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Enhancing Reproductive Performance by Boars Used for Pasture Mating

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Introduction

Swine on most large-scale commercial operations in the U.S. are reared in environmentally controlled barns, yet pigs are very adaptable creatures and thrive in a variety of surroundings. In fact, sows and boars managed correctly in outdoor production systems can achieve a level of reproductive performance that approaches, or is equal to, that reported for intensively managed confinement units. For example, in a study conducted in Texas, scientists maintained Newsham sows either in outdoor or indoor production systems. Sows were mated via artificial insemination (AI) and reproductive performance in the outdoor group that farrowed in English-style arc huts was respectable (9.4 pigs born live per litter with 11.8% preweaning mortality), and, in that experiment, reproductivity was not statistically different from sows farrowing indoors in conventional crates (Johnson et al. 2001).

Farmers with an outdoor production operation can use three types of mating systems: pasture (or pen) mating; hand-mating; or AI. With pasture mating, boars and sows are kept together in the same enclosure and mating occurs unsupervised. In hand-mating systems, boars are kept separately from sows and are placed together with females only for detection of estrus (heat) and subsequent mating. With AI, boars are kept separately from females and have contact with sows only for estrus detection; females displaying estrus are then mated by AI using collected semen. The number of boars required to service females is greatest with pasture mating and least for AI.

Pigs per sow per year (PSY) is a key determinant of profitability for any size sow enterprise. The consensus among swine reproductive physiologists is that two factors that impact PSY, farrowing rates (percentage of sows exposed to a boar that farrow) and litter sizes, are both superior for hand-mating and AI, compared with pasture mating. Nevertheless, a considerable number of pig farmers, usually those with small-scale or niche market operations, choose pasture mating because it requires simpler facilities and less labor and technical skills. This publication focuses on management of boars used for pasture mating systems and addresses problems encountered and strategies to enhance reproductive performance.

Selecting Boars for Pasture Mating

"Selection" is the process by which the breed or line of swine to employ on the farm is determined and then choosing within that selection the specific boar or boars to mate. Because an individual boar will breed multiple females, it will have a much greater impact on the performance of the farm than will any individual sow. Thus, selection of boars should be conducted wisely.

Many breeds of swine can excel in outdoor production systems, but focus should be on breeds that are hardy, long-lived, and adaptable. Using pigmented breeds and providing animals access to shade decreases the risk of sunburn. Breeds more common in pasture mating systems include, but are not limited to, Berkshire, Hampshire, Duroc, and various heritage breeds, such as Tamworth, Red Wattle, American Guinea, and Gloucester Old Spot (The Livestock Conservancy 2025) (fig. 1).

Figure 1. Young Gloucester Old Spot boars being raised for use in a pasture breeding operation. (Photograph courtesy of Ayrshire Farm.)

Additionally, using crossbred boars for pasture mating offers two advantages: hybrid vigor (or heterosis), which

is the improved performance of crossbred offspring compared to the average of their purebred parents; and breed complementarity, which allows a breeder to blend the superior traits of one animal with the superior traits of another animal into their crossbred offspring. Research has indicated that crossbred boars sexually mature more quickly and exhibit an advantage in testicle size and weight over their purebred counterparts, even when adjusting the data for body size. Moreover, semen characteristics such as ejaculate volume, mating behavior, and farrowing rate show an advantage for crossbred individuals, particularly when younger boars are considered (Buchanan 1987).

When selecting a specific boar, focus on performance traits of economic importance, such as growth rate, as well as conformation and physical soundness: no buckling of front legs or stiffness in hind legs; strong feet with large, even-sized toes; and normal-appearing external reproductive organs. Boars should be purchased at least 45 to 60 days before they are used for breeding, which allows time for them to acclimate to an unfamiliar environment and to be checked for health issues and reproductive soundness. Information on prepurchase health and disease considerations, transporting boars, and quarantine procedures is available online from the Pork Information Gateway (Singleton and Flowers 2006).

Puberty is the age at which the boar first displays both a complete sequence of normal sexual behaviors (in other words, mounting, erect penis, thrusting) and ejaculates enough fertile sperm cells to impregnate a female. Both environmental factors and genetics influence age at puberty onset and is 6 to 8 months in most commercial boars. Crossbred boars become sexually active earlier than their purebred counterparts. After achieving puberty, reproductive characteristics continue to develop, and boars are sexually mature at approximately 12 months of age. For example, boars produce pheromones that help advance puberty and stimulate the "standing estrus response" in gilts. In one study, young, pubertal boars (6 to 7 months of age), although sexually active, were 60% less effective at eliciting this response in gilts compared to more mature boars who were at least 11 months old (Kirkwood and Hughes 1981). Once puberty is attained, ejaculates contain 60 billion to 120 billion sperm cells, but that number is influenced by ejaculation frequency and boar age (Flowers 2008). The total number of motile sperm cells in ejaculates continues to increase up to about 30 months of age and then begins to decrease (Knecht et al. 2017). Although it is difficult to predict exactly when, actual boar fertility and libido will undoubtedly begin to decrease as well, and older boars generally have more sperm abnormalities resulting in lower pregnancy rates and litter sizes in mated females.

Nutrition and Feeding in Breeding Boars

Nutrient recommendations for boars and practical feeding strategies were described by Whitney and Baidoo (2010). In general, a balanced 14% crude protein sow gestation feed is acceptable. Rather than feeding boars a standard amount of feed, such as 5 to 6 pounds per head per day, farmers should feed according to body condition (fig. 2) with an average body condition score of three being ideal. If on average boars have lower scores, then the amount of feed allotted each day should be increased. If boars have a higher score, then the amount of feed can be decreased. Increases in feed allowances should be made when boars are subjected to cold weather or when they are in periods of intense mating activity. Finally, young boars are still growing and will need extra feed (approximately a half-pound per day) to allow for moderate weight gains.

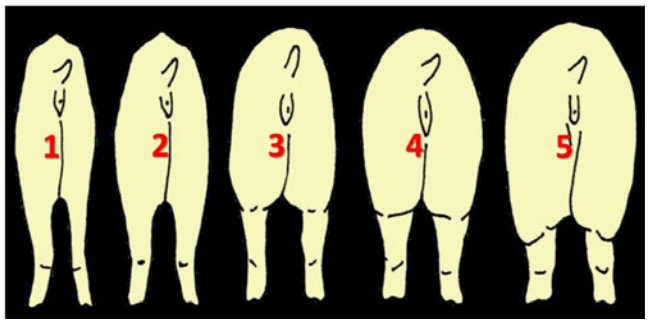

Figure 2. Body condition scale for swine. (Used by permission from PQA-Plus, Version 2.0; National Pork Board, Des Moines, Iowa, 2013). 1 = emaciated, 2 = thin, 3 = ideal, 4 = fat, and 5 = overly fat. Body condition is a key indicator of management and animal well-being, and farmers should strive to maintain boars and sows with a body condition score of three.

The nutritive value of pastures used in outdoor breeding systems depends on soil types, plant species, and weather. Pastures are often overstocked 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 four to six breeding-gestation sows per acre and the available pasture is managed (in other words, animals rotated among pastures, pastures plowed, disked and reseeded every other year, and so forth), then breeding stock will receive some nutritional benefit from legumes and/or grass (Kephart et al. 2006). **However, it's important to note that even with excellent pasture, sows and boars will require daily feeding of a complete diet.** Table 1 provides examples of complete diets that can be used

when breeding stock is maintained on diverse types of pasture. Designs for pasture subdivisions for practical management of hogs are described in Pietrosemoli and Arnold (2022).

Table 1. Composition of diets to be fed when breeding sows and boars are maintained on diverse types of decent quality pasture. (Adapted from Kephart et al. 2006)

	TYPE OF PASTURE			
Component, %	Legume	Grass	Legume-Grass Mix	Rapeseed
Corn	87.7	68.5	76.0	92.8
Soybean Meal, 48%	8.7	26.3	18.6	0.6
Ground Limestone	---	0.8	1.2	0.9
Dicalcium Phosphate	---	3.2	3.0	4.5
Monosodium Phosphate	2.4	---	---	---
Salt	0.6	0.6	0.6	0.6
Vitamin premix	0.3	0.3	0.3	0.3
Trace mineral premix	0.3	0.3	0.3	0.3
	100	100	100	100

Diseases Causing Reproductive Failure in Swine

Although many diseases cause reproductive failure in swine (porcine reproductive and respiratory syndrome, porcine circovirus type 2, and brucellosis, among others), there are three against which all boars should be vaccinated: leptospirosis, erysipelas, and parvovirus. All three diseases can be transmitted between boar and sow during natural mating. Leptospirosis is a bacterial disease that may cause abortions, stillbirths, and poor survival of newborn pigs. A bacterium also causes swine erysipelas, and the characteristically high fevers that result can induce abortions in pregnant gilts and sows. Parvovirus in swine causes dramatic increases in the farrowing of stillbirths and mummified fetuses.

Commercial products that provide protection against leptospirosis, erysipelas, and parvovirus with a single injection are available. The vaccines cost less than $1 per dose. Farmers should vaccinate boars twice yearly. Whether raising pigs in sophisticated indoor facilities or outside on pasture, it is imperative to collaborate 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 dewormers to keep the animals from contracting serious health conditions.

Determining Boar Power Needed for Pasture Mating

Having an inadequate number of boars, or "boar power," is often a problem on farms using pasture mating. For boars ejaculating frequently over the course of a few days, there is a rapid decrease in the number and quality of sperm cells contained in semen. In one study, semen was collected from 12-month-old Pietrain boars for a total of four days. On day four, the total number of sperm cells was 33.3 billion in ejaculates from boars collected once every two days (two total ejaculations), compared with only 1.4 billion sperm cells in ejaculates from boars collected twice daily (eight total ejaculations) (Pruneda et al. 2005). A minimum of 2.5 to 3 billion motile sperm cells is necessary to impregnate a sow. Sometimes an aggressive boar may continue to mate with females even after depleting his sperm supply.

Moreover, sows remain in estrus for up to three days and optimum fertility is contingent upon the boar depositing the required 2.5 to 3 billion motile sperm cells into the reproductive tract zero to 24 hours before ovulation, which occurs at about 75% of the way through the total duration of estrus. The odds that a pasture mating occurs during the optimum time increase if sows are mated more than once during estrus.

Finally, boars will often find a particular sow in estrus and will mate with her repeatedly rather than mating other sows that are also in estrus. Having an adequate number of boars increases the likelihood that a sow in estrus will be identified and mated multiple times by boars ejaculating enough sperm cells.

Table 2 displays general recommendations for the boar power required in pasture breeding operations. Note that the boar-to-sow ratio is dramatically different when sows display synchronized estrous cycles compared with randomly cycling sows.

Table 2. Boar-to-sow ratios for use in pasture mating.

Age of boar	Synchronized estrous cycles[a]	Estrous cycles not synchronized[b]
Young (8 to 12 months of age)	1:1	1:4
Mature (over 12 months of age)	1:3	1:12

[a] For example, a group of sows weaned on the same day after a 3- to 4-week lactation.

[b] For example, a group of sows weaned after a 4- to 8-week lactation and then exposed to boars for a one-month breeding period starting 10 to 14 days post weaning.

Group weaning after a three- to four-week lactation period is a management tool that can result in the synchronous onset of estrus among sows in four to seven days. The synchrony of response decreases after longer lactation lengths (five to six weeks) and sows may display estrus prior to weaning. Figure 3 shows examples of the number of sows in estrus when the groups of females are randomly cycling, or when estrous cycles are synchronized by group weaning after a three-week lactation period. Sows remain in estrus for up to three days, but sows that return to estrus earlier after weaning remain in estrus longer than do sows with a greater weaning-to-estrus interval. It is evident that a substantial number of sows in estrus will accumulate on days five, six, and seven post-weaning and more boar power will be necessary than if the females are cycling randomly.

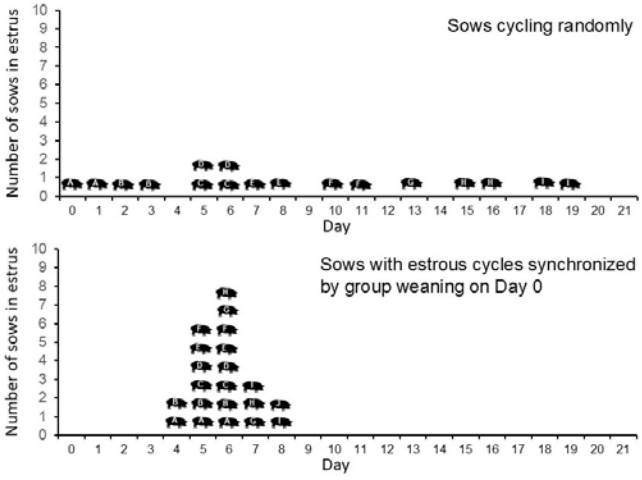

Figure 3. This figure shows hypothetical examples of the accumulation of sows in estrus when the females are randomly cycling or when group weaning after a three-week lactation period causes a synchronized onset of estrus. Each example is for a group of 10 sows, identified as "A" through "I." Note the large accumulation of sows in estrus between five to seven days post-weaning.

Necessary boar power is less in situations in which sows and gilts are randomly cycling (top chart), and in this example, one mature boar or two young boars would be sufficient. When sows display synchronized estruses, however, four mature boars or five young boars are required. This group of four to five boars could be subdivided into two groups with Group 1 containing two boars and Group 2 containing two to three boars. Each day, one group of boars would be moved out of a "rest" pen into the breeding pen with the 10 sows. The other group would be moved out of the breeding pen and into the rest pen for one day. The number of sows in estrus that accumulate can be controlled and managed by employing "split-weaning" systems in which only a portion of lactating sows are weaned every two to three days.

Systems Approach to Pasture Mating

Production systems employing pasture breeding 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 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 disadvantages of this system is not knowing the general time when sows are bred and consequently, keeping infertile animals in the herd too long, which can be expensive. An example of this is when a sow comes into heat 10 days after weaning and is bred by a boar but does not conceive. It then recycles and is rebred 20 days later but again does not conceive. If it stays in the herd for just 60 days after that second breeding, it has accumulated 90 nonproductive days. If you figure sow maintenance costs at approximately $2 a day, then this sow has cost a farmer $180 with no return. If weaned pigs are valued at $30 per head, then other sows will need to wean an additional six pigs just to pay for the 90 nonproductive days from the first sow.

Compared with continuous breeding described above, the two-litter system is more intensive. With this system, all sows farrow as a group in the spring and fall (table 3). 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 of the pigs will be ready to market only twice each year. Farmers raising "niche" pork may need a more consistent supply of product.

Table 3. Example of a two-litter pork production system employing pasture mating.

Month	Reproductive Management Activity
January	-----
February	-----
March	Farrowing (March 1 to 31)
April	Weaning (April 30; pigs ~4 to 8 weeks of age)
May	Breeding (begin ~May 10)
June	Breeding (end ~June 8)
July	-----
August	-----
September	Farrowing (September 1 to 30)
October	Weaning (October 31; pigs ~4 to 8 weeks of age)
November	Breeding (begin ~November 7)
December	Breeding (end ~December 7)

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.

The number of sow groups used, as well as the interval between groups of sows farrowing, varies among farms. Shown in Table 4 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 batch farrowing 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 downtime. The breeding period can last for up to two weeks. Sows bred during the first week of the breeding period will wean older pigs (21 to 28 days of age) down the line. If sows are bred over the entire two-week period, then weaning ages will be 14 to 28 days.

Table 4. Activities for a 4/5 batch farrowing system over a 16-week period.

Week	Group A	Group B	Group C	Group D
1	Breed	---	---	---
2	Breed	Farrow	---	---
3	---	Farrow	---	---
4	---	---	---	---
5	---	Wean[1]	---	---
6	---	Breed	---	---
7	---	Breed	Farrow	---
8	---	---	Farrow	---
9	---	---	---	---
10	---	---	Wean[1]	---
11	---	---	Breed	---
12	---	---	Breed	Farrow
13	---	---	---	Farrow
14	---	---	---	---
15	---	---	---	Wean[1]
16	---	---	---	Breed
17	Farrow	---	---	Breed

[1]If sows 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 will be 21 to 28 days of age.

Figure 4 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 mature boars in the two-litter system are housed at a boar to sow ratio of 1:12.

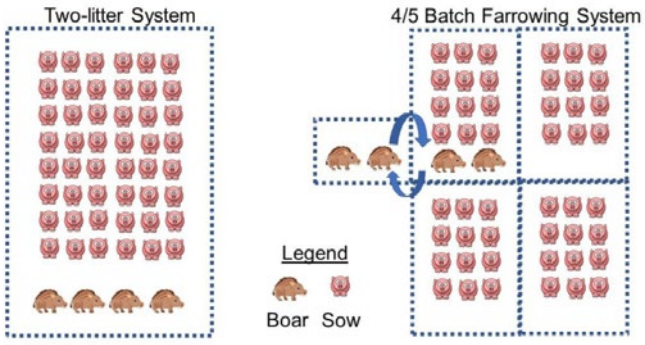

Figure 4. Depiction of boar requirements for 48-sow pasture breeding using 2-litter (left) or 4/5 batch farrowing (right) production systems. The total number of boars required is equal, but during breeding periods the ratios of boar to sows for the two-litter and batch farrowing systems are 1:12 and 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.

Conversely, in the 4/5 batch farrowing system (right hand side of figure 4), 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. In fact, mating twice versus once during estrus increases conception rates by 10% to 30% (Evans et al. 2006). 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.

Heat Stress and Boar Reproduction

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 sperm cells can be adversely affected when swine are exposed to 85 F or higher temperatures for as little as 72 hours (Stone 1982).

The negative effects of acute heat stress on semen quality may be immediate. A "lag" period of approximately two 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 six to seven weeks is necessary before fertility returns to normal. That is because heat stress impairs spermatogenesis, the six-week-long process by which new sperm cells are created in the testicles. 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 a July heat wave.

Flowers (1997) reported data obtained from seven commercial boar studs in southeastern North Carolina from June through October in a year when the average weekly temperature high at these facilities never exceeded 84 F. Nevertheless, during this period there was a significant increase in the number of ejaculates rejected due to inadequate quality and a decrease in the number of AI doses per ejaculate. The reduction in the number of AI doses per ejaculate began five to six weeks after the weekly temperature high had stabilized at approximately 81 F. Thus, boars may also be sensitive to chronic periods of only moderately elevated temperatures not recognized as classic heat stress conditions.

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 estrus.

Producers that use boars for pasture 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 customary 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%.

Boars penned outside should have access to shade. In an experiment conducted in Oklahoma boars maintained on outside lots with both shade and sprinklers (promoting evaporative cooling) had 20% higher fertility than those provided shade only (Wettemann et al. 1978). Shade can be provided naturally with trees or artificially with a lean-to or awning. As is always the case, boars should have free access to clean and cool water to drink.

Solutions for Miscellaneous Problems Encountered with Pasture Mating

It is common for certain boars to display an abnormal sequence of sexual behaviors and consequently, females in estrus are not mated. If this is suspected, the first course of action should be to definitively determine if a boar has a low level of libido. A suspect boar can be individually penned overnight. The following morning after animals are fed, the boar can be moved into a pen with a sow known to be in estrus. Observe the boar for his ability to pursue the female and mount, obtain an erection, enter the vagina, and successfully ejaculate. Confirm ejaculation by observing the rectum of the boar for contractions of the muscles surrounding the anus ("winking"). If the boar demonstrates poor sexual behavior, then potential causes of this condition need to be addressed. For example:

Is the boar sexually immature or is he suffering from heat stress? An acceptable method of determining if boars are heat stressed is to monitor their respiration rate by observing movement of the rib cage. Normal respiration rate is 25 to 30 breaths per minute but can increase to 75 to 100 breaths per minute during heat stress conditions.

Is the boar sick or injured? Injuries or diseases to the feet, legs, back, penis or prepuce may cause sufficient pain to inhibit sexual activity. In pasture mating, same-gender activity among boars or difficulty entering the vulva of sows can result in trauma to the shaft and spiral tip of the penis and blood in the semen, which has been associated with reduced conception rates.

Has the boar been overworked and in need of sexual rest? Recall that a boar ejaculating frequently over the course of a few days quickly depletes its sperm supply. Libido may also decrease.

Is the boar being fed appropriately and in good condition (Body Condition Score of 3)? Boars with low body condition scores may exhibit poor semen quality and sex drive. Boars fed diets with low protein had reduced libido and semen volume (Louis et al. 1994a), and when diets were low in both protein and energy, the boars displayed decreased libido, semen volume, and sperm output (Louis et al. 1994b). Over-conditioning, however, can cause laziness and poor libido, and it also decreases the ability of the boar to successfully mount and breed a sow.

Boars kept together in a pasture may fight excessively. Also, boars sometimes will interrupt mating between a female and another boar. These problems may be remedied or at least decreased by rotating boars among subdivided pastures.

Finally, producers should determine if boars have become too large for gilts and smaller sows to support during natural mating. This is particularly important in pasture mating systems because females in estrus may be mounted excessively, increasing the risk that injuries may occur.

Summary

In pasture mating systems, farmers place boars and females together for a designated period and mating occurs unsupervised. Compared to other systems, pasture mating requires the simplest facilities, the least labor, and no estrus detection skills. However, reproductive performance is generally not as good as with hand-mating or AI; more boars are required, resulting in increased costs of feed, veterinary supplies, and so forth; there is relatively little control over boar usage; and it is difficult to determine when females are bred and thus when they are expected to farrow. Pig farmers electing to use pasture mating should have an adequate number of boars with a ratio of one boar to two or three sows to be mated if the estrous cycles of females are synchronized. Boars should be observed for normal sexual behavior, given sexual rest to replenish sperm supply, and methods of cooling the animals during the summer should be employed. If necessary, boars should be housed in individual pens to prevent fighting. Rotating boars among pastures increases the likelihood that females in estrus are found and mated multiple times and increases the odds that a mating occurs at the most fertile period during the sow or gilt estrus.

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