Implementing Effective Modern Sow Gestation Housing Solutions

A VAL-CO® white paper

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VAL-CO® – a global manufacturer of high-quality systems and components for commercial poultry production, pig production, and egg production.

Executive Summary

Animal husbandry of dry (pregnant) sows in the United States is in the midst of a transition from indoor individual gestation stall housing to indoor loose housing with group pens that enables greater sow socialization, space, movement and choice. Committed to this conversion, many U.S. sow producers are actively retrofitting existing barns and designing new enclosures for loose sow housing. To provide optimal animal welfare, loose sow housing success demands shared industry expertise and experiences, science and ongoing research, as well as the right combination of best practices, planning, products, people, and pigs. Sow producers are responding to social opinions, consumer preferences, animal welfare activists, major suppliers,[1] grocers, restaurants, and legislative mandates to make sow welfare and quality of life their highest priority.

Heightened consumer scrutiny on food production practices has led many food suppliers and retailers to focus their marketing efforts on differentiation (such as embracing non-GMO, local, sustainable, organic, antibiotic free and animal welfare-focused products) as a way to drive sales, customer loyalty, and increase margins by enhancing perceived value. In deference to this mounting pressure, suppliers are calling for the transition away from the use of gestation stalls (also called crates), and sow integrators, aggregators, and producers have been responding by transitioning their sow housing stalls to loose housing.

Swine industry research repeatedly reveals that there is no single best housing solution for gestating sows. Copious amounts of research indicate that skilled, dedicated stockperson knowledge and management in any modern design can yield healthy, high performing sows: A Texas Tech University review of 17 papers published from 2005 to 2012 that compared effects of housing systems on the welfare of gestating sows notes that all studies found similar productivity, physiology, health, and behavior among individually stalled or pen-grouped sows during gestation.[2]

While the National Pork Producers Council supports producer choice in the decision of sow housing, they oppose legislation that would mandate on-farm food-animal production practices, including banning the use of individual sow housing, because scientific research has shown that there is no one, single best way to house a pregnant sow.[3] Tom Parsons, University of Pennsylvania, V.M.D., Ph.D., wrote, "Scientific evidence remains equivocal with regard to what is the best way to house gestating sows. However, both legislative initiatives and market forces will move sows out of gestation stalls over the next five to 10 years," [4] at an estimated cost of $3.3 billion to sow producers. As such, the question as to whether gestation stalls are detrimental to sow welfare is no longer the debate. This paper will offer a broader view of the current debate, and detail housing practices to be considered when making the transition to loose group sow housing.

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1 Crate-free Future. "Food Company Policies on Gestation Crates" Retrieved December 1, 2015
2 John J. McGlone , PAS. "REVIEW: Updated Scientific Evidence on the Welfare of Gestating Sows Kept in Different Housing Systems" Texas Tech University. The Professional Animal Scientist 29. p.189–198 2013
3 "Sow Housing" National Pork Producers Council Accessed December 21, 2015
4 Tom Parsons, V.M.D., Ph.D. "Electronic sow feeding: An alternative that's manageable" University of Pennsylvania. Oct 22, 2015

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CHAPTER ONE: Responding to Bans on Gestation Stalls

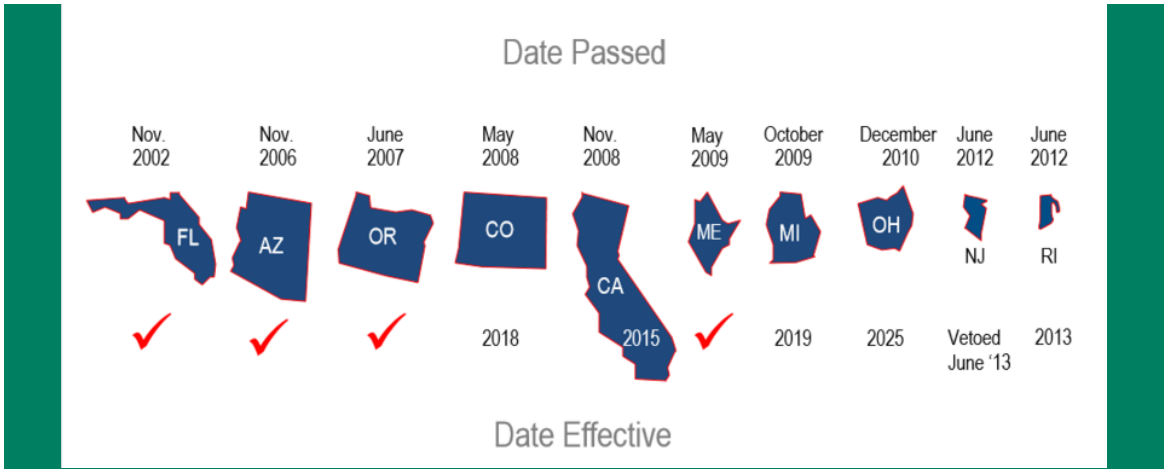
The transition to loose dry sow gestation housing (pen gestation) from approximately 42 days post breeding or insemination until just before farrowing is here to stay, and has gained momentum in the United States, emulating elements of loose sow housing practices of the E.U. and other counties focused on animal welfare around the world.

Current legislation in the European Union (E.U.) banned the use of sow tethers and gestation stalls as of January 1, 2013, (a condition of the 2001 Pigs Directive (2008/120/EC),[5] except for the period from weaning of the previous litter until the end of the first four weeks of gestation. (See E.U. general rules for all common farm animals and specific E.U. pig requirements.)

Sweden, Norway and Switzerland have banned the farrowing crate.[6,7]A prominent sow producer in the E.U. noted the emerging trend in Europe of loose housing in farrowing pens, as well. Gestation stalls have been banned in the United Kingdom since 1999. Canada has mandated that, for all sow housing newly built or rebuilt or brought into use for the first time after July 1, 2014, mated gilts and sows must be housed in groups.[8] All gestation crates have been banned in New Zealand as of December 2015. (67 percent of New Zealand pig farmers currently use farrowing crates.)

Nine U.S. states (Arizona, California, Colorado, Florida, Maine, Michigan, Ohio, Oregon, and Rhode Island) have adopted legislation to phase out gestation stalls over the next five to 10 years, and many major retailers[9] are pushing for all suppliers to move to group housing by 2025.

Table 1[10]: States with Bans on the Use of Gestation Stalls



National Pork Producers Council, 2014

5 Frédéric Vincent. Press Release: Animal Welfare: Commission steps up pressure on Member States to Implement Ban on Individual Sow Stalls. April 26, 2012
6 Safe.org "Pig Housing" Retrieved December 20, 2015
7 Compassion in World Farming. "Welfare Issues for Pigs" Retrieved December 20, 2015
8 Alexis Croswell "Victory for Pigs! Canada Bans Gestation Crates". March 7, 2015.
9 Crate Free Future. "Food Company Policies on Gestation Crates" Retrieved December 20, 2015
10 Table 1: Announced Changes: Individual Sow Housing; NPPC

With the shift toward loose group housing of dry sows, it should be noted that the American Veterinary Medical Association (AVMA) conducted their own thorough research into dry sow housing and published that, "There are advantages and disadvantages to any sow housing system," and, "To address animal welfare in the long term, advantages of current housing systems should be retained while making improvements in design to overcome problems identified."[11]

The AVMA does not specifically endorse or censure any current dry sow housing practice, and concluded in November 2015 that:

> The three gestation sow housing systems (gestation stall, group pen and free range) vary in their advantages and disadvantages regarding the welfare of the sow. When comparing housing systems for pregnant sows, making a definitive welfare judgment requires assigning weights to an array of contributing welfare indicators including, but not limited to, type, severity and incidence of injuries; behavioral and social opportunities; and exposure to parasites, disease, and harmful or aversive stimuli.[55]

As no universally accepted weighting system exists, there is no clear consensus as to which is the superior system across all situations.

> However, the public is generally more critical of gestation stall housing than other systems, which has led to voluntary and mandatory transition to alternative housing systems by some producers.[1] As such, there is an ongoing need to develop an array of housing systems that suit local conditions,[45] effectively provide enhanced opportunities for the sows to move and interact socially, and avoid an unacceptable increase in negative outcomes such as injury associated with aggression[1] or exposure to environmental hazards.[12]

Similarly, American Association of Swine Veterinarians Sow Housing Mission professes:[13]

> As swine veterinarians, our mission is to protect and improve the health and well-being of the animal. Given the variability inherent in different housing systems, the American Association of Swine Veterinarians supports the use of sow housing configurations that:
>
> - Provide every animal with access to appropriate food and water
> - Protect sows and piglets from detrimental effects associated with environmental extremes, particularly temperature extremes
> - Reduce exposure to hazards that result in disease, pain or injury to sows or piglets
> - Allow sows and piglets to express appropriate behaviors and minimize expression of inappropriate behaviors within the constraints of the housing type
> - Minimize aggression and competition between sows
> - Promote good air quality and allow proper sanitation
> - Facilitate evaluation and care of individual animals while protecting worker safety
>
> We strive to foster these essential components where supported by the scientific literature, in all housing systems.

Our goal is to teach and promote appropriate stockmanship, which is as important as housing design type in meeting the needs of the animals.

Many sow producers in the U.S. are evaluating the transition toward loose sow housing operations with a heightened focus on enhancing sow welfare, while recognizing that scientific measurements of physiology, behavior, health, and productivity show no difference between sows in group housing verses individual housing.[14]

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11 AVMA. "Pregnant Sow Housing" 2011. Print.
12 AVMA. Peer Review (Ed.). Welfare Implications of Gestation Sow Housing. November 19, 2015.
13 American Association of Swine Veterinarians "Sow Housing" Retrieved December 20, 2015
14 Ronald Plain, Ph.D. "Introduction to Pork Production at the National Pork Board Sow Housing Seminar" University of Missouri-Columbia. February 3, 2015.

Gestation stalls have been the mainstay of dry sow housing in the United States since sows began moving indoors in the late 1960s and 1970s. Individual stalls enable one-to-one care for medicating and feeding sows to appropriate Body Conditioning Scores (BCS), prevention of sow injuries by aggressive sows, and reduced chances of injuries to stockpersons.[15]

However, pressure from animal welfare groups, retailers seeking marketing advantages,[16] and, ultimately, government involvement has led to a number of U.S. states passing resolutions regulating the housing of dry sows. Prominent suppliers are urging, and even requiring, major producers and their contract farms to eliminate gestation stalls over time by retrofitting existing housing or building new sow barns with group penning areas and/or free-access systems.

Large and small producers alike have responded with commitments toward transitioning to loose sow housing. Smithfield Foods, Inc., the world's largest pig producer,[17,18] announced in 2007 that it would transition all of its company-owned sow farms to group housing by 2017.[19] Smithfield reports that it is on schedule to meet its goal.[20] Cargill Pork (acquired by JBS USA Pork, October 2015)[21] reported in 2015 that their transition to group housing is complete. Hormel Foods has also pledged to phase out all gestation stalls before 2018.[22]

With the transition to loose group sow housing, pork industry associations, experts and producers have been developing recommended planning and best practices templates such as those provided by Pork Checkoff[23] and the FASS Scientific Advisory Committee on Animal Care and the American Veterinary Medical Association (AVMA) collaboration[24] in the U.S. and Prairie Swine Center[25] in Canada to facilitate loose housing transitions that ensure the highest welfare of sows, least expense for barn retrofits and new construction for producers, while in order to keep higher consumer costs as low as possible.

Although today's consumers have become increasingly disconnected from sources of their food,[26] a spotlight on both real and perceived sow welfare concerns[27] has propelled pork producers in the U.S. on a mission to review and modify their dry sow indoor housing practices. This movement requires that sow farmers, from large producers to small contract operations, evaluate the most efficient and affordable path to developing sow group housing solutions that are optimal for suppliers and consumers, sows' well-being, production demands, sustainability and farmers' livelihoods.

Rhodes Tracey R, Michael C. Appleby, Kathy, Chinn K, Lawrence Douglas, Lawrence D. Firkins, Katherine A. Houpt, Christa Irwin, John J. McGlone, Paul Sundberg, Lisa Tokach, and Robert W. Wills. 2005. A comprehensive review of housing for pregnant sows. J. American Vet Medical Assoc (JAVMA). 227(10):1580-1590.

McGlone J.J., E. Von Borell, J. Deen, A.K. Johnson, D.G. Levis, M. Meunier-Salaun, J. Morrow, D. Reeves, J.L. Salak-Johnson, and P.L. Sundberg. 2004. Review: Compilation of the scientific literature comparing housing systems for gestating sows and gilts using measures of behavior, performance and health. Professional Animal Scientist. 20:105-117.

John J. McGlone. 2013. Review: Updated scientific evidence on the welfare of gestating sows kept in different housing systems. Professional Animal Scientist 29:189-198

15 Barrie, E. "Management of Sows in Loose Housing Systems." OMAFRA Agdex 441/50 Jun 2011

16 Corporate Commitments on Farm Animal Confinement Issues. Cage Free Future.

17 Smithfield Foods. "Understanding Smithfield: who we are." Accessed November 11, 2011

18 Successful Farming. "Pork Powerhouses 2007." 2007. Print.

19 Smithfield Foods. "Smithfield Foods makes landmark decision regarding animal management" 2007. Print.

20 Meat+ Poultry "Smithfield on schedule for gestation-crate-free target" VA January 4, 2016

21 Notice to Market: JBS Concludes Cargill Pork Acquisition, JBS® October 30, 2015

22 "Hormel Foods Corporate Responsibility Report." Hormel Foods. 2009. Print.

23 Options for Sow Housing Pork Checkoff. Accessed December 12, 2015

24 FASS Scientific Advisory Committee on Animal Care and the American Veterinary Medical Association (AVMA) Current and Emerging Issues in Animal Welfare Webinar Series. Accessed December 30, 2015

25 Prairie Swine Center, Canada

26 Vileisis, A. Kitchen Literacy. Washington, D.C.: Island Press, 2008

27 Pork Industry Animal Abuse Exposed - A New MFA Undercover Investigation (Pork Industry Animal Abuse Exposed - A New MFA Undercover Investigation) Accessed December 21, 2015

Since the 1900s, farmers in the United States have consistently raised about 60 million pigs[28] per year with farms turning over twice each year. In 1920, there were 4.85 million hog farms in the U.S.; yet today there are fewer than 65,000 hog farms.[29] Many more people are being fed by far fewer farmers[30] due to a shift to large-scale production and improved housing, feeding, breeding, biotech, genetic, and management techniques. The demand for pig products is growing, with 24 billion pounds of pork produced in the United States (the world's third-largest producer and consumer of pork and pork products) in 2015, a quarter of which was exported.[31]

Globally, China, the country with the largest pig population and highest pork consumption, projects that their total meat production will reach 93 million tons by the end of the decade. Currently, China produces twice the amount of the meat produced in all 27 E.U. countries and five times the amount produced in the U.S.[32] With the 2013 merger of China's Shuangui and the United States' Smithfield Foods Inc. (the largest pork producer in the U.S.), the U.S. pork industry is positioned to expand by 1.5 percent per[33] year on a global scale, making it even more critical for U.S. producers to institute and document effective, humane dry sow housing design, technologies, strategies, implementation, management, and accountability processes in the United States.

Meat companies are growing thanks to mergers and acquisitions, and are expanding across countries and animal species. Today, there are ten major meat producers around the globe, four of which are based in the U.S.: Cargill ($33 billion in food sales a year), Tyson ($33 billion in food sales a year), Smithfield Foods ($13 billion in food sales a year), and Hormel Foods ($8 billion in food sales a year).[34]

Responding to pleas for heightened animal welfare, in 2007, Smithfield committed to transition to stall-free sow gestation by 2017. The company reported at the end of 2015 that it has transitioned 81.8 percent of sows on its company-owned farms in the United States to group housing systems, and is on schedule to meet its 2017 goal.[35] Smithfield's international hog production operations also will complete their conversions from gestation stalls to group housing systems on company-owned farms by 2022.[36]

Sow gestation stalls have been in use since the 1970s in the U.S. and have been used extensively throughout modern sow production, as studies and practices at the time indicated better sow care when using individualized housing.[37] Animal welfare advocates' and consumers' opinions, European producers, as well as other compelling experts, have influenced producers in the U.S. to transition from sow gestation stalls to group housing, despite data and experience often showing sows' preference for individual stalls even when group loafing space is available.

> *"The western division went with "free-access housing" with groups of 30-60 sows per pen in which sows can enter stalls on their own for privacy and to feed — again, with each sow tending to adopt its own stall — and can exit stalls when they want to move around and socialize in a "loafing area," Elkin said. What's interesting, he noted, is that 90% of the sows choose to stay in their stalls 90% of the time." — Dave Elkin, Murphy-Brown director of engineering, 2013*

28 Hahn Niman, N. "Pig Farming Matters" June 11, 2012
29 Ronald Plain, Ph.D. "Introduction to Pork Production at the National Pork Board Sow Housing Seminar" University of Missouri-Columbia. February 3, 2015
30 Grove, M. "Farmers Feeding the World More with Less." WCF Courier. September 7, 2011
31 Martha C White and Mike Brunker "The Big Bucks of Bacon: American Meat Industry by the Numbers" October 26, 2015
32 Sam Brasch "How China Became the World's Largest Pork Producer" March 11, 2014
33 Kent Bang. National Pork Board, Sow Housing Seminar. February 3, 2015
34 " Megan Willett "How People Consume Meat Around the World" Business Insider. January 13, 2014
35 Meat+ Poultry "Smithfield on schedule for gestation-crate-free target" VA January 4, 2016
36 Rod Smith "Murphy-Brown Sow Housing Conversion: Process 'More than a Facelift'" Feedstuffs FoodLink. May 28, 2013
37 Dr. Jennifer Brown "Introduction to Group Housing: Dynamic ESF" Prairie Swine Center, Inc., September 29, 2014

The U.S. percentage of loose sow housing is increasing, but less than a quarter of gestating sows are housed in group pens today.

Table 2[38]

Group vs. Individual Sow Penning[39]

Penning Type	Gestation	Farrowing
Individual	77.6%	99.4%
Group	22.4%	0.5%

2012 USDA-NAMS data; USDA, 2015

CHAPTER TWO: Options within Group Housing for Dry Sows

There are two methods of grouping sows, static and dynamic. In the static system, once a group of sows is assembled and penned together, no more animals are added. Animals that do not adapt are removed to stalls. The dynamic system is a group of sows with animals added and removed weekly. With both systems, sows are moved out to farrow over one to two weeks.

The impact of group housing on the reproductive and, ultimately, financial performance of any operation is based on numerous factors and their complex interactions. A space allotment that one producer may consider too small for sows works quite nicely for another producer when combined with a high-fiber diet that causes sows to interrupt their eating cycles to drink more frequently,[40] allowing timid sows more chances at the feeder.

In individual gestation stall sow housing, fewer variables affect performance than in loose group sow housing.

> *Housing sows in group pens increases the number of care variables, and their concomitant interactions, which affect the total productivity of the sow.*

Social interaction, and the inevitable agonistic sow encounters, can result in lesions, lameness, and disparities in feed intakes among sows in groups.

The requirements on the stockperson may also be increased with selecting and managing sow groups, the lack of individualized sow observation, and specific care that individual stalls allow. It is important to be very aware of how many of the changes in macro-environment (e.g., diet, feeding system, ventilation, parities of sows present) may affect the micro-environment of sow interactions at the level of the individual sow grouping and how these interactions may affect total performance.

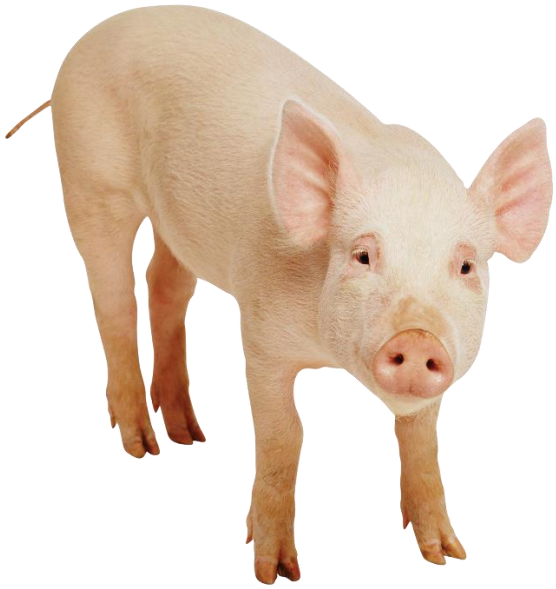
Sow production levels are often negatively affected, at least temporarily, through movement, depopulation, and increased culling experienced during transitions. An initial disaster when

38 Table 2: Group vs. Individual Sow Penning
39 Ronald Plain, Ph.D. "Sow Housing Status," University of Missouri-Columbia. Presentation at National Pork Board Sow Housing Seminar February 3, 2015
40 Salak-Johnson, J. "Impact of Group Size and Diet on Behavior and Physiology of Sows." Pork Checkoff Project 07-105. 2011

switching to group housing may improve after two or three parities due to indirect selection for docile replacement gilts.[41]

Technology has certainly made group housing of gestating and farrowing sows much simpler and safer, but the high cost and knowledge needed to implement solutions like pneumatic flooring to protect piglets as the mother sow stands or sits or electronic feeding systems to manage individual sow health and welfare makes the transition for many producers a great challenge.

What works well for one producer may fail for another because ventilation, temperature, lighting, diet, breed, sow age, sow size, sow training, average parity, cull rate, stockmanship, post-implantation stall time, feeding system, age and upkeep of penning, stalls and concrete, depth of bedding, and slope of flooring all interact to produce different results for producers who manage group housing of dry sows.



41 Miller, D. "Sows Flourish in Pen Gestation." National Hog Farmer 15 Mar 2004

Considerations for Group Housing

Group Size and Status (Dynamic vs. Static)

One of the first considerations for making the transition to group housing is the number of sows to place into one pen section. This will depend heavily on the number of sows, size of the groups, feeding plan and farrowing program.

Dynamic Housing Works Well for Large Groups

Dynamic groups involve routinely adding and removing sows from the group after initial formation. When the number of sows in a group changes there tends to be a period of aggression while the social order is re-established. This can range from one to four days, with the worst of the aggression usually occurring within the first four hours.[42,43] (This also holds true in static groups.)

Advantages:

- Allows maximum use of facility space by always maintaining stocking levels in pens
- Facilitates simplified management of large sow operations when strategic mixing is employed[44,45]
- It has been reported that when gilts are housed in groups of four, mixing cycling gilts had no detrimental effect on estrus expression within a five-week period when compared to non-mixed gilt groups[46]
- More cost efficient if using Electronic Sow Feeding (ESF, described later)
- Easier to introduce new sows/gilts into the group[47] as timid sows can blend into the crowd and avoid dominate sows

Disadvantages:

- More difficult for stockpersons to give individual attention to sows/gilts[48]
- More frequent mixing creates more agonistic encounters and injury to sows as social orders are constantly rearranging[49]
- Unless farrowing in equally large batches, mixing and re-mixing of sows will be necessary, possibly increasing cull rate of sows from damage
- When moving or adding gilts to a new group, stockpersons must take extra time and care to socialize gilts and be aware of their addition to an existing social group so they are not the target of established dominant or older sows' attacks

42 Kay, R. "Sow Aggression Under Spotlight." Farmers Weekly 1999
43 Burfoot, A. and R. Kay. "Aggression Between Sows Mixed in Small Stable Groups." ADAS Report 1995
44 Dr. Jennifer Brown, "Group Formation and Mixing Times for Gestating Sows" from the 2015 Allen D. Leman Swine Conference, September 19-22, 2015, St. Paul, Minnesota, USA. 2015
45 "When to mix sows in groups?" Pig Progress. December 30, 2015
46 Soede, N.M., M.J.W. van Sleuwen, R. Molenaar, F.W. Rietveld, W.P.G. Schouten, W. Hazeleger, and B. Kemp, Influence of repeated regrouping on reproduction in gilts. Anim. Reprod. Sci., 2006. 96(1-2): p. 133-145.
47 Gadd, J. Modern Pig Production Technology. Malta: Nottingham University Press, 2011.
48 Miller, D. op. cit.
49 Durrell. op. cit.

Considerations for Group Housing (continued)

Group Size and Status (Dynamic vs. Static) (continued)

Dynamic Housing Works Well for Large Groups (continued)

A review of the effects of chronic stress on gilts, resulting from crowding, size of the group and negative handling, reported great variability among gilts in negative effects on reproduction. While most gilts exposed to stress may not show any adverse effects on reproduction, there is often a third of the gilts that show susceptibility, but with no measure obtained to suggest why certain gilts were affected and others were not.[50]

Static Housing Works Best for Small Groups

Static groups of sows are assembled initially and then no further sows/gilts are added to the group until such time as the size of the group has dwindled through recycles and attrition that the group size is no longer viable, at which point, the group is dissolved and a new group formed.

Advantages:

- Easier to work with static groups and small-batch farrowing
- Individual attention and observation of sows easier
- Once a hierarchy is established, significantly less agonistic behavior is noted among static groups than dynamic groups[51]
- If using a batch farrowing system, static batches work well with the all-in, all-out methodology for cleaning and disinfecting

Disadvantages:

- Harder to introduce new sows/gilts into the group
- Not cost effective if ESF is desired
- Higher capital costs may be realized if pens are stocked to a certain density and not restocked following removal of recycles and cull sows
    - Extra pens would be required to maintain the overall number of sows needed in a static group system
    - Pens can be initially overstocked in anticipation of attrition, but must be carefully monitored and managed during the overstocked phase

50 Rob V. Knox, University of Illinois, Mark J. Estienne, Virginia Tech "Group Housing Systems: Forming Gilt and Sow Groups" National Pork Board. 2013

51 Durrell, J., et al. "Sow Behaviour and Welfare in Voluntary Cubicle Pens (Small Static Groups) and Split-yard Systems (Large Dynamic Groups)." Animal Science 75 (2002): Pages 67-74

Considerations for Group Housing (continued)

Determining the Best Feeding Strategies

There are multiple methods of feeding dry sows in loose housing that are relative to each unique housing design (whether an existing barn is retrofitted or a new design is constructed), sizes, ages and number of sows, prowess and preferences of stockpersons, and budget. They include drop feeding (by hand or automatic/trickle), feeding in short shoulder-only stalls that provide some protection from aggressive sows, and free-access stalls that give sows the freedom to enter and exit the feeding areas. Both short stalls and free-access stalls can use ESF.

Table 3[52]

Quick Comparison of Housing~Feeding Systems [53]

Feeding System	Floor or Drop Fed (Hand or Automatic)	Short Shoulder Stalls	Electronic Feeding Systems - ESF	Free-Access Stalls
Floor Type	Some Solid Flooring Required	Solid, Part or Full Slats	Solid, Part or Full Slats	Part or Full Slats
Floor Space	*	**	*	***
Initial Cost	*	*	**	***
Management Level	***	***	**	*

*** Low **Medium ***High**

52 Table 3: Quick Comparison of Housing~Feeding Systems
53 Dr. Jennifer Brown "Introduction to Group Housing: Dynamic ESF" Prairie Swine Center, Inc., September 29, 2014

Considerations for Group Housing (continued)

Determining the Best Feeding Strategies (continued)

COMPETITIVE FEEDING OPTIONS

Drop Feeding – This can be as simple (yet, time consuming) as hand-feeding sows over the fencerow on a concrete slab or as complex as automatic volumetric drops timed to release a certain portion of food multiple times throughout the course of a day. Drop feeding on the floor results in the highest incidence of sow aggression and injuries, and lower ability to custom feed, of any feeding system. Trough feeding is another option, however, it also creates competition for food amongst sows.

Hand Feeding

Advantages:

- Maintain more intimate oversight and interaction[54] for better quality management
- Some renowned pig producers prefer or even insist on hand-feeding to maintain the person-pig interaction for best performance

Disadvantages:

- Requires special attention and skill of stockpersons to oversee each weight and wellness of each individual sow
- Time consuming to feed and document results for larger sow counts

Automatic Drop Feeding – As it sounds, food is electronically measured and dropped on a set schedule in designated areas of pens

Advantages:

- Simple system to design and implement – minimal electronics
- Spatially and temporally separating feed drops within the pen reduces agonistic interactions that result from a single point of feed[55]
- Easier retrofit into an existing barn versus ESF[56]

Disadvantages:

- Requires heightened daily monitoring of sows for weight and health
  - No individual feeding of sows based on BCS, although this can be overcome somewhat if sows are held in stalls for the first 28-42 days post breeding/insemination or groups are formed based on BCS feed requirements
- Requires more careful grouping to protect less dominant sows

54 Miller, D. "Sows Flourish in Pen Gestation." National Hog Farmer. March 15, 2004
55 Kains, K.Z.F. "Making Group Sow Housing Work." National Hog Farmer. June 15, 2008
56 Barrie, E. "Management of Sows in Loose Housing Systems" OMAFRA Agdex 441/50 June 2011

Considerations for Group Housing (continued)

Determining the Best Feeding Strategies (continued)

COMPETITIVE FEEDING OPTIONS (CONTINUED)

Free-access Stall Feeding – Enables individual protected feeding so that sows can choose to enter and exit the feeding stall as they wish, without intimidation from dominant sows.

Trickle Feeding – A variant of automated drop feeding where feed is slowly released at a controlled rate for up to a half hour, rather than dropped all at once onto the feeding pad.

Advantages:

- This method serves to accomplish much the same result as dropping feed multiple times throughout the day
- Trickling feed slowly can reduce aggression in non-locking stalls
- Enables sows to eat simultaneously

Disadvantages:

- Does not enable custom feeding to BCS
- Dominant sows can push out subordinate sows

Short or Shoulder Stall Feeding – Enables semi-protected feeding, so competition can still exist. Feeding stalls may be contained within each sow pen, or a separate feeding stall area may be shared by several groups of sows, involving greater labor to move the sows to and from the area.

NON-COMPETITIVE FEEDING OPTIONS

Electronic Sow Feeding (ESF) – This system utilizes special penning arrangements to direct animals into and out of a protected feed area where an individual ration is fed to each sow identified by an RFID tag in her ear. Small portions are fed until the sow ceases to eat or reaches her daily allotment, at which point gates are opened and the next sow enters. A version of unprotected ESF delivers feed through a nozzle into the sows' mouths as they are recognized by ear transponders. Typical ESF stations using one computer can serve between 60-80 sows who are grouped together in a single pen. With ESF, several experts recommend keeping sows in static groups, rather than continually adding and removing sows from a group for better results.

The intent of the E.U. rules against tethering and crating gestating sows is to facilitate healthy natural pig behaviors, including the ability for pregnant sows to eat together as a social group simultaneously as they do in the wild. This is an emerging issue for producers to consider when retrofitting or designing penning spaces. Some pig scientists consider this behavior important to ensuring high quality pig welfare, and recommend installing two ESF stations per pen.[57]

57 Texas Tech University, Department of Animal and Food Science. "New EU rules related to ESF" Accessed December 30, 2015

Considerations for Group Housing (continued)

Determining the Best Feeding Strategies (continued)

NON-COMPETITIVE FEEDING OPTIONS (CONTINUED)

Electronic Sow Feeding (ESF) (continued)

Advantages:

- Sows are fed individually, allowing feeding to BCS throughout the gestation period
- Helps producers overcome two perceived challenges of group housing: sow aggression and inefficient feed intake
- Works with modest space availability
- Sows are completely protected while eating in free access stalls with ESF, allowing timid sows to eat their full allotment without threats from aggressive sows
- Mobile access and software prints out a daily report of feed intakes or skipped feedings per sow to simplify customized sow care
- Time and labor saving with proper stockperson training and regular maintenance

Disadvantages:

- ESF can be a labor-intensive system, relying as it does on complex mechanical and electrical systems that need protection from the environment and regular maintenance, along with tracking down animals skipping feedings or without RFID transponders in a large pen, and regular updates to the individual sow daily allowances[58]
- RFID transponder loss or failures lead to risks of not feeding sows if stockpersons are not personally knowledgeable about each sow
- Separate training area(s) needed to familiarize and train sows accessing the system
- Location of solid areas of flooring would be the most common example of compromise encountered when converting a partially slatted stall barn to ESF[59]
- ESF systems require substantial changes to pen design in retrofit scenarios, along with a higher cost than many drop feeding systems[60]
- Larger pens with ESF require specific fencing layouts to house the 60-80 sows per station
- One U.S. university study found ESF to significantly reduce sow productivity[61]
- Critical that standardized work instructions are in place
    - Audits should be put in place to ensure protocols are being followed correctly
- Startup training on ESF farms is critical; leadership must be engaged to ensure success

58 Barrie, E. "Management of Sows in Loose Housing Systems." OMAFRA Agdex 441/50 Jun 2011
59 Tom Parsons, V.M.D., Ph.D. University of Pennsylvania "Electronic sow feeding: An alternative that's manageable" National Hog Farmer. Oct 22, 2015
60 Ibid.
61 Steve Pollmann, Ph.D. "Conversion to Group Housing for Sows: Integrator's Perceptive" ASABE Meeting Presentation. July 23, 2013

Considerations for Group Housing (continued)

Determining the Best Feeding Strategies (continued)

NON-COMPETITIVE FEEDING OPTIONS (CONTINUED)

Electronic Sow Feeding (ESF) (continued)

Disadvantages: (continued)

- ESF Systems require more technical aptitude by stockpersons
- ESF settings should be standardized across system to reduce variation and time allowed for sows to eat, which is critical (i.e. if time is not adequate, aggression results)
- Approximately two percent of sows will fail to adapt to the system[62]

Loose Sow Housing Strategies

Group housing is based, in large part, upon the feeding system used, as well as size and mixing strategies of groups, as detailed above. ESF is used in larger pens that include the specific fencing layouts required to house the 60-80 sows per station. New layouts often show large pens for hundreds of sows with multiple feeding stations. Successful loose housing can enable sows to eat, semi protected, at shoulder stanchions (partial or short stalls) or, fully protected, at free-access feeding stations, which give sows the freedom to enter and exit at will to eat, and can be locked by stockpersons for sow protection, assessment or medical care, if needed. Group pens often have floors sloped at five percent towards slats to get urine to drain out quickly, to discourage dunging, and can provide hiding places with partition walls (cement or hanging rubber mats) for sows being pursued and/or the ability to add a boar at the right size and temperament to the group.[63]

Dry sow group housing systems include open shoulder stalls, gated free-access stalls, and open group penning.

Shoulder (Short or Partial) Stalls – In some cases stalls are provided, either open-backed or free-access locking stalls (which close behind the sow upon entering and open again only when the sow backs out), so that the sows may choose whether to mingle in an open communal space or have the relative privacy of a stall for eating or lying. This is often selected for retrofitted barns because it enables group housing at the least expense and effort as it offers low-tech feeding options. Shoulder stalls provide some protection of sows during feeding, and work the best with static, uniform groups of sows. Feeding stalls may be contained within each sow pen, or a separate feeding stall area may be used by several groups of sows, involving greater labor to move the sows to and from the area.[64]

62 Trish Holyoake "Guidelines for Group-Housing Pregnant Sows" September 2010
63 Barrie, E. "Management of Sows in Loose Housing Systems." OMAFRA Agdex 441/50 June 2011
64 Mark Whitney, Ph.D. "Gestating Sow Housing – Options and Considerations Related to Feeding" University of Minnesota Extension. 2007

Considerations for Group Housing (continued)

Loose Sow Housing Strategies (continued)

Shoulder (Short or Partial) Stalls (continued)

Advantages:

- Simplest and easiest housing system to use for retrofitted barns
- Can be accomplished by cutting the last two thirds of the gestation stall off and creating a pen of six or 10 sows
  - Options: Three stalls back to back → Six per pen; Five stalls back to back → 10 per pen
- Can reuse a large portion of original investment in retrofit situations if reusing existing stalls less backs
- Works with small pen conversions
- Can use automatic drop and trickle feeding
- Low capital investment for retrofits
- Sows have some protection during eating, and that may limit agonistic encounters

Disadvantages:

- Vulva biting and tail biting is a common occurrence while sows are waiting their turn into the stalls to feed[65]

Free-access Stalls – Considered by many experts as the ideal group-housing solution, free-access stalls give sows choices to enter and exit the feeding area at will for undisturbed feeding or care. It works best with a group of 30-60 sows. This model requires little sow training and low stockperson management input, but does require more floor space and significantly higher capital investments.

Typically, if using free-access stalls, one stall must be provided for every sow to allow all to eat at the same time; studies show that sow welfare increases with communal eating as in nature. Free-access stall pens are usually divided into either an 'I' configuration consisting of an open slatted alley of 3' (.9m) to 10' (3m) behind the stalls or a "T" configuration with an alley behind the stalls leading down to a solid-floored open resting area which may be deep-bedded. (See Figure 1 on page 17.) Alley widths in "I" pens have been tested at 3' (.9m), 7' (2.1m) and 10' (3m) widths to determine what effect, if any, the size of open space had on sow activity and comfort.

One published study determined there to be minimal differences between widths on production and physiological responses.[66] It showed no difference in aggression among sows between widths, nor litter size nor other productivity measures. The sows in stalls with a 3' (.9m) alley used the alley space less than those housed with wider alleys and had fewer interactions. The 3' (.9m) width did negatively impact the sows' ability to turn around, a measure of animal welfare.

65 Barrie, E. "Management of Sows in Loose Housing Systems." OMAFRA Agdex 441/50 June 2011
66 Pajor, E. "The Effect of Alleyway Width on Sow Behavior and Welfare in a Free-Access Gestation Stall System." Pork Checkoff Project 07-083. 2011

Considerations for Group Housing (continued)

Loose Sow Housing Strategies (continued)

Free-access Stalls (continued)

Advantages: (continued)

- Sows safely eat and drink in stalls, undisturbed by other sows
- Sows choose their locations – open group space or stall
- More available square feet for sows to move and socialize
- 90 percent of floor space for sows (vs. 68 percent in a stalled system)
- Solid floor in the open loafing area
- Crates are lockable for individualized care and medical treatments [67]
- Exercise as a result of group penning with free-access stalls has reduced lameness
- Improved sow movement safety when loading farrowing[68]
- May help reduce stress and aggression and improve reproductive performance if sows or gilts can be locked in for feeding, reproductive management, and limiting aggression for certain animals when needed[69]
- Some free-access stall systems offer automatic electronic locking and opening controls
- Creates a calm group atmosphere by preventing sows from re-entering feeding stations immediately after exiting[70]

Disadvantages:

- Higher capital investment than completely open or partial stall pens
- Requires more floor space, so is often not an option for smaller facilities or smaller budgets
- Additional maintenance required anytime one adds additional mechanical components (i.e. crates) to a pen

Free-access feeding stations with small pens are the preferred systems for dry sow group housing for many producers, including companies like Smithfield Foods (Hog Production Division) who notes that free-access systems will be implemented when constructing new facilities in the future.

67 Chris J. Rademacher, D.V.M., Iowa State University. "Practical Considerations for Adoption of Group Sow Housing" September 19, 2015

68 Steve Pollmann, Ph.D. "Conversion to Group Housing for Sows: Integrator's Perceptive" ASABE Meeting Presentation. July 23, 2013

69 Rademacher, C., Sow housing perspective: Murphy-Brown Western Operations, in Allen D. Leman Swine Conference 2012, University of Minnesota: St. Paul, MN. p. 2. 2012

70 The Pig Site "Pig Pen Design is Key to Optimum Performance" November 27, 2015

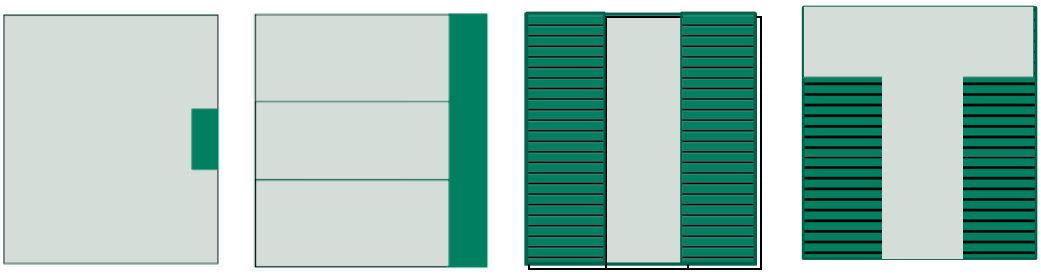
Considerations for Group Housing (continued)

Loose Sow Housing Strategies (continued)

Free-access Stalls (continued)

Table 4[71]

Floor Space: Functionality and Feeding Systems



A. ESF Feeders B. Shoulder Feeders C. Free Access w/Alley D. Free Access w/ Pen

A. ESF feeder in small pen with open area for socialization, movement and resting. Similar design is used for floor feeding.

B. Shoulder stalls allow for some protection from aggressive sows while eating in small pens

C. Free access feeder stalls with an "I" configuration with an open slatted alley pen behind two rows of free-access stalls. Alleys must be wide enough that sows can pass without incurring aggression.

D. Free access feeder stalls with a wide alley and pen "T" configuration (right) showing an alley behind two rows of stalls with extra solid-floored resting space at the end of the alley.

71 Table 4: Floor Space: Functionality and Feeding Systems

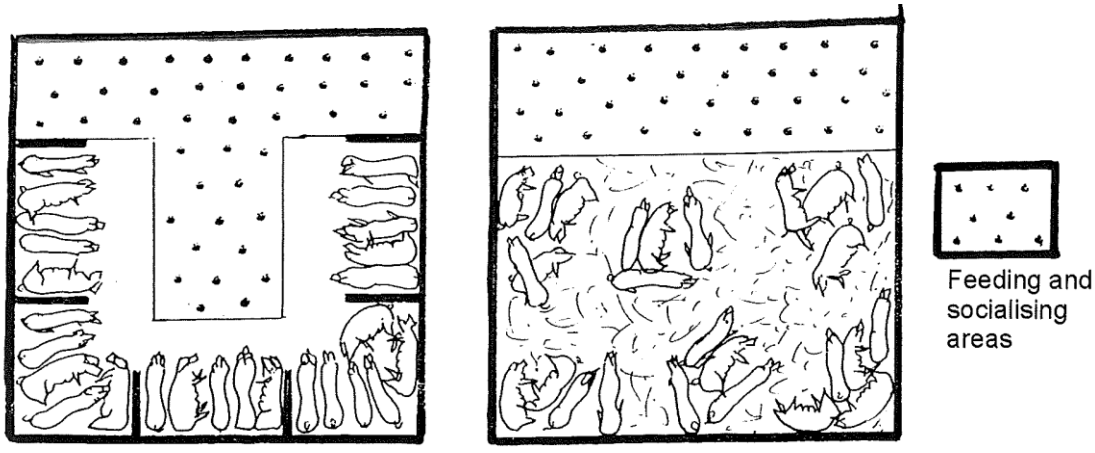
Considerations for Group Housing (continued)

Loose Sow Housing Strategies (continued)

Fully-open Pen Design – In this housing design, no full stalls are provided. Open pens can be designed with either separate sleeping/lying areas (typically solid floored, either concrete with half-wall dividers or deep-bedded with straw – see Figure 2 below) or fully slatted with no special lying areas called out. Drop feeding can be onto solid pads with no divisions or with short, ¼ stall solid dividers to prevent eye contact between feeding sows.

Table 5[72]

Fully-open Solid Floor Penning Options



HARD FLOORS
Figure 1

DEEP STRAW RESTING AREA
Figure 2

Examples of solid floor, non-bedded sleeping/resting area (left) and solid floor, deep-bedded sleeping/resting area (right.[73]) Feeding and socializing areas are typically on slatted floors.

Durable rubber or other mats, bedding material, and hay for nesting and comfort add to the welfare of dry sows in open penning settings.

72 Table 5: Solid Floor Penning Options
73 Gadd. op. cit.

Considerations for Group Housing (continued)

Space Considerations

The amount of floor space to allocate per sow/gilt is a matter of no small debate, and usually rises quickly to the forefront of any discussion regarding loose housing sows as it has one of the easiest-to-quantify economic impacts on an operation.

In practice, sow area has varied from 15ft^2 (1.39m^2) to 38ft^2 (3.5m^2) per sow. While there may be no consensus among producers today regarding the optimum floor space allocations, there are a number of references available, whether through published legislative guidelines, scientific examples, or producer best practices that will be referenced herein. Much will be based on the systems selected above for feeding, bedding, and housing the sows, as well as the breed temperament of producers' individual sow lines.

Models, notes, and findings about floor space:

- Current group housing space per sow has a wide range of 15 ft^2 to 50 ft.^{2} Less than 15 ft^2 clearly compromises animal well-being, but research shows that greater than 25 ft^2 resulted in no additional advantage, and little research exists for comparison between 15-25 ft^2 [74]
- E.U. space guidelines require a *minimum* of 17 ft² for gilts and 24 ft² for sows. An industry expert reported that, as sow sizes increase, Denmark producers are increasing the size of gestation stalls to 14.69 ft² (6'10" x 2'2'' (210cm x 65cm - 1.37 m²) and farrowing stalls to 49.41 ft² (8'10" x 5'7") (270cm x 170cm - 4.59 m²), noting that stall sizes are adapted to size of sows, rather than a one-size-fits-all system.
- A large (70k + sows) U.S.-based producer has historically always housed sows in groups of five in an 8' x 10' fully slatted pen (16ft^2 per sow) and has always shown very good production numbers. They are big proponents of individual sow attention and hand-feed their pens.[75] They have been using this system since 1989.
- A prominent ESF manufacturer recommends a minimum of 24 ft^2 (2.23m^2) per sow, 60 percent of which should be solid floored laying area.[76]
- The UK, which has been stall-free since the late '90s, recommends between 24.76 ft^2 (2.3m^2) and 31.22ft^2 (2.9m^2) per sow in pens with or without free access stalls,[77] although RSPCA guidelines call for 37.6 ft^2 (3.5m^2) per sow.[78] This number (3.5m^2 per sow) has also been cited as a good stocking rate for a separate pen specifically used to mix groups for the first 24 hours before placing the mixed group into the standard pen.[79] The mixing pen allows more fleeing space with feed and water access to minimize aggression during the critical first 24 hours of a new groups' formation.

74 Chris J. Rademacher, D.V.M. "Practical Considerations for Adoption of Group Sow Housing Presentation" September 19, 2015
75 Miller. op. cit.
76 Wyse, G. Personal Interview. June 7, 2011
77 Gadd, J. Modern Pig Production Technology. Malta: Nottingham University Press, 2011
78 RSPCA. "RSPCA Welfare Standards for Pigs." January 2010
79 Gadd. op. cit.

Considerations for Group Housing (continued)

Space Considerations (continued)

Models, notes, and findings about floor space: (continued)

- The common wisdom of "larger equals better" comes with the caveat that too large of a lying area leads to dunging on the lying floor, as opposed the dunging area of slatted flooring.[80] A 2" (5cm) step-down from the lying area to the slatted dunging area is recommended to minimize soiling of the laying area, along with a minimum width of the slatted floor of 8' (2.4m). Slot width of slats should be no more than ¾" (2cm) with well rounded edges.

80 Barrie, E. "Management of Sows in Loose Housing Systems." OMAFRA Agdex 441/50 Jun 2011

Additional Management Considerations

- Adding hanging partition walls (hanging rubber mats or colliery belting) can reduce aggression by providing hiding places for sows being pursued[81]
- Mixing sows towards the end of the day, immediately before lights-out – full, calm sows in a dark environment are less aggressive[82,83]
- Introduce more than three sows/gilts at a time into the main group, regardless of the size of the main group, to reduce singling out of any one new entrant[84]
- If introducing gilts to a group, make sure to pre-introduce the gilts to each other for at least 24 hours – gilts are extra-excitable and need time to familiarize with each other prior to joining a group[85]
- The use of sedatives (e.g. amperozide) seems to merely delay aggression, not prevent it[86]
- Some lines, or at least some batches within some lines, of breeding stock tend to be more flighty than others, and docility is a blessing in pen gestation[87]
- Removing the boss sow tends to be less effective at preventing aggression versus removing the timid sow undergoing abuse, says a producer in MI[88]
- Current legislation in the U.S. allows sows to be kept in stalls for 28-42 days post-breeding which helps protect the welfare of the growing embryos

  (While there have been some studies showing no loss of reproductive performance from sows moved into group pen gestation prior to this time,[89] most of the articles cited herein recommended against this practice until further research and documentation have occurred.)
- Diet and floor space seem to be connected, showing that high-fiber diets combined with optimal floor space result in better reproductive performance[90]
  - One study showed best results from a high-fiber floor-fed diet in sows housed at 18.3ft^2 (1.7m^2) per sow
- Careful design of ESF pens with respect to location of feeders, watering, and alley size is important as most aggressive behaviors in ESF pens are seen at the entrance to the ESF station[91]
- In deep-bedded pens, one prominent pig expert recommends against including divisions in the laying areas as the divisions tend to hinder the natural grouping of resting areas by the various sub-groups of sows in the pen[92]

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81 Ibid.
82 Ibid.
83 Gadd. op. cit.
84 Ibid.
85 Ibid.
86 Ibid.
87 Ibid.
88 Vansickle, J. "Gestation Pens Fare Favorably to Stalls." National Hog Farmer 15 Mar 2
89 Bierman, C and D. Kohler. "Timing of Post-insemination Movement of Sows into Loose-Sow Gestation Housing and Its Subsequent Effects on Reproductive Efficiency." Babcock Genetics 2011
90 Salak-Johnson, J. "Impact of Group Size and Diet on Behavior and Physiology of Sows." Pork Checkoff Project 07-105. 2011
91 Deen, J. "Effect of Timing of Grouping of Sows During Early Gestation on Welfare and Performance of Sows and Group Pens with Electronic Sow Feeders" National Pork Board Research 08-154. 2010
92 Gadd. op. cit.

CONCLUSION

With increasing pressure to convert to loose housing of dry sows, producers need to be well informed about emerging tactics and strategies. The challenge for pork producers now is to rethink the management practices of the past, so as to maintain a strong and productive industry well into the future. Each system or combination of systems will have inherent merits and drawbacks; it will be the task of the producer, combining knowledge from university research, allied industries, governmental extension services, and others in the field to find the best solutions with the strongest appeal to them and their customers that fits their specific farm model. Excellent stockmanship is mandatory for the success of loose sow housing, and no electronic, mechanical or automatic systems can replace good, caring attention to detail, careful consideration of the information available, and individual stockman work ethic. Producers adapting their farms for group housing can access models and tools online developed by Pork Checkoff, Prairie Swine Center and other swine industry leaders who simplify group sow housing planning, design and budgeting processes. The challenge for pork producers in the U.S. now is to rethink and fine tune management practices of the past, so they can maintain a strong and productive swine industry well into the future. Each system or combination of systems will have inherent merits and drawbacks; it will be the task of the producer, combining knowledge from university research, allied industries, equipment manufacturers, governmental extension services, and others in the field to find the best solutions with the strongest appeal to them and their customers that fits their specific farm model.

To meet the expectations of consumers and animal advocates, producers, swine experts and animal welfare oversight organizations will need to document and communicate progress, challenges and triumphs in nurturing sows in group housing.

"A segregation and verification system must be implemented to track pigs from sow to packer and to track pork from packer to retailer before consumers can be assured of the production history behind their pork purchases."

Ronald Plain, Ph.D., University of Missouri-Columbia [93]

Excellent stockmanship and continual training is crucial for the success of loose dry sow housing. No electronic, mechanical or automatic systems can replace good, caring attention to detail, careful consideration of the information available, and the individual stockman work ethic.

93 Ronald Plain, Ph.D. "Sow Housing Status," University of Missouri-Columbia. Presentation at National Pork Board Sow Housing Seminar February 3, 2015

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