

## Managing Boars in Artificial Insemination Centers

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### Introduction

Daily care and management of sires in an artificial insemination (AI) center can have a large influence on semen quality and sperm output. A typical boar produces from 1100 to 1200 doses of semen per year (22 doses/wk x 52 wks) and therefore, semen quality of a single sire influences a large number of matings and services per year. A rule of thumb is that each female inventoried will require about six doses of semen on an annual basis (2.2 L/S/Y x 2.2 matings per service x 80% FR x 10% semen wastage (unused doses)). Therefore, each sire inventoried in the boar stud could meet the semen needs for 150 to 200 females inventoried on the breeding farm. The following are some important points to consider for optimal management of sires maintained in a commercial AI center.

### Objectives

The objectives of this fact sheet are to review the following important aspects of managing boars in AI centers:

- Health and biosecurity
- Facility design
- Boar nutrition
- Factors that influence sperm output and semen quality
- Hygiene during semen collection and processing and sanitation of animal and laboratory facilities

The introduction of healthy boars of high genetic merit should be the goal of all AI centers. For detailed information regarding health and bio-security, obtain a copy of "Bio-security and Health Assurance at a Boar Stud" [1] from the National Pork Board ([www.pork.org](http://www.pork.org)).

**Pre-entry.** Request that your veterinarian explore the health status and history of the source farm prior to shipment of the replacement boars. At minimum, the source farm's status for PRRSV (Porcine Reproductive and Respiratory Syndrome Virus), PRV (Parvovirus), SIV (Swine Influenza Virus), TGE (Transmissible Gastroenteritis), PRCV (Porcine Respiratory Corona Virus), APP (Actinobacillus Pleuropneumoniae), Brucellosis and Leptospirosis are of particular importance along with other health records.

**Isolation facility.** Provide an off-site isolation facility for incoming replacement boars. In conjunction with a veterinarian, develop a farm-specific health monitoring protocol. Depending upon the specific diseases

of interest, an isolation period of up to 60 days is generally followed. Practice an all-in-all-out system and thoroughly clean and sanitize the isolation facility between groups of animals [2]. Training of boars for semen collection can begin while in the isolation facility.

**Resident stud.** It is important to develop and follow stringent health and bio-security protocols for the resident stud facility. Limit visitor access and establish a down-time prior to visits (usually >48 hours). Provide a facility that is protected by a chain linked fence. Provide a shower-in-shower out facility and unit clothing/foot wear. Practice rodent [3] and fly [4] control on a regular basis.

Once boars enter the semen production facility, continue to test for such diseases as: Brucellosis, PRV, PRRS, Leptospirosis and SIV as recommended by the attending veterinarian. Avoid potential contamination of the facilities and animals from sources such as meat and bone meal or other food by-products, delivery trucks, semen courier vehicles, and supplies and equipment. Monitor and record health status of working boars for body temperature, animals that are "off feed", lameness and other signs of potential illness on a daily basis.

### Facility design

The overall design of the AI center influences worker safety, boar comfort, and efficiency for animal management and semen collection [5,6]

**Boar stalls.** Boars are typically housed in stalls over total slats (4 to 5" wide, slightly arched top with a 1 to 1¼" slot). Suggested dimensions of boar stalls are shown in Table 1. Placement of the bottom horizontal bar of the stall dividers should be at a maximum of 8" off the floor. In order to prevent boars from turning around in the alley while being moved, provide vertical head gates as opposed to slanted head gates. Feeding can be accomplished with either a recessed trough 3-4" below the floor level or in raised troughs. For animal comfort while lying down, shorter stalls will require recessed troughs.

Some boar studs have utilized the "turn around" stalls which are typically about 27" W x 7' L. These stalls may require more maintenance as compared to standard stalls. Also, injuries from neighboring boars may be a problem [5].

**Boar Pen.** Facilities should include a few pens to accommodate larger boars or boars that are lame or have other minor problems. For labor and hygiene reasons, either partial or total slatted flooring is recommended. To prevent boars from climbing up the side of pens, construct pen partitions with vertical pipe or rods (4-5" on center). Suggested pen sizes are shown in Table 2.

**Alleys.** Design all alleys and gating to facilitate safe and efficient movement of animals to and from the semen collection area. Narrow alleys (24") will prevent boars from turning around during handling and will also provide a back stop for the stall gate to lock it into the open position when returning the boar to his stall. All gating and fencing should be constructed either of solid materials or vertical pipe or rod to prevent boars from climbing.

**Ventilation.** A properly designed ventilation system is of critical importance in maintaining fertility of

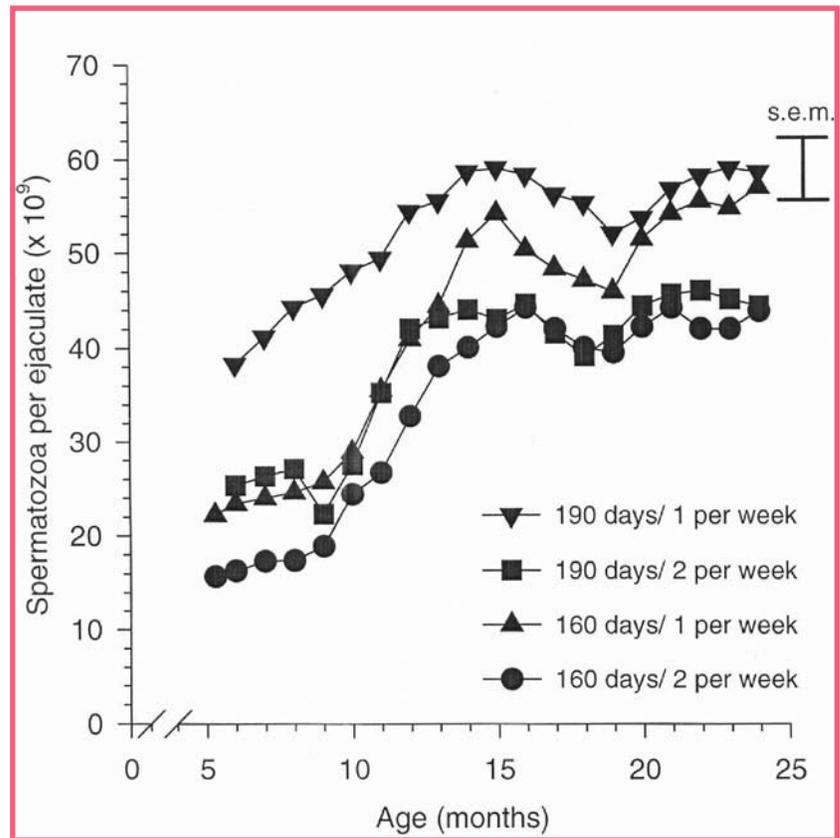


Figure 1. Effect of age at initiation of semen collection and collection frequency of boars on spermatozoa collected per ejaculate over time.

boars, especially during extreme weather conditions. Evaporative coolers, drippers, misters and stir fans in conjunction with properly sized fans and controls can be used [7].

**Lighting.** For proper observation of the animal's health status and body condition, provide adequate lighting throughout the facility. The recommended level of lighting for animal observation is 20 foot candles [6]. The intensity, duration, or type of lighting has not been shown to significantly affect sperm production. However, a ratio of 10 hours of light to 14 hours of darkness is generally recommended. Provide additional light in the semen collection area.

### Semen collection and warm-up area.

Provide one collection pen /warm up area for every 25-50 boars in inventory. With a properly designed facility, one technician can collect four to five boars per hour. In larger studs (>200 boars) consider locating the collection area near the center of the building to minimize time and labor required for boar movement [8]. Locate the semen processing laboratory as close as possible to the collection area to facilitate transfer of the ejaculates. Pneumatic systems can be used to transport ejaculates from the semen collection area to a laboratory located at greater distances. Placing a boar in the warm-up pen for 5 to 10 minutes adjacent to the semen collection area can aid in sexually stimulating most boars. The sight, sound, and odor from other boars being collected should decrease the time required for a boar to mount the dummy sow once he enters the collection pen. Additionally, most boars, especially those housed in stalls, will urinate and defecate in the warm-up pen, thus promoting a higher level of hygiene in the semen collection pen.

Both the warm-up and semen collection pens should be approximately 9' x 9', with 3.5' high escape posts with a 10" gap between posts. Total slatted flooring in both pens with a breeding mat in the collection pens will provide a non-slip surface that is easy to clean.

### Boar Nutrition

The goals of the nutrition program for stud boars are to provide nutrients that will optimize sperm output and semen quality, in addition to promoting the overall well-being of the animal. Traditionally, boars used for natural service were limit fed to promote longevity and to limit their growth. This type of feeding prevented them from becoming too large to mate with smaller sows and gilts. Although this feeding method reduced growth rate and may have resulted in decreased sperm production, boars still produced an adequate number of sperm cells in the ejaculate to achieve satisfactory reproductive performance. However, in the case of stud boars, the goal is to optimize sperm output, and this requires that a minimum level of growth continues to occur. Table 3 provides guidelines for suggested body weight gain to maximize sperm production. These guidelines may vary for different genotypes. For more specific information on composition of feedstuffs and specific diets [9].

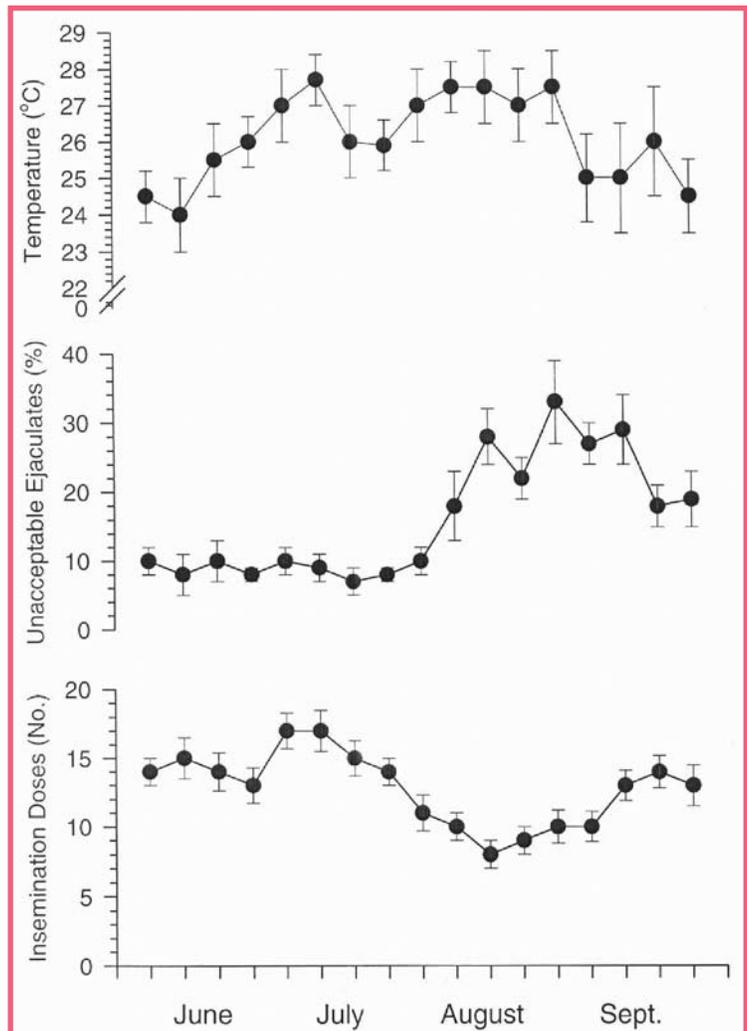


Figure 2. Average weekly high ambient temperature (top), percentage of ejaculates rejected for further processing (middle), and average number of insemination doses per ejaculate (bottom) for commercial boar studs in N.C. between June and September (adopted with permission from J. Reprod. Fert. Suppl. 52:67-78).

In recent years, several studies have been conducted to study the possible benefit of various vitamins, minerals and fatty acids (i.e., zinc, biotin, vitamin E, chromium tripicolinate and others). Results from many of these experiments have been inconclusive. However, several commercial supplements are available in the form of top dressings and may be of benefit in some situations.

Boar size/weight	Width	Length	Height
Large(>500lbs)	28"	96"	46"
Medium(350-500lbs)	24"	84"	45"
Small^(<350lbs)	24"	84"	44"

**Table 1. Recommended dimensions for boar stalls**

In order to insure that the nutritional needs are being met, it is recommended that a body condition scoring system (i.e., 1–5, with 3 being ideal body condition) be developed and that body condition scores be assigned by a third party observer on at least a quarterly basis.

Boar size/weight	Square feet
Large(>500lbs)	70
Medium (350-500lbs)	48
Small^(<350lbs)	40

**Table 2. Recommended space for boar pens (4 feet high)**

**Water.** Water is provided by a nipple waterer or in the feed trough.

Depending upon such factors as size and season, boars require up to eight gallons of water per day.

Nipples should provide a flow rate of one quart per minute.

### Factors influencing sperm output and semen quality

**Age.** Testicular growth and spermatogenesis in young boars increases dramatically from 100 to 200 days of age. Ejaculation of fertile sperm can begin as early as 24-28 weeks of age. Most boars will reach their maximum sperm production potential at about 18-24 months of age. Table 4 presents data representing the effect of age on sperm output. It should be noted that this is “older” data and in the context of present day management systems and modern genotypes individual boars may perform somewhat differently.

It is important to maintain a regular culling and replacement program for boars much like parity distribution in females. Young boars (less than 10 months of age) produce fewer doses of semen than mature boars (greater than 12 months of age). Therefore, in order to meet the demand for doses at the sow farms, the proper distribution of boar ages is critical in maintaining a constant level of semen production from the AI center.

Recently, it has been suggested [12] that if boars are placed on an intense semen collection regimen at young ages, then their lifetime sperm production will be compromised. The rationale for this assumption is not clear. Data presented in Figure 1 illustrates some important relationships between age at initiation of semen collection, collection frequency and sperm production for boars. In this experiment, boars of similar genetic background were randomly assigned to a factorial arrangement of treatments involving age at first collection (160 or 190 days of age), and collection frequency (once or twice per week). Sperm output was monitored until the boars were 24 months of age. These data indicate that neither age or collection frequency had a significant, long term effect on total numbers of spermatozoa collected per boar. This statement is based on the observation that total sperm production per month eventually leveled off at the same plateau for each treatment. However, it does appear that twice per week collections in conjunction with a young age at first collection delays the age at which boars reached their adult plateau.

In boars, the precursor to a new sperm cell begins to develop every six to eight days. The transition of this cell to a mature spermatozoon takes between five and six weeks. After maturation, spermatozoa remain stored in the epididymal tail until they are ejaculated, voided, or reabsorbed. If age at first semen collection influences adult sperm production, then it is reasonable to speculate that age should affect either the number of sperm cells produced or rate at which spermatozoa mature. There is no physiological evidence supporting this speculation. Instead, what probably happens is that younger boars have fewer spermatozoa stored in their epididymides than older boars. A difference of 30 days in age at the time of first collection would be equivalent to five additional groups of sperm cells that had time to mature prior to their removal. Consequently, ejaculates from boars collected for the first time, at young ages, would be expected to have reduced numbers of spermatozoa initially. However, under a constant collection frequency, removal of spermatozoa reaches equilibrium with sperm maturation and numbers of spermatozoa per ejaculate stabilizes. In summary, the effect of age at first collection on sperm numbers is a function of both storage and release of sperm cells from the epididymides rather than a result of sperm production and maturation rate differences in the testes of boars.

### Frequency of collection.

Frequency of collection is one of the major factors affecting the quantity of semen harvested from a boar, and to some extent its quality. The ideal collection frequency would be one that optimizes the number of sperm cells harvested per unit of time without compromising their quality.

Spermatogenesis is a continuous process and a typical mature boar produces about 15-20 billion cells per day and if sexually rested, about 120-160 billion cells can accumulate in the cauda (tail) of the epididymides where they await ejaculation. When this reservoir is at capacity, a single ejaculate can yield about 50-60% of the epididymal reserves. If the boar does not ejaculate, the excess cells will be excreted in the urine. If a sexually rested boar is collected at a high frequency (i.e. every 24 hour) the total sperm in the ejaculate will drop dramatically for three to four days until the epididymal reserves stabilize at a lower level.

Most studies indicate that frequent collections result in maximum sperm harvest from an individual over a period of time, yet these ejaculates will contain fewer sperm cells and, therefore, fewer doses per collection. This can influence the labor efficiencies of collection due to the processing of fewer doses per collection as compared to an ejaculate that yields a larger number of sperm.

Studies on the influence of collection frequency on semen quality are somewhat contradictory. High collection frequencies (three times/week) have been shown to result in decreased sperm motility, increased percent abnormal sperm and increased the percent of sperm with altered membranes. One study did show a significant increase in pregnancy rates from boars collected at 24 hours compared to those collected at 72 hour intervals (83% vs 70% respectively). However, the interactions in this study indicated some boars were more fertile when the collection interval was increased while others were more fertile when it was decreased.

In addition to the collection frequency, it appears that a constant collection schedule may be important as well. In one study [12] boars were collected one time/week for three months prior to the treatment period and then over a three month treatment period, one-half of the boars were continued on a once per week collection schedule and the other half were collected on a random schedule that was not more than three times per week and not less than one time in three weeks. Semen quality was constant for 18 of 20 boars that remained on the one time per week schedule. For the random collected group semen quality was constant for only eight of 20 boars, improved in three and decreased in nine boars. In four of these nine boars, semen quality did not return to normal during the 60-day post treatment period.

In summary, for maximum sperm harvest, it appears that a collection frequency of three times per week for mature boars (>12 months) and two times per week for young boars (<12 months) may be optimum. However, in practice, the efficiency of collecting and processing ejaculates in conjunction with semen demand must be considered when assigning boars to collection schedules. The current practice of collecting boars every seven to 10 days may provide a schedule that optimizes both sperm harvest and labor efficiencies. Studies which provide data on the subsequent fertility of "high demand" sires which are collected two times per day at frequencies of once or more per week are lacking.

**Temperature and season.** Exposure of boars to elevated ambient temperatures has negative effects

Body Wt. (lb.)	Pounds of feed for maintenance <sup>a</sup>	Target gain/day (lb.)	Pounds of feed for gain <sup>b</sup>	Total feed/day (lb.) <sup>cd</sup>
300	3.42	1.2	1.50	4.9
350	3.78	1.1	1.38	5.2
400	4.14	1.0	1.25	5.4
450	4.47	0.9	1.13	5.6
500	4.80	0.8	1.00	5.8
550	5.11	0.7	0.88	6.0
600	5.42	0.6	0.75	6.2
650	5.71	0.5	0.63	6.3
700	6.00	0.4	0.50	6.5

**Table 3. Feeding guidelines for boars [10].** <sup>a</sup> Based on a corn/soybean meal diet. <sup>b</sup> Assumes 80% efficiency. <sup>c</sup> Add 0.25lb. feed/ejaculate collected. <sup>d</sup> Add 0.1lb. feed for each degree temperature below 68°F

Age (mo)	8-12	13-15.5	16-18
Total volume (mL)	290	381	297
Sperm concentration x10 <sup>6</sup> /mL	117	169	202
Total sperm (x10 <sup>9</sup> )	18.8	33.5	35.4
Daily sperm output (x10 <sup>9</sup> )	8.1	14.3	15.2

**Table 4. Effect of age of boar on semen characteristics when collected three times per week [11]**

on sperm production in boars. These include ejaculates with an increased incidence of morphological abnormalities and impaired fertility. Previous studies indicate that the minimum exposure time and critical air temperature for the threshold of a heat stress effect on spermatozoa are 72 hours and 30°C (85° F) at 60% relative humidity, respectively [13]. In practice, because ambient temperature is monitored closely on a daily basis in most boar studs, it is unlikely that boars are exposed to extreme fluctuations in temperatures even for brief periods of time. Consequently, the detrimental effects of acute periods of heat stress on sperm production probably are not commonly observed in commercial boar studs.

In contrast, a more common situation probably is one in which boars are exposed to temperatures near the upper range of their thermal comfort zone, 26-29°C, (78-84° F) at relative humidities between 65 and 75% for extended periods of time. Chronic exposure to temperatures in this range probably occurs routinely during the summer months in mechanically ventilated facilities located in temperate and semi-tropical climates. Data presented in Figure 2 were obtained from commercial boar studs in North Carolina and seem to indicate that such a phenomenon may exist. The average weekly high temperature in these facilities was never greater than 29°C (84°F) and the relative humidity varied between 70 and 78%. However, a significant increase in the number of ejaculates that were rejected due to poor quality and a corresponding decrease in the number of insemination doses per ejaculate were observed. It is interesting to note that the downward trend in these parameters began about six weeks after the weekly high temperatures stabilized at 27.5°C (81° F). One interpretation of these data is that boars may be sensitive to chronic periods of moderately high temperatures not normally considered to be overtly stressful. Over time, boars exposed to these thermal conditions may gradually lose the ability to dissipate heat, or their bodies might make gradual adjustments in nutrient repartitioning to compensate for the increased metabolic demands of maintaining thermal neutrality over an extended period of time. Nevertheless, until more information is available, reduction of the set point at which supplemental cooling systems are activated probably is advisable in commercial semen production facilities.

**Other potential factors.** There are many other factors that may potentially influence sperm output and quality of individual boars. For example, some animals may experience an increase in body temperature as a reaction to a vaccine. Thus, it is suggested that only 25% of the stud inventory should be vaccinated or blood tested at any one time. Other factors may include a change in collection technicians, weather conditions and feed composition.

It is important to note that individual boars may perform differently under various collection and management regimes. A regular review of semen production records can be useful in determining the proper collection schedule and management practices for individual boars and genetic lines. Table 5 summarizes some of the factors that influence sperm production in boars.

**Hygiene and Sanitation.** Most ejaculates contain some bacteria, and if these are at low levels their growth is usually sufficiently controlled by the preservative antibiotics included in the semen extender. However, when high numbers of bacteria are present or if they are resistant to antibiotics normally used in extenders, then semen quality can be compromised. Other sources of bacteria may include: facilities, laboratory equipment, and water used for extender preparation. Minimum contamination practices are summarized below.

#### Boar Preparation/Semen Collection

- Provide warm-up pens to reduce fecal and urine contamination of the collection pen.
- Trim hair from prepuce at regular intervals.
- Use double gloves. Evacuate the prepuce and clean the sheath and surrounding area with a single use disposable wipe. Remove the outer glove just prior to grasping penis for semen collection.
- Divert pre-sperm fraction away from the semen collection vessel.
- Dispose of filter and rubber band (if used to secure the filter) before transferring semen to the processing laboratory.

## Summary

Since the fertility level of semen from the boar stud can influence the reproductive performance of several hundreds or thousands of females, proper care and management of boars and following proper semen processing procedures are critical. In addition, the quantity and quality of semen harvested is directly related to the potential number of semen doses that are produced and the economic efficiencies of the

boar stud enterprise. Providing close supervision of the animals and the semen processing laboratory along with a program that constantly monitors factors such as boar health, sperm output and semen quality will help to assure that the optimum number of high quality doses of semen are produced from the facility.

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Situation	Description	Effects on Boars <sup>a</sup>
High Ambient Temperatures	> 85° F for 3 days or more	Sharp increase in abnormal sperm per ejaculate
Moderate Ambient Temperatures + High Humidity	79 to 85° F + 75% humidity or greater for 4 weeks or more	Gradual increase in abnormal sperm per ejaculate
Fever	Body temperatures > 103° F for 2 or more days	Sharp increase in abnormal sperm per ejaculate
Increased and Erratic Collection Regimens	> 3 times per week	Gradual decrease in number of normal sperm per ejaculate
Reduced nutrient intake	> 15% reduction in energy or protein intake for more than 8 weeks	Reduced libido and gradual decrease in normal sperm per ejaculate
Suboptimal photoperiods	> 16 hours of light or < 8 hours of dark	Gradual decreases in libido and no consistent changes in sperm output
Immature boars	< 6 to 7 months depending on genotype	Low volume of semen; low numbers of normal spermatozoa and presence of cytoplasmic droplets

**Table 5. Summary of selected situations that influence sperm production of boars in studs. <sup>a</sup> For a description of common sperm abnormalities see: The swine AI Handbook, [13] p 68.**

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