Fine Tuning A.I. Management

Technical Report No. 14

Introduction

In general, the successful adoption of any production technology involves two basic phases: (a) an introductory period; and (b) an adjustment or "fine tuning" period. Basic skills involving the correct use of the technology are practiced and, hopefully, perfected during the introductory phase. These skills are absolutely critical for the successful implementation of the technology and are similar among most operations. During the adjustment period, certain aspects of the basic skills learned during the introductory phase are modified in attempts to optimize the effectiveness and efficiency of the technology. These adjustments are usually designed for a specific production environment and, thus, are often unique to a given operation.

The successful implementation and use of artificial insemination on the farm, like any other production technology, is a continual process that involves both introductory and adjustment phases. Detection of estrus and semen handling techniques are basic skills that need to be mastered during the introductory period, while certain aspects of these basic skills often require adjustments in order to meet the unique needs of an individual operation. Some of these include procurement of semen (scheduling semen deliveries and training boars); processing sperm-rich and whole ejaculates; microscopic evaluation of semen; and administration of pre-mating stimuli. This monograph will discuss some of the physiological factors that need to be considered when attempting to "fine tune" management of A.I. This information should be helpful to both the veterinarians and swine producers in establishing economical and effective A.I. programs.

Scheduling Semen Deliveries

For some operations it may be more advantageous to purchase semen from a commercial boar stud rather than collecting and processing it "on the farm". Scheduling semen deliveries to coincide with the occurrence of estrus in the sow herd is critical for reproductive success. This is due to the fact that the age of semen at the time of insemination has a significant impact on farrowing rate and litter size. The fertility of stored semen remains fairly constant during the first 48 - 72 hours post collection. However, past 72 hours, its fertilizing capacity begins to decrease. Consequently, a desirable goal for operations using purchased semen is to schedule semen deliveries in such a way that semen is no older than 72 hours at insemination. In order to do this effectively, it is important to know several things: (a) normal distribution of estrous activity after weaning for the sow herd; and (b) normal collection schedules and delivery times for the boar stud from which semen is purchased. Information about collection schedules and delivery times are needed to estimate the age of semen when it arrives at the farm. Once this is known, then, based upon the average return pattern of the sow herd, the day of weaning can be adjusted so that semen is inseminated within 72 hours of collection. An example of the logic involved with this process is as follows:

- Herd A wants to purchase semen from a commercial source that normally collects and processes semen on Monday mornings and ships it before noon on the same day. The boar stud guarantees that semen shipped Monday will arrive at the farm on Tuesday by mid-morning. Management of Herd A normally weans on Thursday and 80 percent of the sows "stand for the first time" (exhibit estrus) on Wednesday and Thursday of the following week.

For this particular farm. the normal "return pattern" is 80 percent over a two day period beginning six days after weaning. Breeding would begin on Wednesday and end on Friday (second service for sows exhibiting estrus on Thursday). If semen is collected Monday morning and the shipping time is about 12 hours. then semen is at least 24 hours old when it arrives at the farm. With the current situation, females are bred on Thursday and Friday with semen that is more than 72 hours old (see Figure 1). Reproductive performance will probably be reduced if adjustments are not made because the majority of the sows are receiving at least one insemination with semen of declining fertility (> 72 hours). One solution for this problem is to change weaning from Thursday to Wednesday. This effectively shifts the estrous activity of the herd to more closely coincide with the delivery of semen. If this change is made, then breeding should begin one day earlier, on Tuesday, and semen would be less than 72 hours old at the time of insemination (see Figure 2). Consequently, improved reproduction would be expected.

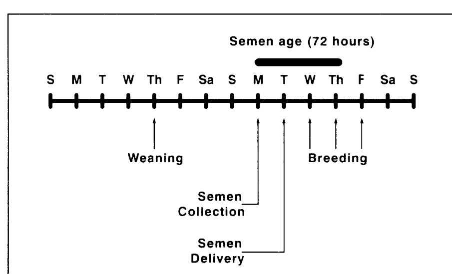

Figure 1. Chronological illustration of information presented for Herd A in terms of weaning, breeding, semen collection and semen delivery. Arrows indicate the occurrence of these events. The solid bar indicates the period of optimal fertility for purchased semen (72 hours). In this situation, at least 50 percent of the sows are bred with semen that is more than 72 hours old.

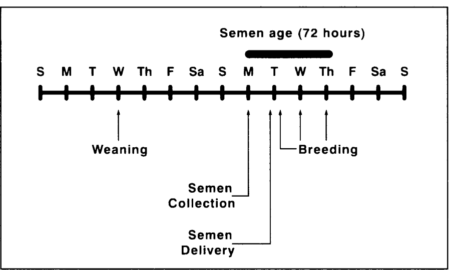

Figure 2. Chronological illustration of information presented for Herd A in terms of weaning,breeding, semen collection and semen delivery if weaning is changed to Wednesday. Arrows indicate the occurrence of these events The solid bar indicates the period of optimal fertility for purchased semen (72 hours). In this situation, all the sows are bred with semen that is less than 72 hours old.

In addition, research indicates that use of exogenous gonadotropins can be used effectively to exert control over the occurrence of estrus in sows in certain situations. Use of P.G. 600® reduced the weaning to estrus interval for first and second parity sows weaned in the summer and fall, Thus, P.G. 600® can be used to increase the probability that the estrous activity of a herd will occur at a predetermined time. If gonadotropin therapy is going to be used for this purpose, it is necessary to collect information with regard to how quickly females exhibit estrus after its administration. This data can be used to facilitate the timely delivery of semen. For example, if it is determined that 80 percent of the sows in Herd A exhibit estrus on Tuesday in response to an injection of P.G. 600® at weaning on the previous Thursday, then no change in the weaning date would be necessary to facilitate the occurrence of estrus with the arrival of purchased semen (see Figure 3). In summary, the key to successfully scheduling semen deliveries for sows is to, first, obtain information about the herds typical response to weaning or use of P.G. 600®, and second, adjust the timing of these events so that the majority of the herds estrous activity coincides with the arrival of semen.

Training Boars

The alternative to purchased semen is collection of boars on the farm. The most effective and efficient way to do this is to teach boars to mount and be collected from a dummy sow. Two things must be accomplished early in the training period if boars are going to be trained successfully: (a) boars must be forced to focus their attention on the dummy sow upon entry into the collection pen; and (b) boars must associate the collection area and process with a pleasurable experience. The first goal is accomplished by the physical characteristics of the collection pen, while the second goal is dependent upon the manner in which boars interact with people during the training period.

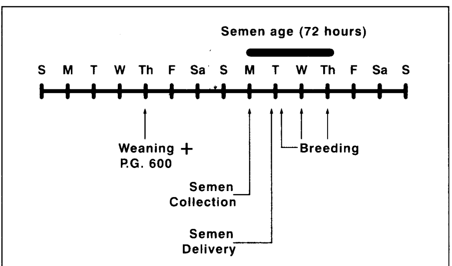

Figure 3. Chronological illustration of information presented for Herd A in terms of weaning, breeding, semen collection and semen delivery if P.G. 600® is administered at weaning on Thursday. Arrows indicate the occurrence of these events. The solid bar indicates the period of optimal fertility for purchased semen (72 hours). In this situation. all the sows are bred with semen that is less than 72 hours old.

The primary stimuli for initiation of the mounting reflex in boars is an immobile object that resembles another pig. Therefore, a collection pen that is clean and free of other extraneous items forces boars to focus their attention on the dummy sow and supplies the visual stimulus necessary for a successful mount. Similarly, a collection dummy with a strong swine odor supplies the necessary olfactory cues. It is interesting to note that sexually naive boars exhibit faster recognition and reaction times to dummies covered with boar odor than those immersed with female secretions. Urine and saliva from a mature boar, or commercial products such as SOA™ "(Sex Odor Aerosol), can be used to make the collection dummy smell like a boar. Another important point to remember is that a young boar's attention span is limited. Mounting activity usually occurs within the first 5 to 7 minutes of the training session. Consequently, if mounting or an interest in the collection dummy has not occurred by this time, then the probability that it will during the current training session is unlikely. In this situation, it is probably best to remove the boar from the collection pen and re-introduce him at a later time.

Boars that associate pain or fear with the collection pen or process are difficult to train. In addition, unpleasant experiences during collection can reduce the sexual activity of trained A.I. boars. Avoidance of rough handling and loud noises during the training process is critical. At times, young boars will mount a dummy sow upon introduction into the collection area and, after mounting, may routinely drop off the dummy when attempts are made to collect them from their right or left side. In these situations, remaining directly behind the boar and reaching forward to apply pressure to the tip of the penis may be necessary. Once an erection occurs, the breeding technician usually can shift around to the side and continue collecting without causing the boar to dismount.

Other important guidelines for training boars are as follows: Young, aggressive boars that are sexually naive are the easiest animals to train. This does not mean that older, sexually experienced males cannot be taught to mount and be collected from a dummy sow, but the training interval is usually much longer and the success rate lower compared to their younger, more inexperienced counterparts. An inverse relationship exists between the age of the boar at the initiation of the training period and the success rate. When training is initiated at less than 10 months of age, a success rate of 90 percent is not uncommon. Furthermore, the majority of young boars can be trained to mount and be collected within the first 3 to 4 weeks after their initial exposure to the dummy sow. In contrast, if the training period begins when boars are between 10 and 18 months old, the success rate normally drops to 70 percent or lower.

For young boars that will not mount the dummy sow within 3 to 4 weeks after their initial exposure, several different strategies can be used to stimulate their interest. In this situation, the following steps can be tried (in sequential order):

1. Check to make sure that the collection area is free of distractions and the dummy sow smells like another pig.

2. Place two partitions on either side of the dummy sow in such a way that the boar is not allowed lateral movement around the dummy sow (see Figure 4). The partitions should be positioned so that if the boar moves forward in the collection area, he encounters the dummy sow. It is more effective to have the partitions in place before the boar enters the collection pen than to position them after the boar has been given access to the pen.

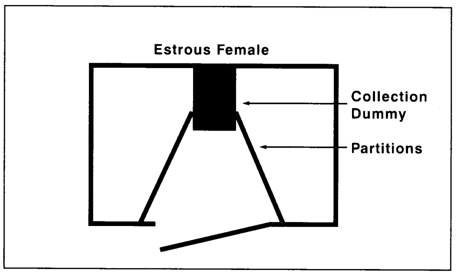

Figure 4. Diagram of a collection pen and correct placement of partitions or estrous females to make boars focus attention on the collection dummy.

3. If possible, place an estrous female adjacent to the collection pen and position the dummy in such a way that it is between the boar in the pen and the estrous female (see Figure 4). The logic behind this is that the sight, smell and sound of sow in heat will sexually arouse the boar and in order to attempt to mount the sow, he will have to literally "jump" across the dummy sow.

4 As a last resort, move an estrous female into the collection pen and collect the boar in the pen after he mounts the sow. If the boar mounts and is collected from the female then, within 24 hours, attempts should be made to get the boar to mount the dummy sow according to the procedures described in Step 3.

Processing Sperm-Rich and Whole Ejaculates

Both the sperm-rich and whole ejaculates can be collected for further processing. The two types of fluid are similar in terms of total number of spermatozoa, yet differ in terms of volume and composition. The majority of the volume of whole ejaculates is composed of fluids from accessory sex glands, while a limited amount of these fluids is present in sperm-rich collections. Consequently, the volume and the buffering and nutritional properties are greater for whole than for sperm-rich collections. Both can be used successfully in A.I. programs, yet differences do exist in how each should be handled after collection.

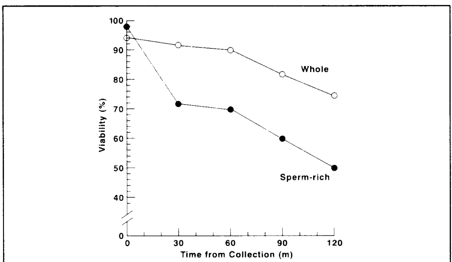

Figure 5. Changes over time in viability)/of unextended sperm-rich and whole ejaculates maintained at room temperature (72˚F)

The most important difference is that the viability of spermatozoa in sperm-rich collections declines quicker over time than that of sperm cells in whole ejaculates. This is due to the absence of the naturally occurring buffers and nutrients contained in the accessory sex fluids. Data presented in Figure 5 demonstrate just how quickly this decrease occurs. Within 30 minutes after collection, significant reductions occur in spermatozoa viability in sperm-rich ejaculates. Similar losses in the number of viable sperm cells are not observed until between 1.5 to 2 hours after collection for whole ejaculates. Consequently, it is critical that the extension process for sperm-rich ejaculates begins as quickly as possible after collection, preferably within 30 minutes. In contrast, if necessary, whole ejaculates can be held for periods of 1 to 1.5 hours prior to extension before appreciable reductions in viability occur. It is important to remember that the entire extension process does not need to be completed within 30 minutes after collection for sperm-rich collections. Addition of an equal volume of semen extender to the sperm-rich fraction will maintain viability of spermatozoa for several hours.

Another point that is often overlooked when processing both sperm-rich and whole ejaculates is a concept called the dilution rate. The dilution rate refers to the ratio of semen to semen extender in the final insemination dose. Examples of how to calculate dilution rates are illustrated in Table 1. In both of these examples, final insemination doses of 3 billion sperm cells in a volume of 80 mls are prepared. However, due to the volume and total number of spermatozoa collected, dilution rates vary considerably.

Research has demonstrated that dilution rates (semen:semen extender) less than 1:3 and greater than 1:32 are detrimental to the survival of spermatozoa and reduce fertility. This occurs when dilution rates are low because the final insemination dose contains inadequate amounts of nutrients and buffers for the survival of spermatozoa. Reasons for the reduction in fertility and viability when dilution rates are high are not completely understood. However, a phenomenon called osmotic shock is probably involved. Essentially, during osmotic shock, the efficiency of biochemical processes necessary for the survival of spermatozoa is reduced. Consequently, the dilution rate should receive consideration equal to that of the total number of spermatozoa in making the final insemination dose.

Adjustment of the dilution rate can be accomplished via several methods. Increasing the dilution rates can be accomplished by either reducing the volume of semen collected or increasing the volume of the final insemination dose. For example, the ejaculate collected from Boar A had a dilution rate of 1:3 (see Table 1) which is at the minimally acceptable level. To increase this, the volume of the final insemination dose can be increased to 100 ml or by collection of only the sperm-rich fraction. If the insemination dose was increased to 100 ml, then the dilution rate would increase to 1:4. If the sperm-rich fraction (normally 30 ml to 50 ml) was collected, then the dilution rate for this boar would be about 1:11. Conversely, decreasing the dilution rate can be done by increasing the volume of semen being collected or by decreasing the volume of the final insemination dose.

Table 1: Calculation of Dilution Rates for Extended Semen

Variable	Boar A	Boar B	Calculations
Total Volume of Semen Collected (mL)	120.0	100.0	Collected fro Boar
Total Number of Spermatozoa (billions)	18.0	75.0	Determined by Technician
Number of Insemination Doses	6.0	25.0	Total No. Sperm DIVIDED BY Sperm in Insemination Dose
Total Volume Needed (mL)	480.0	2000.0	No. of Doses TIMES Dose Volume
Volume of Additional Extender Needed (mL)	360.0	1900.0	Total Volume MINUS Collection Volume
Dilution Rate	1:3	1:19	Collection Volume DIVIDED BY Extender Volume

Insemination Dose = 3 billion spermatozoa in a volume of 80 mL.

Microscopic Evaluation of Sperm Cells

Semen evaluation prior to insemination can be useful in the identification and solution of problems with boars and semen handling procedures. Two microscopic tests that are commonly used to evaluate spermatozoa are motility and morphology. Motility estimates provide an indication of sperm cell viability and morphological evaluations can be used to "pinpoint" potential causes of low motility and/or fertility. However, both must be done correctly to be useful.

Motility of spermatozoa is influenced by a number of different environmental factors including temperature, length of storage and the semen extender used for dilution. The most important of these factors is temperature. Motility of porcine spermatozoa is highest when temperatures are between 32˚ and 38˚C (90˚-100˚F). Consequently, for an accurate assessment of motility, it is important to conduct motility evaluations within this temperature range.

Furthermore, when preparing microscope slides of spermatozoa for evaluations of motility ~he temperature of the slide and the semen sample need to be within 1 to 2 C of each other or temperature shock will result. If temperature shock occurs, then motility (and sometimes morphology) will be poor and semen may be judged as being low quality when, in fact, it is not. Several precautions can be taken to prevent obtaining biased motility estimates due to poor slide preparation. Microscope slides stored in an incubator maintained at 32°-35°C or placed on a slide warmer should be used to evaluate fresh, unextended semen. For extended semen that has been removed from storage, a different approach must be used. First, allow the semen to warm up to room temperature before a sample is obtained for evaluation. Next, place a sample of the extended semen on a microscope slide that has been stored at room temperature. Finally, place the microscope slide with the sample of extended semen on a slide warmer and allow it to warm up to 32°C.

In addition to temperature, both the length of storage and the type of semen extender used for dilution can influence motility. It is common for porcine sperm cells that have been stored at reduced temperatures to exhibit anabiosis as they are warmed. Anabiosis in sperm cells is somewhat analogous to humans awakening from a deep sleep—all the important systems are still functional, but aren't operating at peak efficiency. Sperm cells experiencing anabiosis appear to quiver or vibrate without exhibiting forward motility. Anabiosis is common in semen stored for more than 24 hours. For spermatozoa exhibiting anabiosis, it may be necessary to re-evaluate their motility after waiting 10 to 15 minutes in order to obtain a true estimation.

Description	Possible Causes	Appearance
Curved Tails	▪ Temperature shock during processing ▪ Osmotic shock during processing ▪ pH shock during processing ▪ Contact with spermicidal Compounds during processing ▪ Exposure of boars to heat-stress conditions ▪ Sick boar with high body temperature	
Coiled Tails	▪ Genetic defect	
Fillaform Tails	▪ Genetic defect	
Cytoplasmic Droplet	▪ Sexually immature boar ▪ Overused boar ▪ Testicular injury	Proximal Distal
Translocated Cytoplasmic Droplet	▪ Developmental problem	

In order to improve the longevity of stored semen, some semen extenders actually contain formulations that decrease the motility of spermatozoa. Most extenders that are hypotonic relative to semen, including Androhep and Kiev, depress the motility of semen during storage. Consequently even when temperature is optimal for evaluation motility may still be reduced due~e to the action of the extender In these situations it is necessary to add caffeine (2 uM) to the semen sample or conduct the motility evaluation on caffeine-coated slides. Caffeine stimulates motility biochemically independent of temperature. When caffeine is used, it is important not to use more than 2 uM and conduct the evaluations within minutes after its addition. Excess caffeine can lead to hyper-stimulation of motility which eventually leads to the death of spermatozoa.

A final point to keep in mind concerning motility is that it is a better estimation of viability than fertility. Research studies have demonstrated the following concerning motility and fertility. First, no relationship between motility and fertility is present when scores are over 60 percent. Second, the fertility of samples with less than 60 percent motile sperm cells is lower than those with scores higher than 60 percent. Consequently, it is common to discard semen samples less than 60 percent motility,

Morphological evaluations can be conducted on fresh samples of spermatozoa or on semen that has been stained with a morphological or "background" stain. Spermatozoa are easier to see under a microscope when a morphological stain has been used. The key feature to look for during morphology examinations is the relationship between the head of the sperm cell and its tail. An illustration of a sperm cell with normal morphology is shown in Figure 6. A brief summary of the most common abnormalities is presented in Table 2. A diagram and a list of possible causes are also included with this information. It is important to note that the presence of cytoplasmic droplets (see diagram in Table 2)is not an abnormal sperm configuration, but rather is a normal maturational phase for porcine spermatozoa. In other words, sperm cells with cytoplasmic droplets are immature a generally considered incapable of fertilization but they are normal. The only exception to this is the presence of a translocated cytoplasmic droplet. Semen samples with more than 15 percent abnormal spermatozoa commonly are considered to be subfertile.

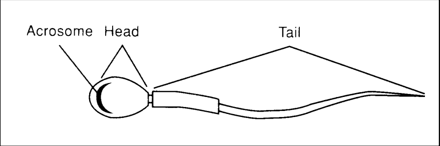

Figure 6. A porcine sperm cell with normal morphology.

Pre-Breeding Stimulation

In addition to viable sperm cells, other components of the mating process contribute to reproductive success with A.I. This is due to the fact that many of the stimuli associated with mating influence events associated with fertilization. For example, the presence of the boar during mating enhances the standing reflex of the female. Similarly, the physical manipulation of the cervix during breeding is involved with the transport of semen in the female reproductive tract. Consequently, implementation of management practices that supply these stimuli to females during breeding is a common practice in most A.I. programs, However, it is important to understand the circumstances under which various types of stimuli will be most effective.

Boar Exposure During Insemination

The primary benefit of boar contact during artificial matings is to facilitate and intensify the standing reflex associated with estrus. Pheromones predominantly produced in the boar's saliva help stimulate this behavior The insemination process technically is easier and can be done faster when sows exhibit a strong standing reflex. Consequently, on most operations, boar exposure during mating is included as a standard procedure

It is important to recognize that there are "correct" and 'incorrect" ways to supply boar exposure during insemination, Since pheromones in the saliva are the key component, it is important that sows are in close contact with the boar during insemination. If sows are bred in crates. movement of the boar in the alley in front of the crates should be restricted to no more than 5 or 6 crates. Boars can be trained to give "face to face" contact to females housed in crates. The easiest way to do this is to place a small portion of feed in front of each crate. Boars will move

slowly from crate to crate consuming the feed. After several days, the placement of feed in front of the crates can be discontinued and the boar will still move slowly in front of the crates looking for feed and providing "face-to-face" contact with the sows. 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 pen for insemination. This is a better strategy than moving a boar to a pen of sows, because the concentration of pheromones should be higher in the area where the boar is housed than in the pen for sows. Thus, an increased exposure of pheromones and standing reflex would result by moving the sows to the boar

Use of Vasectomized Boars

Use of vasectomized boars (V-boars) or epididiectomized boars (didiboars)is another form of pre-mating stimuli that can be used in conjunction with A.I. In theory, use of vasectomized males should enhance the detection of estrus and stimulation of the cervix because a sterile male is allowed to breed an estrous female before an artificial mating is administered. On some operations this technique has improved reproductive performance, while on others it has not. Based on research data, a positive response to use of a sterile male prior to A.I. would be expected to increase performance if one or more of the following conditions exists: (a) detection of estrus is suboptimal; (b)insemination doses contain less than 2.5 billion sperm cells; or (c) A.I. occurs within one hour after the sterile Consequently, if none of these situat!ions is present. then the use of vasectomized boars in A.I. programs would not be expected to significantly enhance farrowing rates and litter sizes.

Use of Oxytocin

Oxytocin is a naturally occurring hormone. that stimulates smooth muscle contractions. Uterine contractions are responsible for transport of semen from the cervix to the site of fertilization in the sow. Consequently, attempts have been made to use oxytocin before or during insemination to enhance fertility via improved sperm transport. Addition of oxytocin to semen prior to insemination is of limited usefulness for this purpose because of its short biological half-life and the presence of compounds in boar semen that can attach to oxytocin and render it inactive. In contrast, an intramuscular injection of 5 I.U. of oxytocin 2 to 3 minutes prior to breeding has been shown to improve farrowing rates and litter size, but only in situations where semen of reduced fertility was inseminated. Consequently, if fertile semen is inseminated by an experienced technician, use of oxytocin as a pre-breeding stimuli offers no significant advantage to A.I. programs.

*Oxytocin is not currently approved for this use in swine.

Conclusion

Once the technical aspects of basic semen handling and estrous detection procedures have been perfected, it may be possible to make small adjustments in some of these skills and enhance the efficiency and effectiveness of the entire A.I. program. Several areas in which "fine tuning" might occur include scheduling semen deliveries, more predictable return to heat via hormonal therapy (e.g. P.G. 600®), training boars, processing sperm-rich and whole ejaculates, evaluating semen microscopically and administering pre-breeding stimuli. The key to successfully "fine tuning" any A.I. program is to understand (a) the rationale for making each adjustment and (b) the production situations in which a given adjustment is likely to be beneficial.

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Part No.: 8002015 macgra04/02