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pork industry handbook

Michigan State University Extension

Artificial Insemination of Sows and Gilts

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The placement of semen into the reproductive tract of sows and gilts with a catheter (artificial insemination) is a relatively simple process that almost any person can accomplish with a minimum of training and equipment. Fertility results (farrowing rate and litter size) from the use of modern artificial insemination (AI) techniques should equal those from natural matings. Artificial insemination can be used by any size pork enterprise to impregnate sows and gilts.

Estrus Detection

The most critical factor in achieving maximum farrowing rate and litter size is to inseminate females at the correct time. Insemination strategies are based on the time when estrus is first detected and the duration of estrus. The best method to heat check is to prohibit close male-female contact for one hour before actual time of heat-checking and insemination. This separation causes the females to quickly exhibit a strong immobilization response when encountering boar stimuli. Estrus detection is discussed in detail in PIH 64, "Estrus or Heat Detection."

Equipment

Equipment needed for the insemination process includes: 1) an insulated container to hold the semen prior to insemination, 2) insemination catheters, 3) semen storage containers (tubes, bottles, or cochette bags), 4) bottle/tube cutters, 5) non-spermicidal lubricant, 6) maximum/minimum thermometer to monitor temperature of the container used to deliver semen to barn location of insemination, 7) marking sticks, 8) a microscope to evaluate semen motility, 9) a trash box to dispose of used catheters and semen vessels 10) single-use paper towels, and 11) a recording system. If semen is to be stored prior to use, it must be stored at 60°F to 64°F in a system specifically designed to cool boar semen.

Insemination Procedure

Transporting semen. Keep semen temperature stable any time that it is taken from the semen storage container. Transport semen to the insemination area in an insulated box containing gel packs maintained at the same temperature as the semen.

Boar exposure. Generally, the insemination process is easier when females exhibit a strong standing reflex. The primary benefit of boar contact during artificial mating is to facilitate and intensify the standing reflex associated with estrus. Pheromones emitted from the boar's saliva help stimulate the behavior. Because pheromones in the saliva are the key component, it is important that females have close head-to-head contact with the boar during insemination. If sows are inseminated in crates, movement of the boar in the alley in front of the crates should be restricted to no more than two or four crates. Methods used to restrict the boar are tethering a boar in the front alley, using moveable gates in the front and rear of the boar, or putting a boar in a cart and pulling him down the front alley while the inseminator is standing in the rear alley. If sows are housed in pens, enhancement of boar exposure during insemination can be accomplished by moving females in estrus to a pen adjacent to a boar for insemination. Moving females to a boar instead of taking a boar to a pen of females is a better strategy to prevent estrous sows from becoming refractory to boar stimuli prior to insemination. Some estrous sows will only exhibit a standing response for five to 10 minutes. Thus, some estrous sows may become refractory to boar stimuli during the time other estrous sows in the pen are being

inseminated.

Vulvar hygiene. Clean the vulva and surrounding area with a single-use paper towel or toilet tissue prior to insemination. Herds with poor hygiene at breeding time have lower reproductive performance than herds with better hygiene during service.

Inserting catheter. Basically, there are two types of catheters: spiral tip (Figure 1) or foam (bulbous) tip (Figure 2) catheters. The catheter should remain in its wrapper until the moment of use. Handle catheters carefully and only touch the end of the catheter that remains outside of the vulva. Lubricate the tip of all catheters with a nonspermicidal fluid or gel which are available from AI equipment suppliers.

Spiral tip catheter. To insert the spiral tip catheter, open the vulvar lips and slowly insert the catheter into the vagina. Be sure to keep the tip pointed upward, at about a 30 degree angle, to prevent entrance into the urethral orifice (Figure 3). Slide the catheter gently through the vagina until it reaches the cervix (Figure 4). The cervix is usually eight to 10 inches inside the vulva, but it will vary among females. In some gilts, resistance may be encountered about four inches inside the vulva. This may be the remains of a nonfunctional membrane. When the spirette catheter cannot be pushed forward any further, begin to turn the catheter **counterclockwise** until it **locks** into the cervix (Figure 5). The locked spirette should spin back 1/4 turn after releasing the free end. This locking action reduces semen loss. The locking mechanism is the muscles of the cervix squeezing on the spiral tip. If a lock is not achieved, withdraw the spirette slightly and try again until a lock is achieved. Occasionally, a female will not lock on the spirette. This occurs most often in sows, or if the female is not in heat. The spirette is removed by turning clockwise while gently pulling outward.

Figure 1. Spiral tip catheters.

Figure 2. Bulbous tip catheters.

Foam-tipped catheter. Open the vulvar lips and slowly insert the bulbous tip catheter into the vagina with a slight right to left upwards rotating movement (Figure 3). Resistance will be felt when the cervix is encountered (Figure 4). Apply firm forward pressure to the catheter until the bulbous tip is locked into the cervix (Figure 5). A slight resistance should be felt when pulling back on the catheter. Bulbous type catheters do not have to be rotated to lock into the cervix. The bulbous catheter is removed by gently pulling outward.

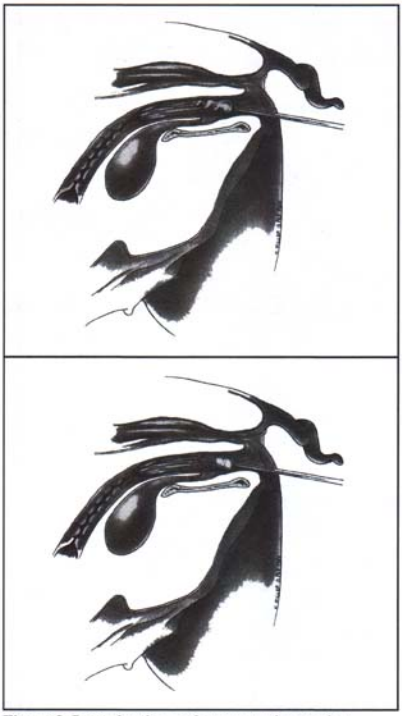

Figure 3. Insemination catheter entering vagina.

Attaching semen vessel. There are three basic types of semen storage vessels: plastic bottles, plastic tubes, and cochette bags (Figure 6). All three types are satisfactory. Prior to attaching the semen vessel to the catheter, the package containing 80 to 100 ml of semen should be gently inverted two or three times to mix the semen and extender. If bottles or tubes are used, remove a portion of the nozzle with scissors or a cap cutter. Push the nozzle of the plastic bottle or tube firmly into the end of the catheter. If an elongated connection is needed between the semen bottle or tube, a metal adapter is placed on the end of the catheter and then the semen vessel is connected to the metal adapter with disposable tubing. When using a cochette bag, separate the two tabs and carefully insert the catheter into the neck of the cochette bag. Attach the catheter to the cochette before inserting the catheter into the female. Note that due to the variations in the diameters of catheter shafts, not all catheters are compatible with cochette bags.

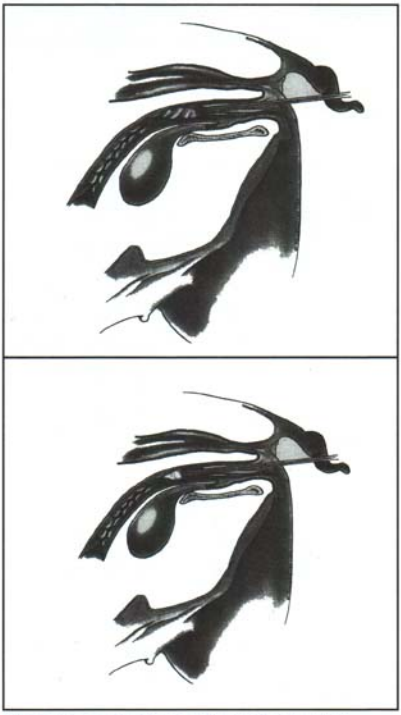

Figure 4. Insemination catheter entering cervix.

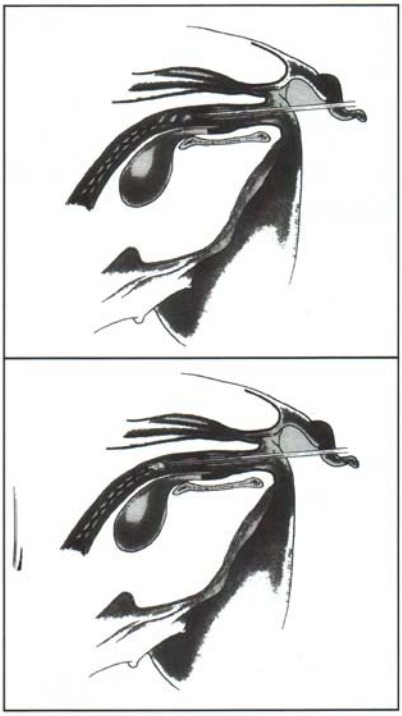

Figure 5. Insemination catheter "locked" in cervix.

Duration of insemination. Normally, the insemination process will range from three to 10 minutes. Sometimes uterine contractions occur very rapidly which will remove semen from the vessel. If semen flow is too fast (within 90 seconds), there may be a substantial amount of back-flow. To prevent a female from taking the semen too quickly, intermittently lower the semen vessel below the vulva. If uterine contractions are slow, more time will be required to deposit the semen. It is better to allow the semen to enter the reproductive tract by "gravity" than to force the semen into the sow. When force is applied, the semen may be forced backwards out the cervix and wasted. If a female is not taking the semen, punch a small hole in the bottom of the bottle or tube with a clean hypodermic needle so that air can enter. After the semen vessel is emptied, do not remove the insemination catheter from the female for two to five minutes. This procedure helps prevent semen run back after removal of the catheter, especially when the female empties the semen vessel within two minutes. When using a bottle, remove the bottle from the catheter, make a bend in the insemination catheter about two inches from the end, remove the cap from the bottle, and place the bent catheter inside the bottle. If cochette bags are used, one

Figure 6. Semen storage vessels.

of the holes in the bottom of the bag is placed over the bend. If tubes are used, a small rubber band is placed over the bend or a small slice is made in the tube and the bent catheter is placed in the tube.

Stimulation of females. Throughout the insemination process, stimulate the female to keep her attention on mating. Provide head-to-head contact with a boar if possible. A combination of gently rubbing a female's back, flank, or underline, and applying pressure on her back facilitates uterine contractions. Proper stimulation of the female will result in the release of oxytocin which stimulates uterine contractions and sperm transport. Uterine contractions actually transport the sperm cells from the cervix to the oviduct where they fertilize eggs. The process of transporting sperm from the cervix to the oviduct (site of fertilization) takes 15 minutes to two hours. Most of the sperm cells become lost in the numerous crypts and folds of the uterus.

Inseminator skills. The insemination technician can have a large influence on farrowing rate and litter size born live (Table 1). Thus, a training program needs to be developed for new breeding technicians. It is also advisable to develop a performance monitoring system for experienced employees. For a monitoring system to be accurate, the same individual needs to perform all inseminations on the same female. Pork enterprises have used a scoring system (Table 2) to rate the quality of each insemination. It has been suggested that some inseminators may become fatigued after performing 10 inseminations; thus, it is important for inseminators to take breaks.

Biological Variation

The same protocol for number of inseminations and interval between inseminations of sows and gilts will not work on every pork production enterprise because of the frequency of estrus detection and the large amount of variation that occurs in the weaning-to-estrus interval, duration of estrus, onset of ovulation, duration of ovulation, sperm capacitation, life span of sperm cells, and life span of eggs. In addition, research has shown these traits vary considerably among animals within the same genetics and management.

Table 1. Influence of artificial insemination technician on farrowing rate and litter size.

Technician	Farrowing rate (%)	Litter size	Total pigs
1	91.5[a]	10.3[a]	2060[a]
2	91.3[a]	10.4[a]	2070[a]
3	90.2[a]	10.2[a]	2009[a]
4	87.2[a]	10.5[a]	1995[a,b]
5	82.3[a]	10.3[a]	1050[b]
6	65.4[b]	7.5[b]	1050[c]

[a,b,c] Different superscripts in a column indicate significant difference (P < .05)
Reference: 1996 A. D. Leman Conference.

Table 2. Insemination scores for standing reflex, cervical lock, and semen backflow.

Item	Insemination score		
	1	2	3
Standing reflex	Female is restless	Locked-up, Some movement	Locked-up, no movement
Cervical lock	No lock	Loose lock	Tight lock
Semen backflow	Large amount	Small amount	None

Weaning to estrus. Because the number and timing of inseminations are based on the onset of estrus, checking the females more frequently for estrus will result in a more accurate estimate of the time of onset or beginning of estrus. A significant relationship between the weaning-to-estrus interval, the duration of estrus, and the onset of estrus to ovulation has been reported. In general, an increase in the weaning-to-estrus interval results in a decrease in the duration of estrus and a decrease in the interval from onset of estrus to ovulation (Figure 7). Numerous factors influence the weaning-to-estrus interval; such as, genetics, nutrition, parity, social environment postweaning, feed intake, season, photoperiod, lactation length, litter size nursed, and body condition.

Duration of estrus. The number of inseminations that can be given over a specific period of time is influenced by the duration of estrus. The duration of estrus averages from 50 to 60 hours; however, it may range from 8 to 153 hours. Duration of estrus in gilts is about 10 hours shorter than in multiparous sows. Duration of estrus influences the time of ovulation. As duration of estrus increases, there is a linear increase to the time of ovulation (Figure 8).

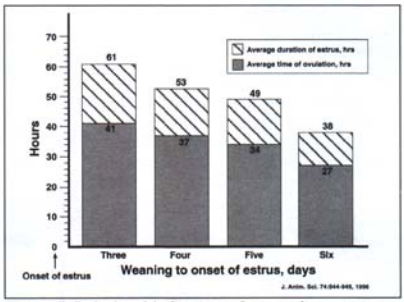

Figure 7. Relationship between the weaning-to-estrus interval, duration of estrus, and onset of ovulation.

Onset of ovulation. The interval from onset of estrus to ovulation averages from 35 to 45 hours in weaned sows; however, the interval may range from 10 to 120 hours.

Duration of ovulation. In spontaneously ovulating sows, the duration of ovulation ranges from 1.1 to 7 hours. To increase the proportion of eggs developing normally, insemination should not occur later than two to six hours after ovulation.

Life-span of eggs. The life-span of eggs is uncertain; however, most studies indicate that it is very short, two to eight hours. Therefore, adequate numbers of viable sperm cells must be in the oviduct of the female and waiting for ovulation to occur to ensure a high fertilization rate of eggs.

Life-span of sperm. Most studies indicate that the life-span of sperm cells in the oviduct is between 24 and 72 hours. Because of the limited life-span of the sperm cells, multiple matings during estrus serve to replenish the supply of viable sperm cells in the oviduct.

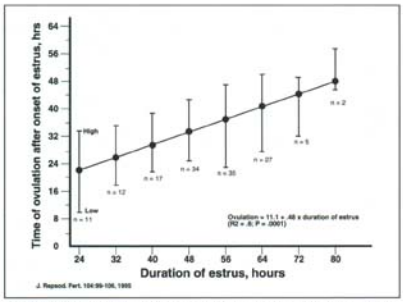

Figure 8. Relationship between duration of estrus and time of ovulation.

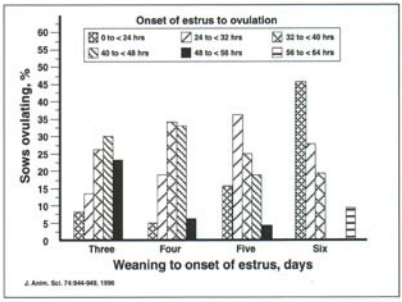

Figure 9. Influence of the weaning-to-estrus interval on proportion of sows ovulating within 0 to 64 after onset of estrus.

Sperm capacitation. Sperm cells must reside in the female reproductive tract for a time period of two to six hours after insemination while they undergo morphological, physiological and biochemical changes. These changes, called capacitation, enable the sperm cell to penetrate the layer of cells surrounding the egg. Because of the short life span of eggs, viable sperm cells need to be present in the oviduct prior to ovulation.

Number of Inseminations and Interval Between Inseminations

Successful fertilization depends mainly on the time of insemination relative to time of ovulation. When using liquid semen, it has been suggested that the optimal time to inseminate before ovulation is between zero and 24 hours in multiparous sows and zero to 12 hours in gilts. Because of the biological variation, the more frequently a gilt or sow is inseminated, the higher the probability that one of the inseminations will occur at, or close to, the optimum time. A study in The Netherlands indicated that the proportion of sows ovulating between zero to 32 hours after first detected in estrus on day 3, 4, 5 and 6 after weaning was 21, 24, 52 and 72%, respectively (Figure 9). To ensure that viable sperm cells are present at the appropriate time in relation to ovulation, the time of inseminating sows first detected in estrus on day 4 (Figure 10) would be different than for sows first detected in estrus on day 6 (Figure 11). Sows first detected in estrus on day 4 post-weaning would be inseminated at 1 pm on day 1 and 9 am and 3 pm on day 2 of estrus; however, sows first detected in estrus on day 6 post-weaning would be inseminated at 8 am and 3 pm on day 1 and 8 am on day 2 of estrus.

Table 3 clearly indicates that the number of inseminations has more influence on reproductive performance than the interval between inseminations. Also, it appears that the number of pigs born alive is related more to multiple inseminations than farrowing rate. The data in Table 3 indicate that only one insemination is adequate for gilts that stand for one day. Therefore, do not force a second insemination on a gilt that will not stand. Research has suggested that when females are heat-checked once per day and inseminated at 0, 24 and 36 hours after first found in estrus, the third insemination may reduce

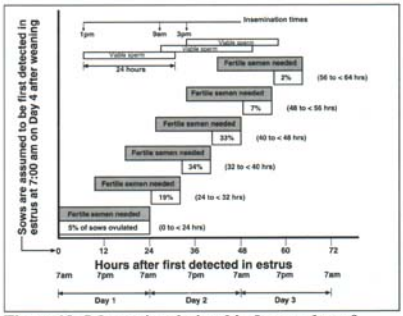

Figure 10. Schematic relationship for number of inseminations and interval between inseminations to ensure viable sperm cells are present at the appropriate time for sows first detected in estrus on day 4 after weaning.

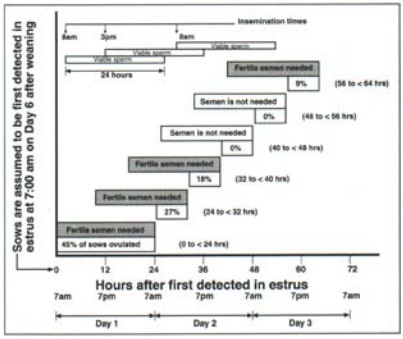

Figure 11. Schematic relationship for number of inseminations and interval between inseminations to ensure viable sperm cells are present at the appropriate time for sows first detected in estrus on day 6 after weaning.

farrowing rate and litter size. The reason for the reduced reproductive performance is not known.

Age of Semen

Research has demonstrated that farrowing rate and litter size decline as the age of liquid semen increases at time of insemination. The rate of decline in fertility is influenced by several factors such as storage temperature, type of semen extender, storage concentration, initial semen quality, and individual boar characteristics. Most farms that are successfully using artificial insemination require semen to be used within 48 to 72 hours of collection.

Use of Oxytocin

An intramuscular injection of five I.U. of oxytocin two to three minutes prior to insemination has improved farrowing rate and litter size only in situations where inexperienced technicians are inseminating females or when using semen which has been stored for greater than 72 hours.

Post-Insemination

After insemination, leave the female in a quiet surrounding for 20 to 30 minutes. This quiet time should facilitate the transport of sperm to the oviduct. To prevent the possibility of losing embryos due to "stress," it is best to not move or mix bred sows during the first 28 days after insemination. A research study reported that grouping sows (25 to 50 sows per pen) during the first week after mating had a 20% return to service rate and 10.5 piglets per litter compared with 10% return to service rate and 10.7 piglets in sows grouped during the fourth week after mating. If females have to be mixed before 28 days after insemination, it should be done before day 5 after insemination.

Contingency Plan

Pork producers who are purchasing semen should have a contingency plan in case semen does not arrive on time, especially during the winter months. Some pork producers are using heat-check boars as back-up boars to supply semen in case of an emergency. The heat-check boars are medium quality boars and collected once per week from an estrous female. In addition to a semen collection kit, a detailed semen collection and processing manual is maintained.

Related Publications

The following PIH fact sheets contain additional information related to artificial insemination.

PIH-64	Estrus or Heat Detection
PIH-136	Semen Collection, Evaluation and Processing in the Boar

Table 3. Effect of the number of inseminations and interval between inseminations on reproductive performance of gilts exhibiting the standing response for one or two days.

	Farrowing rate (%)	Litter size (born live)	Fecundity index[a]
Gilts in estrus for one day			
One insemination			
AM	87.4	8.5	743
PM	85.3	8.3	708
Two inseminations			
AM & PM	88.2	8.7	767
Gilts in estrus for two days			
One insemination			
PM-Day 1	72.3[b]	8.0[b]	578
AM-Day 2	74.3[b]	8.0[b]	594
Two inseminations			
AM-D1/AM-D2	86.4[c]	8.6[b]	743
PM-D1/AM-D2	85.7[c]	8.7[b]	746
Three inseminations			
AM & PM-D1/AM-D2	87.5[c]	8.9[b,c]	778
PM D1/AM & PM-D	86.5[c]	8.8[b,c]	761
Four inseminations			
AM&PM-D1/ AM&PM-D2	88.7[c]	9.2[c]	816

[a] Fecundity index = (farrowing rate x litter size) x 100
[b,c] Different superscripts in a column indicate significant difference (P < .05)

Reference: J. Reprod. Fert. (Supl 48):217-228, 1993.

Table 4. Suggested intervals for inseminating weaned sows when detecting estrus once or twice per day.

Weaning-to-estrus interval, days	Estrus detection			
	Once per day		Twice per day	
	2 matings	3 matings	2 matings	3 matings
3 to 5	AM-D1/AM-D2	AM-D1/ AM&PM-D2	PM-D1/AM-D2	PM-D1/ AM&PM-D2
6+	AM-D1/AM-D2	AM&PM-D1/ AM-D2	PM-D1/AM-D2	AM-D1/ AM&PM-D2
Returns	AM-D1/AM-D2	AM&PM-D1/ AM-D2	PM-D1/AM-D2	PM-D1/ AM&PM-D2

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