weeks pregnant fight less when regrouped than those that have recently been bred.

When to Re-Group

Considerable variation exists in the time at which sows are regrouped both in legislation and commercial practice. The range includes forming groups immediately after weaning until after pregnancy is confirmed by ultrasound (typically 35 days post-breeding). Physiological studies in which stress is applied at different times during this period have generally failed to generate a significant difference in loss of embryos, although the period from 10-15 days post-breeding seems the most sensitive (Einarsson et al., 1996); this coincides with the time when embryos are migrating within the uterine horns prior to implantation.

In a survey of commercial farms it was reported that excellent productivity could be obtained regardless of the time of re-grouping on well managed operations (Spoolder et al., 2009). Of the farms with poorer productivity, the largest proportion re-grouped their animals between 7 and 21 days post-breeding; this coincides with the period of embryo migration. Some producers have found that if re-grouping prior to implantation, it is critical to do so within 2-3 days of breeding (ten Beek, 2011). Our experience with an ESF system at the Elstow research facility was that regrouping at 7-9 days post-breeding resulted in a 5% reduction in farrowing rate compared to waiting until 35 days (Gonyou et al., 2006). Another alternative is to wean sows directly into group housing; despite concerns of mixing at weaning, there may be benefits which are overlooked. For example, weaning sows directly into groups may facilitate subgroup formation and familiarization which can be advantageous when mixing sows into larger groups. By establishing familiarity within a small cohort, incoming sows may face fewer dominance conflicts and reduced aggression when introduced to a larger group (Pierdon and Parsons, 2018). This aligns with Rault et al., (2014) who compared sows weaned directly into groups to those weaned in individual stalls, whereby both treatments were then grouped 6 days after weaning (within 2 days post-insemination) into pens with individual full length feeding stalls. No differences in cortisol levels or aggressive behaviour at feeding were detected between groups 7 days after mixing, though stall-weaned sows had more skin injuries; this indicates that these sows experienced more severe aggression when integrated into new groups. The latter likely benefited from early familiarization within their cohorts before they were moved to a new group.

Einarsson et al. (1996) examined three sources of stress that could be key to how to manage re-grouping to support embryo survival. Heat stress will affect farrowing rate regardless of the system, but re-grouping in hot weather probably adds to the problem; re-grouping in the coolest part of the day, or the use of cooling devices, should help to alleviate the problem. Aggression is often considered the reason for the loss in productivity, but again, research has failed to demonstrate this clearly. Practices to reduce re-grouping aggression, as outlined above, should be enacted for animal welfare and production effects. The final stressor considered is reduced feed intake. In non-protected systems, such as floor feeding and short stalls, subordinate animals may be subject to reduced intake during the critical period of implantation. In a heavily stocked ESF system, subordinate animals and those unfamiliar with the system may go without optimum intake. Only free access stalls are likely to guarantee adequate nutrition. Re-grouping sows during the critical implantation period may be more detrimental in competitive and ESF systems than in free access stalls. This is particularly relevant because aggression is typically more intense during this period (2–9 days post-insemination), likely due to hormonal changes associated with the first trimester of pregnancy (Lende et al., 1994).

In summary, the critical period for loss of pregnancy appears to be 7-21 days after breeding. Systems that manage heat stress, re-grouping aggression, and feed intake well should be able to achieve acceptable productivity.

The Time Course of Implantation

After breeding, pregnancy is confirmed by the absence of a return to oestrus at 21 days, or a positive ultrasound test at about 28 days after breeding. Any loss of pregnancy during this time is generally attributed to stress, such as regrouping of the animals. Einarsson et al. (1996) suggested that several types of stress could affect pregnancy during this time such as food deprivation, poor thermal conditions, as well as social stress of regrouping. To understand what is happening during this period of time, he reviewed the process of implantation.

Embryos enter the uterus 2-3 days after breeding and then must migrate throughout the uterine horns to evenly distribute themselves. Migration of the embryos continues up to approximately day 12 post-breeding, and then follows the process of attachment or implantation which occurs from about day 13 to day 18 after breeding. Disturbance before embryos begin migration at 2-3 days post-breeding is likely minimally disruptive to pregnancy

In an effort to determine at what stage pregnancy loss was most susceptible to stress, Arnold et al. (1982) injected a number of sows with ACTH (a stress hormone) once daily for 5 days from periods of 1-5, 6-10, 11-15 and 16-20 days of gestation. Although there was not a significant effect on embryo survival, the lowest level was observed for animals injected between days 11-15 after breeding. Several other papers have suggested that day 11-15 after breeding, during the initial stages of implantation, may be the period of pregnancy most susceptible to failure.

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Dynamic Mixing to Increase Group Size

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One of the roles we play in raising livestock is that of social managers of the animals. We decide which animals live together in a group, and when and how the group is formed. In the case of gestating sows, we decide which sows live with each other during their period of gestation. Our default social group, the one that happens if we disregard our role as managers, would be the breeding cohort. This would include all of the animals that were bred during a set period, which on most farms would be a week.

In previous issues, we have discussed the most common social management decisions, which involve sorting the cohort according to one or more of the following criteria: nutritional needs, competitiveness, or experience with the housing system (particularly ESF). The outcome of this sorting would be multiple groups, each of which is more uniform than the original breeding cohort. Another outcome is that the groups are smaller than the cohort as a whole is. These groups are often managed as static groups - no animals are added to a group once it has been formed.

The two main options for managing sow groups are to either keep them as a large (breeding cohort) group that includes a great deal of variation, or to form a series of small groups that are uniform. Nevertheless, there is another option. Dynamic grouping involves adding animals, usually from a subsequent breeding cohort, to a previously formed group. If you simply combine two entire cohorts, you have a very large group with a great deal of variation. However, if you combine animals already sorted by one of the above factors, you have a larger group of uniform sows. An example would be a group comprised of only gilts, but from two or more breeding cohorts. Dynamic social management exists in order to create larger groups of animals. However, it involves a second re-grouping event that will result in another bout of aggression. Is there an advantage to dynamic mixing?

WHY LARGER GROUPS?

There is a variety of reasons to house sows in larger groups. One of the most evident is that sows in large groups (over 40 animals) can share space and require less space per animal than those in smaller groups. The EU recommendations are that the standard recommended space allowance should be increased 10% for groups of six or fewer animals, but can be decreased by 10% when group size is of 40 or above, animals. (Council Directive, 2001).

A second reason for using larger groups is related to building costs, because as pen size increases the ratio of perimeter:area decreases. What this means is that the amount of penning needed (and related costs) per sow decreases as group size increases. To house 15 sows in a square pen at 1.8 m^2 (19.4 ft^2) per sow requires a 27 m^2 (291 ft^2) pen (5.2 x 5.2 m, 17 x 17 ft) with 20.8 m of perimeter penning. To house 30 sows in a square pen at the same space allowance would require a 54 m^2 pen (7.4 x 7.4 m, 24 x 24 ft) with 29.6 m (97 ft) of perimeter penning. On a per sow basis, penning requirements are reduced by nearly 30%.

A third reason to house sows in larger groups is to take advantage of expensive technology. This is best illustrated by the ESF system; the major cost of this system is the feeding station that must be

able to identify each sow, dispense a specific amount of feed for each sow, and keep track of which sows have fed. The technology can be used to manage individual feed with preprogrammed increases throughout gestation, to identify problem sows that are not eating regularly, to sort sows out of the group for management events (pregnancy checks, vaccinations, moving to farrowing), and even for heat detection. The system is costly, and it is to the producer's advantage to minimise the cost per sow. If your group size is 30 animals, the cost per animal will be double that for groups of 60 using the same single feeding station.

One additional reason for keeping large groups relates to the social behaviour of pigs. Pigs in small groups have a strict social linear hierarchy whereby one animal (the alpha) is dominant to all others, and a second animal is dominant to all but the alpha pig etc. Such a rigid hierarchy requires effort to establish and maintain. The system works when the benefits of being a dominant animal exceed the cost of maintaining the hierarchy. From research with growing pigs, we know that an alternative system forms when the benefits of being dominant are less than the costs. In large groups, pigs become more tolerant of other animals and do not need to maintain a strict linear hierarchy reinforced by aggression (Andersen et al., 2004). The result is that pigs from large groups fight less than pigs from small groups (Samarakone and Gonyou, 2009). The benefits of being dominant in competitive sow housing systems such as floor feeding may always be greater than the costs of that status, but in non-competitive systems such as ESF and gated stalls, we can expect to see social tolerance develop and reduced aggression in larger groups. ESF can be competitive in overstocked situations and pushed systems to their limits; most walk-through ESF systems have been studied at 80 sows/feeder.

Is Dynamic Grouping all that Different?

A key concept of dynamic grouping is that a new group of sows is added to an already established group. These are often referred to as the 'unfamiliar' (or 'new'), and the 'familiar' (or 'resident') sows, respectively. In general, aggression within the new combined group occurs between 'familiar' and 'unfamiliar' sows. Aggression among familiar animals is very low, and unfamiliar animals appear to avoid aggression as much as possible as they are the 'invaders' attempting to join the established group (Krauss and Hoy, 2011).

If we consider a static system, in which all members of a breeding cohort are grouped together on the same day, we find some similarities with a dynamic group. In a typical operation, animal flow is such that over 50% of the sows in a static group are likely to have been grouped together during their previous gestation. These are the animals which were not culled and that cycled normally after weaning. These animals will recognise each other as group mates (Arey, 1999) and are similar to the familiar sows in a dynamic system. The unfamiliar sows in a static system are the gilts, and the sows that failed to cycle normally after the last gestation (delayed oestrus or found open and rebred). Thus, in a static system we have large proportions of familiar and unfamiliar animals, similar to what we have in a dynamic system.

There are, however, some differences. The unfamiliar animals in a dynamic system include all parities in a proportion similar to that of the familiar animals. In the static system, the majority of the unfamiliar animals will be gilts, which lack both size and social experience to compete for dominance. In addition, in the dynamic system, re-grouping aggression will occur after each addition of new sows, at least twice during a gestation. In a static system, re-grouping aggression only occurs once during a sow's gestation.

We know that newly added sows in a dynamic system will try to avoid confrontation with the established group by lying in a separate area (Moore et al., 1993); it may be helpful to section off the loafing area before a new group is added so they can claim that space when they arrive. To ensure that there are enough new animals to act as a cohesive group, it appears that the group should be at least 20% of the resident group (O'Connell et al., 2004).

STATIC VERSUS DYNAMIC

Most experimental farms operate using either a static or a dynamic system for their group-housed sows, but few have made systematic comparisons between these systems. As a result, most advice is based on professional judgment, experience and common sense, not scientific data. The advantage of static groups is that there is only one re-grouping event, with aggression minimised to a period of a few days. In a dynamic system, there are at least two, and sometimes up to three or more re-groupings, each of which is associated with a period of aggression. However, sows enter the group as 'unfamiliar' animals only when introduced to the pen and then become 'resident' animals for all subsequent additions. Their level of injuries is likely to be higher following their initial entry than when subsequent groups are added.

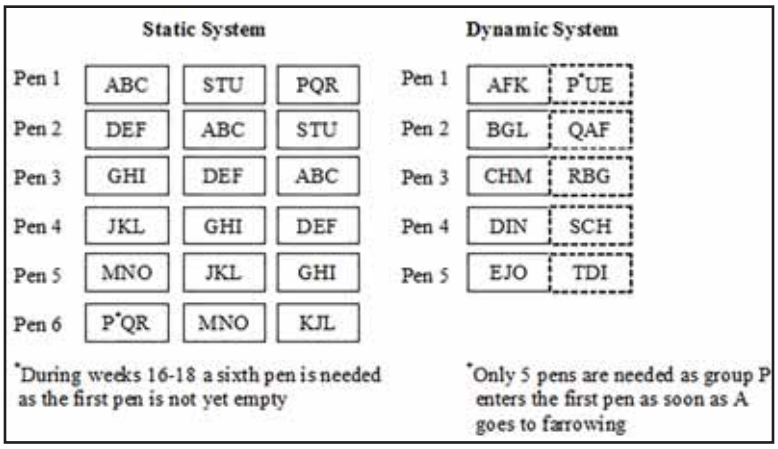

Figure 1. Dynamic mixing of breeding sows in consecutive and staggered systems. Groups A, B, C, etc. represent weekly breeding cohorts.

In studies in which both static and dynamic systems were compared the results show some variation. Neither Strawford et al. (2008) nor Anil et al. (2006) observed a difference in aggression between the two systems. However, some studies reported a difference in injury scores, with higher levels observed in dynamic groups (Anil et al., 2006; Li and Gonyou, 2013), while others did not (Strawford et al., 2008). Interestingly, the difference in injury scores was not evident on the day following introduction, but rather two weeks later. This suggests that dynamic pens took longer to stabilise their social structure than did static groups. Neither research group reported differences in the stress response (cortisol levels) of sows between the two systems. In a cross-sectional study comparing 10 Belgian sow herds either using dynamic or static group management, static herds had lower lameness scores and decreased skin lesion prevalence at the end of gestation compared to dynamic herds, with no difference in claw lesion prevalence (Bos et al., 2016).

Consecutive versus Staggered Dynamic Groups

The most common means of dynamic grouping is by forming 'consecutive' groups. A group of sows is placed into an empty pen and more animals are added over consecutive weeks until the pen is full. The system is easy to manage and eventually all of the sows will be removed for farrowing before a new dynamic group begins to form.

An alternative to the consecutive system is a 'staggered' group. In this system, the addition of new pigs to a group is staggered, with several weeks between each entry. Between these weeks, newly bred animals are placed in other pens in the system (Figure 1). The staggered system has two advantages related to the time of grouping and space use. Sows enter a pen after breeding but, unlike the consecutive system, no new pigs are added for several weeks allowing the initial group to be well past implantation before another round of aggression occurs. In addition, when the new sows are added, those already present are well established socially and further along in pregnancy; both of which will reduce aggression (Hemsworth et al., 2006). Another advantage is that the staggered system can operate with one fewer pen than a consecutive system.

In terms of space use, new sows are added to a dynamic pen within a week of the previous group being moved to farrowing. The result is that no pen sits empty, or partially filled, for an extended period.

Some studies have used staggered system with grower/finisher pigs in an attempt to reduce floor space allowance (Moore et al., 1994). The new group of pigs added every few weeks fought very little and slept by themselves in a corner of the pen. A similar 'retreat' to an unused area of the pen has been reported for new sows in a dynamic system (Moore et al., 1993). A staggered system was used at Prairie Swine Centre with sows in an ESF, and although we could not compare it directly with a consecutive system, we saw no deleterious effects of dynamic grouping on productivity (Gonyou et al., 2006) nor aggression (Strawford et al., 2008).

Producers can combine static and dynamic grouping systems within the same barn to match their specific management goals. A common approach is running a dynamic group for gilts to keep younger animals together, alongside static groups for multiparous sows.

Dynamic Management in Non-ESF Systems

Before implementing a management system in an operation, producers should ensure that the benefits obtained will outweigh the costs. Dynamic systems result in some social costs to the animal, but we have seen that this is minimal. In the case of ESF, where large groups allow us to take advantage of electronic management, the benefits of large groups will often outweigh the costs of a dynamic management system needed to achieve those large groups. Are there advantages to large groups in other feeding systems that would justify the use of a dynamic grouping system?

The greatest benefit to large groups in non-ESF systems would be the reduced floor space per sow needed in groups of over 40 sows. The 10% reduction in space requirements would be advantageous, but there are also costs to managing these large groups. When dynamic groups are used, the resulting large group will have to be sorted for management practices such as pregnancy checking, vaccination, and moving to farrowing. Without the convenience of electronic sorting, as can be done in ESF, those procedures would be more labour intensive. The extended social instability of a dynamic system may also contribute to greater competition in an already competitive system. Although it may be possible to use dynamic grouping in floor feeding, short stall or gated stall systems, it is doubtful that the advantages in these competitive feeding systems would outweigh the disadvantages. For the most part, dynamic social grouping should be restricted to protected feeding systems.

Gonyou et al. (2006) saw no difference in productivity between static and dynamic systems over a period of five gestations. It should be noted that they used a staggered dynamic system that avoided re-grouping a second time during the pre-implantation period. Similar outcome was observed when mixing sows every 5 weeks (Li and Gonyou, 2013). In contrast, Simmins (1993) found static groups had larger litters and a higher number of born alive with significantly heavier litter weight than dynamic groups, although parity was not balanced between the two groups. Nonetheless, it would appear that the relatively minor differences in aggression and/or injuries between static and dynamic systems are not significant enough to affect productivity. It should also be noted that in all of these comparative studies, total group size was confounded with social management system, with dynamic grouping associated with larger groups. Such would be the case on commercial farms as well, and so the results are still applicable to normal production management.

Dynamic grouping has some negative consequences for the sows, but these appear to be minor and can be offset by providing extra space or protective barriers as discussed in previous issues. If dynamic grouping allows producers to obtain some positive benefits for the animals, then it can be used to an advantage. The advantages of an ESF system, such as improved control over feed intake, would seem to warrant the use of dynamic grouping in smaller herds to obtain an efficient group size.

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Hannah Burlet is a Knowledge Transfer Assistant at Prairie Swine Centre, working to create producer-centered resources that promote best management practices. She completed a M.Sc. in Large Animal Clinical Science in 2025, with her project focusing on gestational vitamin supplementation, hoping to support sow health, reproductive performance, and ultimately piglet health. Hannah also holds a B.Sc. in Animal Bioscience from the University of Saskatchewan. Through her research activities, Hannah developed a strong interest in the intersection of nutrition, health, and welfare, as well as the importance of scientific communication. In addition to her work in KT at PSC, she acts as the Ag Education Coordinator for Sask Pork.

Jen-Yun Chou, Ph.D.

Jen-Yun Chou is a research scientist in Ethology at the Prairie Swine Centre and adjunct professor at the University of Saskatchewan in Saskatoon, Saskatchewan, Canada. She is leading the ethology and welfare group at the Centre and a part of the Swine Welfare research team. She obtained her Ph.D. in Clinical Veterinary Sciences at the University of Edinburgh in 2019 and holds an M.A. in Science, Technology and Society. Her research projects collaboratively explore issues surrounding ending painful piglet procedures and providing pigs with a better physical and social environment. She is also interested in subjects such as One Welfare, welfare at transport/slaughter and on-farm euthanasia. She has ongoing research collaborations with partners in the U.S., Europe and Taiwan, where she is from. Her goal is to show animal welfare can be beneficial and profitable for all stakeholders and to contribute to improving pig welfare globally.

Martyna Lagoda, Ph.D.

Martyna holds a B.A. in Science, Zoology, and an M.Sc degree in Animal Behaviour and Welfare. Following the completion of her Ph.D. in Sow Welfare at Teagasc, Ireland, and the Institute of Genetics and Animal Biotechnology, Poland in 2022, Martyna worked as a research technologist on the "Tail Bite Advice" project in Teagasc, aiming to develop algorithms to accurately monitor tail biting behaviour, and to create a data-driven PLF decision support tool that will actively advise farmers on how to reduce tail-biting occurrences. As a Zoologist, Martyna is interested in welfare as a broader concept, and in a range of species. One of her main research interests includes using behaviour to gain insights into welfare states, as well as developing housing environments which promote species specific behaviours. As a Postdoctoral Fellow at the University of Saskatchewan, Martyna continues to work towards improving the welfare of swine.

Arielle Sabourin, M.Sc.

Arielle Sabourin works as a Research Assistant for the Ethology group at Prairie Swine Centre. Arielle has a B.Sc. in Animal Bioscience from the University of Saskatchewan, and a M.Sc. in International Animal Welfare, Ethics, and Law from The University of Edinburgh. Her project focused on the social behaviour of pigs around the feeder – comparing behaviours exhibited by young, uncastrated male pigs to their dominance index and social network analysis metrics. In her role at PSC, Arielle helps execute research projects in the barn and analyze collected data. Moving forward, she hopes to continue to support research into animal behaviour alongside Dr. Jen-Yun Chou, Abby Tillotson, and the rest of the PSC team.

Yolande Seddon, Ph.D.

Yolande Seddon is an associate professor in swine behaviour and welfare and the Enhancement Chair in Swine Welfare at the University of Saskatchewan's Western College of Veterinary Medicine (2025 - 2030). Her academic training is in applied ethology (animal behaviour) and the scientific assessment of animal welfare. She conducts research to help develop lasting solutions to the swine welfare challenges in modern pork production. Her areas of research include management of gestating sows in group-housing, the economics of higher welfare free-farrowing systems, weaner transport, environmental enrichment, assessment of swine welfare. Yolande is a member of the Code of Practice 2024 10-year review, serving as scientific committee Chair.

About the Authors

Abigail Tillotson, M.Sc.

Abigail (Abby) Tillotson currently works as the Research Officer for the Ethology group at Prairie Swine Centre. She graduated from the University of Saskatchewan with a B.Sc. in Animal Bioscience in 2021 and continued with an M.Sc. in Animal Science under the supervision of Dr. Jennifer Brown. Her research focused on effective, practical enrichment for growing pigs. Now, Abby helps to manage current research projects such as evaluating livestock brushes and music as enrichment for pigs, and loose lactation systems for farrowing sows. Abby is particularly interested in sow welfare and is excited to continue studying how to improve current housing systems for livestock animals.

Jennifer Brown, Ph.D. (Retired)

Jennifer Brown completed her Ph.D. in Applied Ethology at the University of Guelph in 2009 under Dr. Tina Widowski, and worked as Research Scientist in Ethology at PSC from 2011 to 2023. At PSC, her research focused on behavior and management of gestating sows, space allowance and weaning stress in nursery pigs, pain control at castration, and transport of weaner and market pigs. Jennifer retired in 2023 and moved to Prince Edward Island in 2026 where she continues to collaborate on ethology research projects.

Harold Gonyou, Ph.D. (Retired)

Harold Gonyou served as Research Scientist in Ethology at the Prairie Swine Centre Inc. for over 20 years, until his retirement in 2011. Dr. Gonyou's work focused on research-based solutions for the swine industry, including the design and management of feeders, group housed gestating sows and large group housing for growing/finishing pigs. Additionally, he led a collaborative project involving five universities and research stations on pig handling and transport. His leadership in the field of animal behaviour has led to his serving as President of the International Society for Applied Ethology and the Editor of Applied Animal Behaviour Science, the leading international journal of applied ethology.

In Memoriam

Fiona Rioja-Lang, Ph.D.

Fiona Lang was raised in a small town on the west coast of Scotland. She graduated from The University of Glasgow in 2003 with a B.Sc. in Zoology, followed by an M.Sc. and Ph.D. in Applied Ethology and Animal Welfare from The University of Edinburgh where she studied space utilisation and feeding behaviour in dairy cows. Fiona worked as a Research Associate in Ethology at Prairie Swine Centre from 2009 to 2011, and then moved to Merida, Mexico, to be with her husband, Rodolfo. She continued collaborating on pig research with PSC and working as a contract research scientist. Sadly, Fiona passed in 2019, but her memory and generous spirit live on. In 2026 the Fiona Rioja-Lang Memorial award was established by the Animal Welfare Foundation of Canada to support young scientists traveling to animal welfare conferences.