Fifty-First
Virginia Pork Industry Conference

March 12, 2020
Central High School Complex
Cultural & Educational Center
Goochland, Virginia

Virginia Cooperative Extension
Virginia Tech • Virginia State University
8:30 – 9:00 am  **Registration**

Informal discussion, networking, and viewing of commercial and educational exhibits

*Agricultural Center Hall and Foyer*
8:30 – 9:00 am and 12:00 noon – 12:30 pm

- Agricultural Technology, Virginia Tech
- Amadas Industries
- Monacan SWCD
- National Pork Board Virtual Hog Farm
- Northeast Agri Systems

- On-Line Master of Agricultural and Life Sciences-Virginia Tech
- Smithfield
- Virginia Agriculture in the Classroom
- VDACS-Veterinary Services

**Agricultural Center Hall and Foyer**

- Virginia Pork Council, Inc.
- Virginia Tech- Tidewater Agricultural Research and Extension Center
- USDA, APHIS
- USDA, Wildlife Services

### Plenary Session: Emerging health issues facing the pork industry *(Eagle Theater)*

9:00 – 9:45 am  **Preparing for, preventing, and responding to the emergence of foreign animal diseases. Dr. Lisa Becton**

9:45 – 10:15 am  **Research Update: On-farm disposal options for catastrophic mortality events on pig farms. Mr. Bobby Clark**

10:15 – 11:30 am  **Economic outlook for U.S. pork production. Dr. Alex White**

11:30 am – 12:00 noon  **National Pork Board update. Mr. John Johnson**

Lunch *(Eagle Theater)*

12:30 pm – 2:00 pm

“An overview of Virginia Pork Council, Inc.”

Ms. Jessica Cunningham, President, President

### Concurrent Session I: Innovations and sustainability of pork production *(Eagle Theater)*

2:00 – 2:45 pm  **On overview of Smithfield biogas capture. Mr. Kraig Westerbeek**

2:45 – 3:30 pm  **Potential effects of cell-culture technology and meatless diets on livestock production. Dr. David Gerrard**

3:30 – 4:15 pm  **Assessing Virginia's Commercial Swine Production and Nutrient Generation in the Chesapeake Bay Watershed Mr. Mark Dubin**

### Concurrent Session II: Enhancing performance and profitability on Niche Market pig farms *(Rosenwald Room)*

2:00 – 2:45 pm  **Raising pigs outdoors: Genetic considerations Dr. Todd See**

2:45 – 3:30 pm  **Management considerations for pasture breeding operations. Dr. Mark Estienne**

3:30 – 4:15 pm  **Alternative farrowing systems for pig farmers Dr. Monique Pairis Garcia**
Table of Contents

Potential effects of cell-culture technology and meatless diets on livestock production  
J.C. Wicks, M.D. Venhuizen, M. Daughtry, and D.E. Gerrard  
4

Management considerations for pasture breeding operations  
M.J. Estienne  
10

Alternative farrowing systems for pig farmers  
B.K. Wagner and M.D. Pairis-Garcia  
19

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Introduction

The global population is expected to reach over 9 billion inhabitants by the year 2050 (United Nations, 2015) with the largest flux projected to occur in developing countries within sub-Saharan Africa (Alexandratos and Bruinsma, 2012). Further, it is expected per capita income will increase 80%, closing the income gap between the developed and developing countries. Historically, as nations grow, industrialize and improve their economy, their meat consumption increases, as does the demand of quantity and quality (Aberle et al., 2001). Therefore, it is projected that global meat production will need to increase more than 60% from what it was in 2007 (Alexandratos and Bruinsma, 2012) to meet the global demand. While chicken and beef will have the steepest incline by increasing 76% and 57% respectively, pork production will need to increase by nearly 35% (United Nations, 2015). However, with competing rights for resources such as land and water, other avenues must be considered.

Winston Churchill once said “Fifty years hence, we shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium” (Churchill, 1932). Although, still an obscure concept to many, alternatives to conventional meat production have begun to find a “place at the table”. Consumer concerns of animal welfare, meat production’s environmental impact, and agriculture sustainability, coupled with the realities of an increasing demand for highly nutritious sources of protein, have allowed for novel technologies to evolve in this new era of agriculture.

Cell-Cultured Meat

Growing synthetic muscle in vitro for potential medical implants has been widely researched for over 20 years and has been integrated into modern medicine (Strohman et al., 1990; Vandenburgh et al., 1996; Vandenburgh and Karlisch, 1989; Vandenburgh et al., 1991). In more recent years, the idea of producing animal-based cell-cultured muscle as meat has evolved. In 2008, the Norwegian Food Research Institute led the first international meeting to explore potential possibilities of developing and commercializing cell-cultured meat (Midgley, 2008), and in 2013 the world’s first cell-cultured hamburger was made for human consumption (Post, 2014).

Producing meat in vitro first begins by harvesting a muscle sample from a biopsy of a healthy meat producing animal. Once the tissue is acquired, muscle stem cells, referred to as myosatellite cells are isolated and placed in an enriched growth medium optimized with essential nutrients for cell growth. Once cells begin to proliferate they will undergo differentiation to become myoblasts.
Myoblasts will begin to organize and form multinucleated myotubes. Maturation of the myotubes will ultimately increase in length and develop into muscle fibers (Kadimet et al., 2015).

While this technology has proven to produce an eco-friendly, efficient muscle tissue that can be harvested for meat consumption, many obstacles still remain and must be addressed before cell-cultured meat could be commercialized. One challenge facing the future of cell-cultured meat is achieving all the properties of meat such as color, texture, flavor and aroma (Bhat et al., 2015; Kadim et al., 2015). This is largely due to the lack adipose tissue which aids in flavoring of meat, limited amount of the pigment protein myoglobin, and the ability for full postmortem metabolism to occur, allowing for the transition from muscle to meat (Orzechowski, 2015). However, and arguably even more challenging is producing high quantities of three-dimensional tissue. Unlike muscle growth and development in-vivo, cell-culture meat does not have the ability to include all the intricacies that make up meat such as adipose and collagen. Therefore, cell-cultured meat is formed in thin layers that lacks the scaffolding structure of collagen and requires further processing to press the newly formed fibers together to create a multidimensional meat product (Benjaminson et al., 2002; Edelman et al., 2005; Van Eelen et al., 1999). The lack of structural support and circulatory system to provide nutrients and excrete waste restricts the growth of cells to 100 – 200 microns thick (Carrier et al., 1999). Therefore, only ground or minced meat products can be produced from cell-cultured meat at this time (Edelman et al., 2005).

While these obstacles are perplexing in their own right, if they are overcome, building a consumer base to support this modern agriculture is needed. Currently cell-cultured meat is being researched across the globe with startup companies in the European Union, Israel, and the United States. In the United States, startup companies such as Memphis Meats have gained a lot of momentum and support in recent years. In fact, Memphis Meats has gained financial backing from both influential people and leading meat packing companies, with Cargill and Tyson both investing in a potential future protein source (AFN, 2018). However, even with support from investors, securing a consumer base may take some convincing. Research has shown that consumers are currently unaware of cell-cultured meat, however when consumers had an increase awareness of cultured meat there was an increase in acceptance (Bryant and Barnett, 2018). Additionally, in a follow up research marketing strategy study which evaluated different messaging angles to bring awareness of the production of cultured meat in hopes of finding consumer acceptance, it was found that using words such as natural and clean did help increase consumer acceptance. However when illustrating the similarities of cultured meat to that of yogurt or beer production, consumers acceptance was highest (Bryant et al., 2019). Although consumer marketing has been researched, due to the high cost of production and limited availability of cell-cultured meat, taste and sensory panels have yet to be conducted, leaving to question if the product would meet consumers eating expectations (Verbeke et al., 2015).

**Alternative plant-based meat substitutes**

With all the arduous challenges still ahead, it is predicted that commercialization of cell-culture meat is still 10 to 20 years off (Maastricht University, 2013). Therefore, more readily available options must be explored. Alternative plant-based proteins, such as the soy Boca Burger, or rice based Gardenburger have been options to consumers for over 25 years (Smith, 2014). However,
these items have shown to only mimic the shape of a burger and have been marketed to consumers who prefer a vegetarian diet (Keefe, 2018). Yet, the development of solely plant-based proteins that appeal to meat consumers has yet to be explored until recently.

Currently leading companies such as Beyond Burger, and Impossible Burger have created a new market of alternative plant-based imitation meat products that retain meat quality attributes such as texture, color, flavor, and aroma. While still very proprietary, the overall theme of meat substitutes is the utilization of an isolated protein source, typically in the form of soy, pea or wheat. The isolated protein is further blended with water, binders, flavorings and a plant-based fat source such as coconut oil in order to mimic the flavor and texture profiles of real meat. Finally, beet juice or processed leghemoglobin, the pigment protein found in plants is used to add color that mirrors the hue of meat. When combined, these ingredients have shown to closely imitate the appearance, flavor, texture, and cookery of meat, even mimicking the concept of purge to stimulate a meat-eating experience.

Much like with the future success of cell-cultured meat, alternative plant-based meat substitutes must appeal to consumers. Research has shown that meat substitutes must resemble traditional meat, and should be achieved in both appearance and in meal application for consumer acceptance (Hoek et al., 2011). Further, consumers were more receptive to meat substitutes when grouped within classification of other meats like ground beef and sausage (Hoek, 2010). However, other studies have shown that consumers may only prefer to use meat substitutes in certain types of dishes such as spaghetti or rice dishes (Elzerman et al., 2011). While meat substitutes may be preferred in a dish versus another, research has shown that meat substitute companies will need to provide variety in order to prevent consumers from becoming bored. Hoek (2010) found that when presented with two meat substitute options, consumers lost interest and acceptance after consumed 20 times. Although, limited in product options, alternative plant-based proteins have claimed territory in a once unexplored market, finding success in national brands such as Burger King and Qdoba Mexican Eats.

Conclusion

Agriculture is an ever-changing industry, striving daily to meet the needs of tomorrow, and while cell-cultured meat may seem impractical now due to financial and technical challenges, continuous progress is being made. These small successes over time could potentially help to alleviate the likely future strains conventional agriculture will face as the year 2050 approaches. However, even with effective research moving cell-cultured meat forward, consumer acceptance will still play a vital role in the success of cell-cultured meat products. Therefore, further investigation is needed in regards to consumers acceptance and willingness to purchase cultured meat. However, it appears marketing of cell-cultured meat products is going to rely heavily on labeling of products as well as how these companies decide to brand themselves. Further, there is strong evidence to support a future adoption of alternative-plant based meat substitutes due to consumer concern of traditional meat production’s environmental impact. Because of that, and its overall resemblance to meat, alternative-plant based meat substitutes is projected to become a $3.5 billion industry by the year 2026 (Markets and Markets, 2018).
References


PROCEEDINGS OF THE FIFTY-FIRST VIRGINIA PORK INDUSTRY CONFERENCE

MANAGEMENT CONSIDERATIONS FOR PASTURE BREEDING OPERATIONS

M.J. Estienne

Virginia Tech- Tidewater Agricultural Research and Extension Center, Suffolk

Introduction

Pigs are very adaptable creatures and can thrive in many different environments. Moreover, sows and boars that are managed correctly in outdoor production systems, can achieve a level of reproductive performance that approaches or is equal to that reported for confinement units. For example, Johnson et al. (2001) compared performance in 287 Newsham sows that were kept in indoor or outdoor production systems. Reproductive performance in the outdoor sows was respectable (9.4 pigs born live with 11.8% pre-weaning mortality), and in that experiment, not significantly different from the sows kept indoors. Sows that are kept outside can be bred using three different methods: hand-mating, artificial insemination (AI), or pen or pasture mating (Levis et al., 2011). With hand-mating, boars are housed separately from sows, and the two sexes are brought together only for heat detection and supervised mating. Similarly, with AI, boars are housed separately from sows, but are used only to identify females in heat. With pen or pasture mating, boars and sows are housed together and mating is unsupervised. Pasture breeding requires more boar power and reproductive performance is generally less than that achieved with hand-mating or AI. Nevertheless, pasture mating systems are popular with small-scale and niche market pig farmers because no heat checking skills are required and there is less labor needed compared with the other two systems. The objective of this paper is to describe management considerations for pig farmers using pasture breeding systems.

Breeding herd health considerations

Whether raising pigs in sophisticated indoor facilities or outside on pasture, it is imperative to work with a veterinarian to develop a complete, farm-specific herd health program that includes regular evaluation of herd health status. The veterinarian will provide advice on the strategic use of vaccinations and possibly de-wormers to keep the animals from contracting serious health conditions. In regard to breeding operations of any kind there are three diseases for which sows and boars should receive vaccinations: leptospirosis, erysipelas, and parvovirus. Leptospirosis is a bacterial disease that may cause abortions, stillbirths, and poor survival of newborn pigs. Swine erysipelas is also caused by a bacterium, and characteristically high fevers can induce abortions in pregnant gilts and sows. Parvovirus in swine results in dramatic increases in the farrowing of stillbirths and mummified fetuses. Once a pregnant sow is infected, the virus spreads from one fetus to the next. Thus, the unborn pigs die at different stages of development as indicated by stillbirths and mummified fetuses of different sizes present at farrowing.
There are several commercial products that in a single injection, provide protection against leptospirosis, erysipelas, and parvovirus. The vaccines cost less than $1.00/dose. Replacement gilts should be vaccinated twice before first breeding, and sows should be revaccinated after farrowing a litter. Boars should also be vaccinated twice yearly. Thus, for a 50-sow operation in which sows farrow twice yearly, total cost of vaccinations would be approximately $125. If weaned pigs are valued at $30/head, then one litter of 8 pigs lost to parvovirus would result in a loss of $240 (8 pigs x $30/pig = $240). Saving that one small litter of pigs more than offsets the vaccine costs for the entire herd.

Feeding sows and boars used in outdoor breeding systems

The nutritive value of pastures used in outdoor breeding systems depends on soil types, plant species, and weather. Pastures are often overstocked and/or not managed, and consequently become “dirt lots”. In general, legume pastures are most practical for pig farmers. If stocking rates are kept to a maximum of 4 to 6 breeding-gestation sows per acre and the available pasture is managed (in other words, sows rotated among pastures, pastures plowed, disked and reseeded every other year, etc.), then breeding stock will receive some nutritional benefit from legumes and/or grass (Kephart et al., 2006). Even on excellent pasture, sows and boars will require daily feeding of a complete diet. Examples of complete diets that can be used when breeding stock is maintained on various types of pasture appear in Table 1. Rather than feeding sows and boars a standard amount of feed, such as 2 to 3 pounds/head/day, farmers should feed according to body condition (Figure 1) with an average body condition score (BCS) of 3 being ideal. If on average, sows and boars have lower body scores, than the amount of feed allotted per head per day is increased. If sows and boars have higher average BCS, then the amount of feed can be decreased.

Table 1. Composition of diets to be fed when breeding sows and boars are maintained on various types of good quality pasture. (adapted from Kephart et al., 2006)

<table>
<thead>
<tr>
<th>Component, %</th>
<th>Legume</th>
<th>Grass</th>
<th>Legume-Grass Mix</th>
<th>Rapeseed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>87.7</td>
<td>68.5</td>
<td>76.0</td>
<td>92.8</td>
</tr>
<tr>
<td>Soybean meal, 48%</td>
<td>8.7</td>
<td>26.3</td>
<td>18.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>---</td>
<td>0.8</td>
<td>1.2</td>
<td>0.9</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>---</td>
<td>3.2</td>
<td>3.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Monosodium phosphate</td>
<td>2.4</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Salt</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Vitamin premix</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Trace mineral premix</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Calculated Composition

<table>
<thead>
<tr>
<th>Component</th>
<th>Legume</th>
<th>Grass</th>
<th>Legume-Grass Mix</th>
<th>Rapeseed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolizable energy, kcal/pound</td>
<td>1499</td>
<td>1470</td>
<td>1469</td>
<td>1453</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>11.7</td>
<td>18.6</td>
<td>15.5</td>
<td>8.2</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.05</td>
<td>1.16</td>
<td>1.23</td>
<td>1.44</td>
</tr>
<tr>
<td>Phosphorous, %</td>
<td>0.81</td>
<td>0.95</td>
<td>0.88</td>
<td>1.09</td>
</tr>
</tbody>
</table>
Figure 1. Body condition scale for sows (taken from PQA-Plus, Version 2.0; National Pork Board, Des Moines, IA, 2013). 1 = emaciated, 2 = thin, 3 = ideal, 4 = fat, and 5 = overly fat. Body condition is a key indicator of management and animal well-being and farmers should strive to maintain sows with a body condition score of “3”.

Production Systems

Production systems employing pasture breeding systems vary based on the goals of the farmer, and available resources and labor. For the very small farmer, the easiest pasture breeding system to operate, in terms of management and labor, consists of continuously keeping a boar and sows together, perhaps only moving sows that are “bagged up” (in other words, obviously near the time of farrowing as indicated by the udders filling with milk) to a separate pasture or pen for birth of the pigs. Among the many disadvantages of this system is not knowing the general time when sows are bred and as a consequence, keeping infertile animals in the herd too long which can be expensive. For example, let’s say a sow comes in to heat 10 days after weaning and is bred by a boar but does not conceive. She then recycles and is rebred 20 days later, but again does not conceive. If she stays in the herd for let’s say just 60 days after that second breeding, she has accumulated 90 “non-productive days”. If you figure sow maintenance costs at approximately $2.00/day, then she has cost a farmer $180 with no return. If weaned pigs are valued at $30/head then another sow or sows will need to wean an additional 6 pigs just to pay for the first sow’s 90 non-productive days.

Compared to the continuous breeding described above, the two-litter system is a more-intensive type of outdoor production system. With this system, all sows farrow as a group in the spring and fall (Table 1). Pigs are weaned at 4 to 8 weeks of age and boars are turned in with sows during spring and fall “breeding seasons”. A disadvantage of this system is that most pigs will be ready to market at two times each year. Farmers raising “niche” pork may need a more consistent supply of product.

A final example of a production system for which pasture breeding can be successfully employed is the batch farrowing system. With batch farrowing, the sow herd is divided into groups
Table 1. Example of a two-litter pork production system

<table>
<thead>
<tr>
<th>Month</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>---</td>
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<tr>
<td>February</td>
<td>---</td>
</tr>
<tr>
<td>March</td>
<td>Farrowing (March 1 to March 31)</td>
</tr>
<tr>
<td>April</td>
<td>Weaning (April 30; pigs ~4 to 8 weeks of age)</td>
</tr>
<tr>
<td>May</td>
<td>Breeding (begin ~May 10)</td>
</tr>
<tr>
<td>June</td>
<td>Breeding (End ~June 8)</td>
</tr>
<tr>
<td>July</td>
<td>---</td>
</tr>
<tr>
<td>August</td>
<td>---</td>
</tr>
<tr>
<td>September</td>
<td>Farrowing (September 1 to September 30)</td>
</tr>
<tr>
<td>October</td>
<td>Weaning (October 31; pigs ~4 to 8 weeks of age)</td>
</tr>
<tr>
<td>November</td>
<td>Breeding (begin ~ November 7)</td>
</tr>
<tr>
<td>December</td>
<td>Breeding (End ~December 7)</td>
</tr>
</tbody>
</table>

of sows that are bred, farrowed and weaned together. The number of sow groups used, as well as the interval between groups of sows farrowing, varies among farms. Shown in Table 2 are the activities associated with a “4/5” batch farrowing system. With this system there are four groups of sows, with a group of sows farrowing at five-week intervals (hence the name, 4/5 system). In terms of weekly activities, one sow group is weaned one week followed by breeding beginning the next week; another sow group begins farrowing over the next two weeks, and then there is one week of “down” times. The breeding period can actually last for up to two weeks, and pig weaning ages will range from 14 to 28 days. Sows bred during the first week of the breeding period will wean older pigs (21 to 28 days of age) down the line.

**Boar usage guidelines**

For optimum fertility (high conception rates and large litter sizes), a sow must be mated 0 to 24 hours before ovulation (the release of eggs from the ovaries) receiving a minimum of **2 to 3 billion** sperm cells. Semen from a 10-month old boar ejaculating 1 to 2 times per week with a 3-day rest between ejaculations typically contains **60 to 130 billion** sperm cells (Knox, 2012). It would seem then that a boar ejaculate contains many more sperm cells than are necessary to impregnate an individual sow, and in many a case, this is true. However, with pasture mating systems, there are several situations that can result in a sow in heat not being bred at the appropriate time and/or not receiving the critical number of sperm cells to become pregnant and have large litters of pigs.
Table 2. Activities for a 4/5 batch farrowing system over a 16-week period.

<table>
<thead>
<tr>
<th>Week</th>
<th>Sow Group</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>Breeding</td>
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<td>2</td>
<td>Breeding</td>
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<td>3</td>
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<td>15</td>
<td>---</td>
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<tr>
<td>16</td>
<td>---</td>
</tr>
<tr>
<td>17</td>
<td>Farrowing</td>
</tr>
</tbody>
</table>

¹If sows are bred over the entire two-week period, then weaning ages will be 14 to 28 days. If sows are bred during the first week after weaning only the range is less and is 21 to 28 days of age.

Healthy, well-fed sows are in heat and receptive to a boar for 48 to 72 hours every 18 to 22 days, unless estrous cycles are interrupted by pregnancy and then lactation. As stated above, however, the sow is most fertile if semen is deposited within the 24-hour period before ovulation, which generally occurs about 40 hours after the onset of standing heat. If multiple sows are in heat at the same time in a pasture breeding system, there is a significant chance that any individual sow may not be bred during heat at the optimum time relative to ovulation, if she is bred at all. Indeed, it is not uncommon for boars to locate a sow in heat and breed her multiple times over the course of two or three days while essentially ignoring other sows that may be in heat.

As mentioned above, a minimum of 2 to 3 billion sperm cells must be deposited at the proper time in order for sows to become pregnant. For boars ejaculating frequently over the course of a few days, however, there is a rapid decrease in the number and quality of sperm cells contained in semen. In a study by Pruneda et al. (2005), 12-month old Pietrain boars were subjected to one of two semen collection frequencies for 4 days (n = 3 boars per group): twice daily (8 total ejaculations) or once every 2 days (2 total ejaculations). On day 4 of the study, total number of sperm cells was 33.3 billion in ejaculates from boars collected once every two days, compared to only 1.4 billion sperm cells in in ejaculates from boars collected twice daily. If these data are
extrapolated to a pasture mating situation, then after 4 days of breeding twice per day, a boar is no longer ejaculating sufficient sperm cells to impregnate sows even if mating occurs at the optimum time. Suffice to say, the willingness of a boar to mount a sow and mate does not guarantee that a sufficient number of sperm cells have been deposited.

It is imperative to have a sufficient number of boars to breed sows in a pasture mating system, especially if sows are weaned as a group. After a 21- to 28-day lactation, sows weaned as a group tend to display a synchronous heat with a large proportion (~85%) of sows displaying heat 4 to 7 days after weaning. Figure 1 depicts the boar requirements for two-litter and 4/5 batch farrowing systems utilizing pasture breeding. Note both systems have 48 sows and require four boars. Because sows are likely to be randomly cycling and the breeding period lasts approximately one month, the boars in the two-litter system are housed at a boar to sow ratio of 1:12. Conversely, in the 4/5 batch farrowing system, weaning stimulates a synchronous heat in the group of 12 sows to be bred, and it is important to have the sows successfully bred as soon as possible after weaning. Thus, for this system, a boar to sow ratio of 1:3 is used. Boars work in pairs and the pairs are rotated in and out of the breeding pasture at 24-hour intervals. This increases the likelihood that sows will be serviced twice during heat (increasing likelihood that sows are bred during the most fertile period before ovulation) and minimizes overuse of individual boars. It is important to point out that if young boars (less than 1 year of age) are used to breed a group of weaned sows, then a boar to sow ratio of 1:1, rather than 1:3 should be considered.

**Figure 1.** Depiction of boar requirements for 48-sow pasture breeding using 2-litter (left) or 4/5 batch farrowing (right) production systems. The total number of boars required is equal, but during breeding periods the ratios of boars to sows for the two-litter and batch farrowing systems are 1:12 and 1:3, respectively. The blue arrows indicate that the boars in the batch farrowing system work in pairs and pairs are rotated in and out of the breeding pasture at 24-hour intervals.
Seasonal Infertility

Boars subjected to heat stress conditions produce semen that has low sperm concentrations, high percentages of abnormal sperm cells, and decreased percentages of progressively motile sperm cells. Research has indicated that the minimum exposure time and critical air temperature above which production of sperm cells is adversely affected is 72 hours (McNitt and First, 1970) and approximately 85°F (Stone, 1982), respectively. Boars may also be sensitive to chronic periods of moderately elevated temperatures (~81°F) not recognized as classic “heat stress” conditions (Flowers, 1997).

The negative effects of acute heat stress on semen quality may be somewhat immediate. A “lag” period of approximately 2 weeks, however, is often observed between the initiation of acute heat stress and the first indications of abnormal sperm production. After the cessation of heat stress conditions, a period of 6 to 7 weeks is necessary before fertility returns to normal. That is because heat stress impairs spermatogenesis, the process by which new sperm cells are created in the testicles that lasts approximately 6 weeks. Thus, acutely heat stressed boars can have a protracted, negative influence on reproduction in a breeding operation. For example, boars exposed to 95°F temperatures for three consecutive days in late-July may be responsible for suppressed conception rates well into September, even in the unlikely situation in which temperatures do not rise above 85°F after the July “heat wave”. The effects of elevated environmental temperatures on various characteristics of libido have not been extensively studied. However, during the summer, boars may become lethargic and display a reluctance or refusal to mount a sow in heat.

Ideally, pigs housed outdoors should have access to a wallow that allows animals to bathe, promoting evaporative cooling. A shade and water sprinklers are often more practical and can provide similar benefits. Research conducted in Oklahoma and Florida revealed that boars maintained on outside lots with a shade and sprinklers had 20% greater fertility than boars provided shade only. Shade can be naturally provided (trees) or artificially provided (lean-to or awning).

Producers that utilize boars for natural mating should anticipate a reduction in fertility during the summer. Breeding extra sows and gilts to compensate for the lower conception rates expected during the summer is a common practice, but boars must not be overworked. When boars are used for natural mating during or after periods of heat stress conditions, it is advisable to decrease the number of sows that they service by approximately 30%.

Summary and Conclusions

The majority of pork consumed in Virginia is, and will continue to be, produced by large corporate operations. However, many families are once again producing pigs as a means for increasing farm revenue. Certain consumers with interest in animal welfare, the environmental impact of agriculture, and farm size, desire pork produced locally on small farms. Indeed, they are willing to pay a premium for pork with certain attributes (for example, raised without
antibiotics) and/or pork from hogs reared under certain conditions (for example, outdoor rearing conditions). If small-scale and niche market pork production continues to flourish, the markets and the farmers that supply them will remain a viable entity in a diverse Virginia agriculture. Pasture mating systems are popular with small-scale and niche market pig farmers because no heat checking skills are required and there is less labor needed compared with other more-intensive systems. As with any breeding system, boars and sows used for pasture mating must be managed properly. Following are management suggestions for those wishing to employ pasture mating on their farms:

- Boars, sows, and replacement gilts should be vaccinated against Leptospirosis, parvovirus and erysipelas as per product label.

- Breeding stock at various stages of the reproductive cycle should be fed diets that meet their individual nutrient requirements. Sows and boars can get a portion of their required nutrients from well-managed pasture.

- Rather than continuously housing boars and sows together, farmers should consider a production system such as the two-litter system or the 4/5 batch farrowing system that matches their goals and available labor and resources.

- For situations in which mature boars are turned out with a group of weaned sows the boar to sow ratio should be 1:3; if boars less than 12 years of age are used then the ratio should be 1:1. The number of sows per boar can be increased if sows are randomly cycling and their estrous cycles are not synchronized.

- Use strategies such as wallows, shades, and sprinklers to keep boars and sows cooler during the summer when fertility is typically compromised be elevated temperatures.

**References**


**Introduction**

Over the past two decades, pork producers have adapted to address the growing public interest in niche market products. Free-range and alternative systems focus on encouraging natural behavior and a stronger bond between the piglets and sows. This has resulted in the development of alternative farrowing systems which include modified stalls, pens, groups and outdoor systems. Each of these systems have advantages and disadvantages and it is up to the producers to decide what works best for their animals. This paper and presentation will briefly outline the most commonly used alternative farrowing systems and breakdown specifics regarding each system’s ability to meet both the needs of the animals and producer.

*Conventional Stall*

In the 1960’s, conventional farrowing stalls were introduced to reduce the incidence of piglet sow crushing (Roberston *et al.*, 1966) and improve environmental cleanliness, ultimately decreasing piglet mortality. Such confinement systems also protect animal caretakers from sustaining injuries as a result of sow aggression (Glencorse *et al.*, 2019). Initially, producers experienced direct economic benefits associated with reduced mortality as well as facility and labor costs (Pairis-Garcia, 2015).

Although some benefits of conventional farrowing stalls exist as a result of individualized sow management, the limited ability of sows to move and perform necessary behaviors leads to compromised sow welfare. For example, sows are extremely motivated to perform nest seeking and building behaviors 24 hours prior to farrowing (Wischner *et al.*, 2009; Pairis-Garcia, 2015). Lack of space and substrate (e.g. straw) prevents the sow from performing these behaviors and this can result in a nervous sow with an activated stress response. The following alternative farrowing systems attempt to preserve the benefits of conventional stalls while thoroughly addressing the complex needs of the sow to improve on-farm pig welfare and maintain farm productivity.

*Modified Stall*

Increased width, provided by modified farrowing stalls, allows the sow more space to turn around and move while still providing protection to the piglets and management benefits. However, previous research indicates only minimal improvements to sow welfare as complete nest building behaviors are still prohibited by the lack of space and substrate. Additional facility costs of implementing modified stalls is not practical as this farrowing system ultimately fails to fully address the needs of the sow.

*Pen System*

Housing farrowing sows in individual pens allows sows to perform a more complete set of behaviors, such as nest seeking and building. Open-concept pens can be simple, however more
elaborate designs can be used to encourage sows to farrow, lie down, nest and develop a consistent dunging pattern (Image 1).

Although sow welfare is improved in farrowing pen systems, the relative increase in piglet mortality (20.7% in simple pens compared with 18.3% and 16.9% in conventional and modified stalls, respectively) remains a productivity challenge (Baxter et al., 2012). In addition, large floor space requirements, increased labor costs and greater risk to caretaker safety remain limitations of implementation of pen systems as well. Increased costs and lack of marked, consistent improvements to piglet survivability or productivity combine to result in an alternative farrowing system that is currently cost-prohibitive for some producers.

**Group System**

Group systems consist of large pens in which sows and litters cohabitate. Substrate is generously provided and most group pens have individual nest sites or boxes that allow sows to separate from the group when needed. However, for a group pen system to be successful sows must be moved in to the pen prior to farrowing to both accommodate the peak in nest building behavior (6 to 12 hours preparturient) and allow sows time to establish a stable group dynamic. In addition, maternal behavior and temperament play a key role in the success of group systems and herd genetics should be carefully considered if adopting a group system (Pairis-Garcia, 2015).

Because of the absence of protective structures to prevent sow crushing, piglet mortality is greater for this system (23%) compared with all other farrowing systems (Baxter et al., 2012). Factors such as piglet loss, increased economic input (e.g. labor input and capital investment) and the greater risk to caretaker safety all contribute to management challenges. Ultimately, excellent managerial skills and genetic selection for both maternal behavior and temperament remain a requirement to successfully implementing a group system (Pairis-Garcia, 2015).

**Outdoor System**

Lastly, outdoor systems are considered the gold standard of farrowing systems and consist of providing sows free-access to pasture and access to individual farrowing sites. The provision of
space and substrate support the biological and behavioral needs of both the sow and the piglet, improving overall pig welfare. In addition to improved animal welfare, outdoor production levels are competitive with productivity of pigs housed indoors (18.7% total mortality) (Meat and Livestock Commission 2000–2009).

Farrowing pigs in an outdoor system does create some management challenges including sow handling, identification of compromised animals and the possibility of inclement weather. To address these challenges, farms must be strategically located geographically and may require the use of additional equipment (e.g. temporary holding pens) and more time dedicated to checking animals. If these management challenges can be addressed, the combination of respectable animal productivity and decreased input costs (e.g. capital investment, maintenance costs) make using an outdoor system for farrowing a viable alternative to conventional stalls for some producers.

Growing consumer demand for improved on-farm animal welfare and alternative products from a niche market has resulted in reassessment of husbandry practices. Implementing alternative farrowing systems can improve on-farm animal welfare and provide unique market access to producers. However, it is critical that a producer evaluates each system design and decides what he or she thinks is best for the animal, the facilities and the people working on the farm.

References


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