pork industry handbook

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Artificial Insemination in Swine

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The techniques and equipment necessary for artificial insemination (AI) in swine are readily available When considering whether or not to use AI, the following advantages are noteworthy.

AI allows more extensive use of older boars on lighter weight females, and decreases the number of boars and time required for breeding when heat is synchronized. It promotes development of a closed herd where no animals are brought into an existing herd. This makes it possible for any size operation to maintain a more effective disease control program and to bring new genetic material into the herd with minimum risk of introducing new disease organisms.

When sows are placed in gestation crates after first service, AI removes the necessity of taking the sow out of the crate for a second insemination 12-13 hr. later. Experienced herdsmen may not have to remove her for the first breeding or heat checking, depending on their system.

One drawback with the use of AI is that a higher level of management is required. However, several benefits result from the greater input of managerial skills. For instance, with better records, a greater awareness of the true reproductive status of the breeding herd will result in more effective selection of breeding stock.

Only healthy disease-free boars should be used as semen donors. Minimum standards of health and sanitation for those interested in merchandising semen have been published by the Livestock Conservation Institute, 239 Livestock Exchange Building, South St. Paul, MN 55075. Anyone using AI should be thoroughly familiar with these guidelines in order to evaluate the health status of semen donors regardless of source, i.e., farm or boar stud.

Heat Detection

The most critical factor in achieving maximum conception rates with AI is to inseminate females at exactly the right time. To accomplish this, the breeder **must** practice proper heat detection. The normal estrous or heat cycle of the pig is 20-22 days in length, but it can range from 18-25 days. The estrous cycle can be divided into segments--the period of receptivity to the male (standing heat or estrus), lasting from a few hours to several days, and the nonreceptive period. The average length of estrus is 1-2 days for gilts and 2-3 days for sows. If the length of estrus is longer or shorter, the chances of picking the right time to inseminate a female are lower.

Estrus detection is a simple technique. The difficulty is in being sure that detection is carried out correctly. When the female is in heat, she often will try to find the boar herself. There may or may not be evidence of swelling of the vulva. In the presence of a male, the female will assume the mating stance; that is, she stands solidly when pressure is applied on her back. The final sign of standing heat is the "ear popping response," where the female's ears will repeatedly move toward an erect position as she assumes the mating stance. Determining the correct time to breed is based on the time the female first shows heat. Therefore, the more frequently heat detection is done, the more likely it is that insemination will be carried out at the appropriate time.

The best method of heat detection is to check each female in the presence of a boar by applying pressure to her back (try to sit on her back) to see if she will assume the mating stance as described (Fig. 1). Unless these criteria are met, the time of ovulation cannot be estimated accurately. Using a boar in combination with

hand pressure is the most accurate method of finding females in heat. Researchers have shown that the presence of a boar increases the chance of detecting all females truly in heat by 30 to 40%.

If you must use a boar to check for heat, how does he fit into the AI program? First, the heat check boar can be raised on the farm. As the heat checker, he should be vasectomized. Second, by using AI, fewer, but genetically superior, boars can be used to breed many more females than with natural service. Currently, researchers feel 3-4 billion live sperm per insemination are required to insure good fertility. The average boar produces enough sperm to impregnate approximately 1,200-2,000 females a year. In a normal pen breeding system, a boar rarely breeds more than 100-200 females per year.

Boar Training and Semen Collection

Training a boar for collection of semen can be the most frustrating part of AI unless extreme patience is used in handling the boar; but with this patience, semen collection can be easy. Boars can be trained to mount a dummy sow or a sow in heat. The dummy sow is preferable since there is no size incompatability, nor is there a problem with a sow that won't stand still long enough for ejaculation to be completed. A simple plan for a boar collection dummy is shown in Figure 2. It is usually easier to train a young boar that has had no sexual contact with females than to train an older, experienced boar. Some boars probably can never be trained, although these are infrequent. These are likely to be the "shy breeder" type.

As soon as a young boar starts to rant, or at approximately 7-8 months of age, he can be brought into contact with the dummy sow to start training. Don't expect a boar to mount the dummy at first contact. Patience is

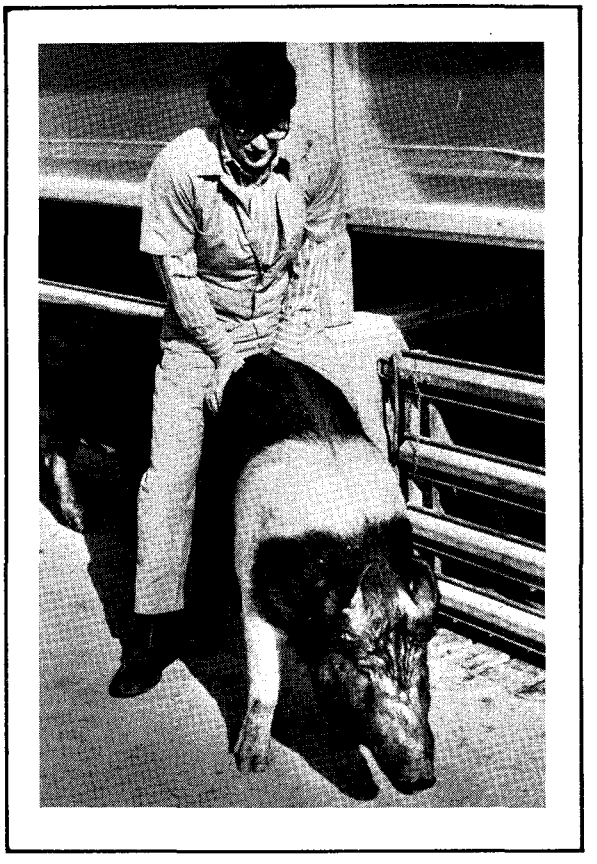

Figure 1. Method of detecting estrus in females. Note the erect ears and rigid stance with pressure applied to the back in the presence of the boar.

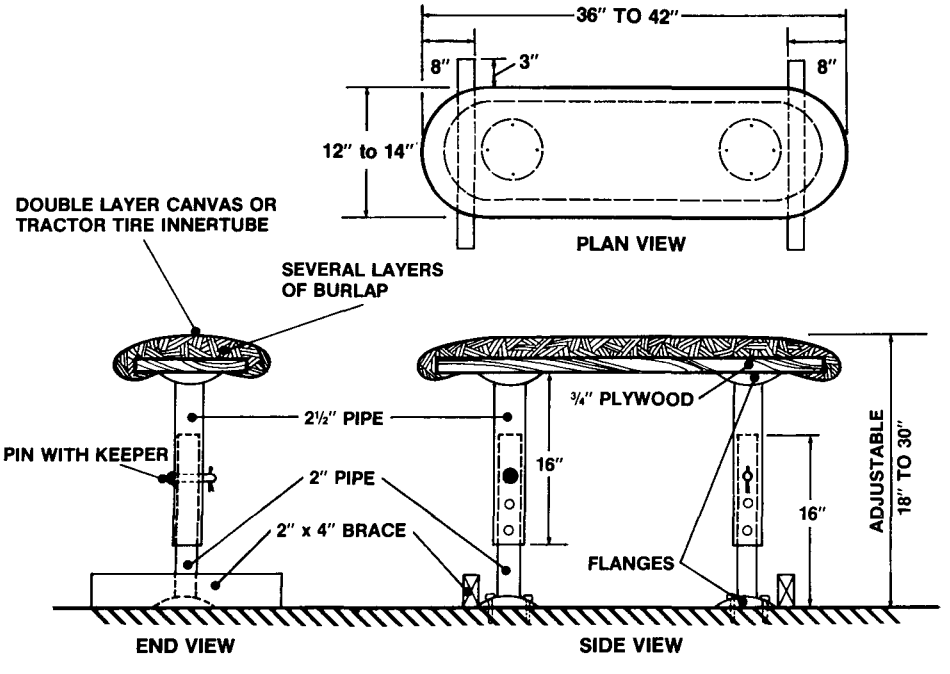

Figure 2. Boar collection dummy.

very important. Handle the boar with care so that he will get acquainted with the collector and the dummy. Be sure the dummy is placed where there is adequate room to move around and where the floor is not slick. The dummy should be securely anchored so it can't be turned over.

If no mounts occur the first time or two, sprinkle semen, boar urine, or fluid from the sheath of a strange boar on the ends of the dummy. Urine from a sow in heat is much less effective than the odor of a strange boar. If there are still no attempts to mount, try bringing several females in heat into the same area as the dummy, and allow the boar to mount a female in estrus several times. If there are further failures to mount, try collecting semen from the boar by placing a sow in heat close to the dummy; later, try collecting the semen using the dummy alone. An alternative method is to start collecting from the boar using a female in heat adjacent to the dummy, lifting the boar over to the dummy after he has stopped thrusting. If all attempts to use a dummy fail, then you may be restricted to using a sow in heat for each collection.

The stimulus for ejaculation in the boar is pressure applied to the spiral portion of the penis (Fig. 3). Once the boar mounts, allow him to start thrusting, then quietly ease down beside him from his rear and grasp the penis firmly enough to retain a grip, using your bare or gloved (rubber) hand. At the same time, begin pulling the penis (gently) from the sheath, and rapidly increase the pressure and pulling action until thrusting stops. Prior to collection, it would be helpful to clip the long sheath hair to aid in gaining a grip. Some boars require what seems to be tremendous pressure to stimulate ejaculation; others require only slight pressure.

Occasionally a boar will start backing off or sliding off the dummy or even a sow when your hand touches his penis. To help prevent or correct this problem, one of the following may be helpful. If you're collecting from a dummy (Fig. 2), try attaching a piece of pipe or a board, 2 in. x 4 in., to the bottom side of the dummy perpendicular to the length at about the halfway point. This will give the boar something to hook his front legs around. Normally an artificial vagina is of no value, but in the case of the shy-breeder type boar, it may facilitate obtaining a collection impossible to get otherwise. Fill the outer jacket of the device with 100°F. water, and lubricate the open end. Guide the boar's penis into the open end, and wait for ejaculation to take place. Finally, a combination of artificial vagina and hand pressure may be used.

There are several phases to ejaculation. The first portion may consist of clear fluid and some gel-like substance. There are no sperm in this portion so it need not be collected. Then the sperm-rich fraction starts (creamy white), followed by more gel and clear fluid. Some gel will be noticed along with the sperm-rich fraction. There will be several alternating phases of sperm-rich and sperm-free fluid; the sperm-free phases do not necessarily need to be collected. The time for ejaculation can be as short as a minute but may be as long as five minutes. The average volume will vary with each boar, but approximately 50-500 cc. (1/3-1/2 pt.) can be expected (see Table 1). Volume varies with breed, age, and collection frequency.

Table 1. Semen characteristics and sperm output of boars.

Number of semen collections per week	1-5
Volume (ml.)	50-500*
Sperm concentration (million/ml.)	150-750
Total sperm/ejac. (billion)	20-120
Total sperm/week (billion)	80-200
Motile sperm (%)	80
Morphologically normal sperm (%)	80

*Gel-free volume.

Semen Evaluation

Figure 4 shows the equipment necessary for collecting semen. A wide-mouthed thermos bottle or a plastic (pint size) bottle with a narrow mouth can be used. If the thermos is used, place a couple of layers of cheesecloth over the mouth to strain out gel and prevent dirt from falling into the semen (Fig. 3). To ease cleaning, a plastic bag may also be used as a liner in

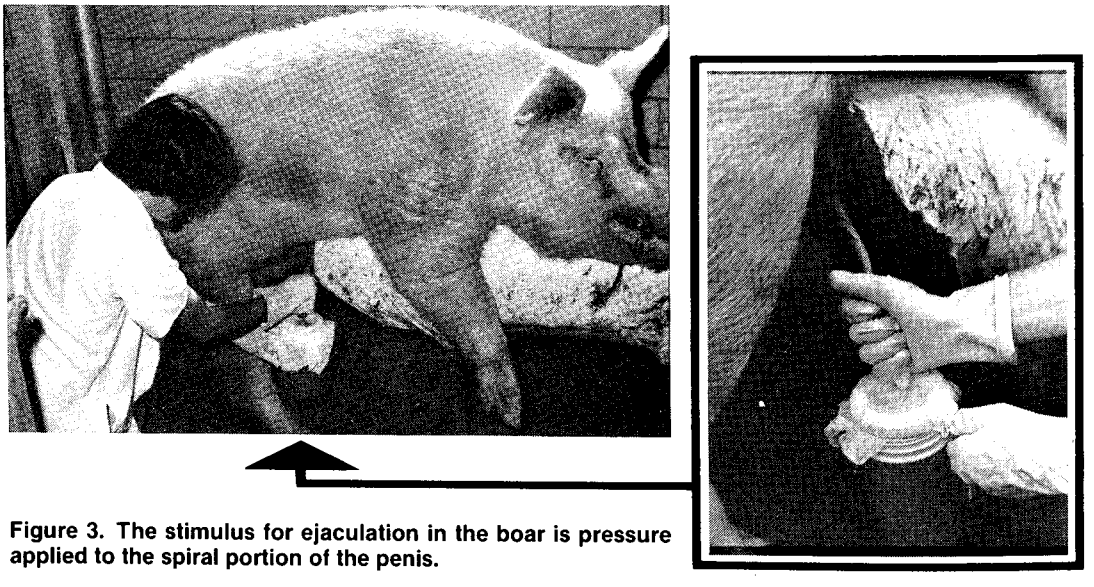

Figure 3. The stimulus for ejaculation in the boar is pressure applied to the spiral portion of the penis.

the thermos. The plastic bottle should be covered with 1 in. of foam rubber for insulation against cold shock.

During and following collection, protect the semen from a rapid change in temperature. The insulation from the thermos or the foam is sufficient protection to prevent sperm damage for 5-10 min. at 20°F. In a warm room (60-70°F.), strain the gel from the semen (through a couple of layers of cheesecloth) if not strained during collection. Note the volume of semen, since this will dictate how much extender you will need to add, depending on the number of females to be bred and whether or not semen will be stored. Throughout the collection and insemination process, care should be taken to be sanitary.

Normally semen will have a chalky, creamy appearance. This shows that sperm concentration is high. As concentration gets lower, the opaqueness diminishes. A microscope is not essential to make an AI program work, but it is useful to verify concentration and motility as well as to check for abnormal sperm. An expensive microscope is not essential, but one that has two or three power settings ranging from 30 up to 1000X would be needed. Accurate sperm counting would require additional equipment. A hemacytometer can be used to accurately evaluate concentration of spermatozoa. This is a critical factor only when extending semen to ratios that would reduce concentration below three billion live sperm per insemination. For details on using this or other equipment properly, contact your state Extension service.

Visual observation of sperm is not a sure indicator of fertility. The only way to be certain is to test-mate prior to the breeding season. The test-mating does not, however, insure that the boar will remain fertile for the entire season.

Frequency of collection depends on the need for sperm. Ideally, a boar should be collected no more than two or three times a week to maximize sperm concentration and semen volume. When the need arises, collection once or twice a day can be maintained for 3-5 days; however, volume, sperm numbers, and sex drive diminish rapidly. This does vary to some extent with the individual boar.

The average ejaculate contains enough sperm to inseminate at least 6-8 females. The best rule to follow is to use the sperm as soon as possible after collection. Two factors are considered in insemination: Number of sperm and volume of fluid. It has been shown that a minimum of 2 billion live sperm in an adequate volume of fluid are required to obtain adequate conception rates. Since some sperm will be dead, more than 2 billion are needed. Researchers have shown that 50 cc. fluid volume is close to the minimum, and it is recommended that 100 cc. total volume be inseminated to maximize conception rates.

How much an ejaculate must be extended depends on the volume of the ejaculate collected, the number of females to be inseminated, and whether or not short-term storage will be used. If five females are to be inseminated with fresh semen, a total volume of 500 cc. of extended semen is needed. If the ejaculate contains 100 cc., then 400 cc. of extender is required to obtain the required 500 cc. for five females. If some semen is to be stored for future use, then a higher rate of extension would be used, and microscopic verification of sperm concentration may be advisable. However, AI should be a routine procedure in herd management before short-time storing of semen is considered. Storage for more than two days is not advisable in most instances. Until "longlife" extenders (greater than 3 days storage time) are proven effective by unbiased investigators, producers would be well advised to be cautious regarding their use.

Before extending the semen, measure the temperature of the ejaculate with a thermometer, and raise or lower the temperature of the extender to within 2 degrees of the semen. Gently but thoroughly mix the two. If extension rates greater than 1:5 are used, it is good practice to add only half of the extender at a time. The extended semen is now ready for insemination or storage. For storage, allow the mixture to cool to room temperature, 70-75°F. Place the container of semen in a small styrofoam box or in a pan of water (same temperature as the semen), and put both in a refrigerator, or Koolatron, to maintain a temperature of 60-65°F. (15-18°C.). Since temperature varies greatly among refrigerators, check ahead of time to be sure the appropriate temperature can be maintained. These precautions are necessary to prevent the mixture from cooling too rapidly, thus causing damage to the sperm. Higher temperatures (65-70°F.) may be used if there is no bacterial contamination, which is not likely with on-farm collection.

Usually, semen can be extended at a ratio of 1 part strained semen to 3 parts extender without any problem. Higher rates of extension are not likely to result in a decrease in conception unless a ratio of 1:10 or greater is used. Then it is advisable to get an estimate of actual sperm concentration so at least 3-4 billion sperm are inseminated. To maximize litter size and conception rate, investigators have shown that the use of two or more ejaculates pooled from different boars can be advantageous.

Two formulas for semen extender are presented in Table 2. These extenders, available commercially, can be stored in dry form until needed. Both extenders can

Table 2. Extenders for use with liquid boar semen.

Component	BTS*		Kiev	
	1 quart	1 liter	1 quart	1 liter
Distilled water (cc.)	†	†	†	†
Glucose (gm.)	39.1	37.0	63.4	60.0
Potassium chloride (gm.)	0.79	0.75		
Sodium bicarbonate (gm.)	1.32	1.25	1.27	1.2
Sodium citrate (gm.)	6.3	6.0	3.96	3.7
EDTA (gm.)	1.32	1.25	3.91	3.7
Penicillin (million Int. Units)	1.1	1.0	1.1	1.0
Dihydrostreptomycin (gm.)	1.1	1.0	1.1	1.0

*Beltsville Thawing Solution.
†Put ingredients in a clean beaker and fill to the appropriate line with distilled water.

be stored frozen. Freezing into cubes or in plastic 125 cc (4 oz.) bottles is a good storage method that is convenient to use.

Skim milk may be used as a semen extender if the following steps are taken prior to mixing with semen: (1) Heat in a double boiler to a temperature of 88-90°C. (190-195°F.) for 8-10 min. Be careful not to scorch the milk. (2) After cooling to room temperature, break one egg and add the egg yolk only (minus the membrane) to 1 qt. of milk. Carefully mix for about 2 min; so as not to raise a froth. (3) Equalize (within 2°C.) the temperature of the milk with that of the semen. (4) Add the extender to the semen by slowly pouring the milk down the side of the container. Semen extended with skim milk should be used immediately. Additional information regarding extenders, as well as other information, can be obtained with the aid of your state swine Extension specialist or boar stud technician.

Insemination

Based on frequency of heat detection, Table 3 presents a "rule of thumb" to determine the appropriate insemination time for sows and gilts using fresh semen. It is recommended that insemination be done at least twice during estrus (Table 3). However, at this time there is conflicting evidence regarding the value of inseminating more than once during estrus using frozen semen. At this time frozen semen is not equal to freshly collected semen. On the average, conception rates will be 10-20% lower, and litter size is likely to be about one to three less pigs per litter. Apparently the freezing and thawing process alters the sperm in such a way as to make them more fragile. Because they are more fragile, the sperm must receive special handling as outlined in the thawing procedures received with the semen shipment. When using frozen semen, twice daily heat detection should be the rule, and insemination should be delayed until 30-35 hr. after the onset of estrus. Ovulation occurs about 37-45 hr. after the onset of heat.

Table 3. Optimum time to inseminate females in heat using fresh semen.

Frequency of heat detection	Best time to inseminate after the onset of heat
Once daily Twice daily	Every day they stand 12 and 24 hr. after the onset of heat*

*Breed at 48 hr. if in heat 3 days. If in heat longer than 3 days, discontinue inseminations.

After having estrus females penned conveniently, take a breeding catheter, and apply light mineral oil, vegetable oil, or KY jelly to the catheter for lubrication. Both the rubber spirette or the plastic type catheters will work; however, there are advantages and disadvantages to both. Many producers prefer the spirette because it is shaped much like a boar's penis, and the female's reproductive tract grips the spiral end just as it would during natural mating. This helps minimize backflow of semen and also is a fair indicator of estrus. In addition, the spirette is flexible, and there is very little chance of injury to the female. The disadvantage is that it must be cleaned promptly after use. A modified spirette is commercially available, which combines the best of the rubber spirette and bovine catheter, being disposable yet retaining the spiral tip.

In contrast to the spirette, the diameter of the plastic bovine or bent-tip type of catheter is small enough that the female tract cannot grip it. Consequently, there is a greater chance for backflow to occur. Usually backflow is not a serious problem unless sperm numbers are expected to be at the minimum requirement, such as with frozen semen. With hard plastic catheters, there is a greater risk of injury to the female. Also, if the female is nervous or jumpy, the bovine catheter will slide in and out with every move, unlike the spirette type which is gripped tightly, flexes and bends, and usually doesn't fall out, even if the sow jumps away from the inseminator. Unless used in a purebred herd or unless a known disease condition is present in the herd, the same catheter can be used for several females. When a positive record of ancestry is required or herd health status is uncertain, use a clean catheter for each female.

Seldom do females need more restraint than being confined to a small pen. Tight restraint or snaring should be avoided. Sometimes having a boar close by will help a nervous female to stand more solidly for insemination. Putting out a small quantity of feed can also be helpful.

For insemination, put about 100 cc. extended semen in a squeeze bottle (4 oz. size) with a cone-shaped tip (see Fig. 4). A large syringe can be used but is more difficult to handle. During cold weather, put the bottle of semen in a protected area, such as a styrofoam box or your shirt pocket, until ready to inseminate the female.

Place a few drops of lubricant on the tip of the rubber spirette (not needed for the bovine type), and insert the tip into the vulva, pointing it toward the backbone to avoid the opening of the urethra. Slide the catheter along the top of the vagina until rather firm resistance is felt. The cervix is usually 8-10 in. (16-25 cm.) inside the vulva but could be deeper in larger females. In some gilts, resistance may be encountered about 4 in. (10 cm.) inside the vulva. This may be the remains of a nonfunctional membrane (hymen). When the cervix is detected, start rotating the spirette counterclockwise (left-hand thread) until it becomes "locked" into the cervix. The opening into the cervix is nearly impossible to miss as it has the shape of a funnel. Occasionally, a female will not clamp down on the spirette. This occurs mostly in sows or if the female is not in heat. Insert the bovine catheter until the tip is deep into the cervix, being careful not to penetrate into the uterus where injury could result.

When the catheter is in place, connect the semen container, and begin squeezing the semen through the catheter. If semen starts running out of the vulva (backflow), release the pressure, wait momentarily, and start again. Allowing the female to move around often helps minimize backflow. There are times when it seems nearly impossible to force the semen into the female—the opening of the catheter may be jammed against some tissue. Work the catheter around and continue. Check the opening of the squeeze bottle; it should be about 1/32 in. in diameter.

Cleaning AI Equipment

Following use, do not allow semen or other material to dry in the equipment. Use plenty of clean water for rinsing. Do not use soap or detergents to clean anything that will come in contact with semen since there are likely to be residues harmful to sperm. Clean thoroughly with a brush and tap water to remove any gel particles left. Rinse all pieces in distilled or deionized water; then boil in distilled or deionized water for 20 min. Do not boil in tap water as this will leave a mineral deposit on the equipment. If you are not able to boil the

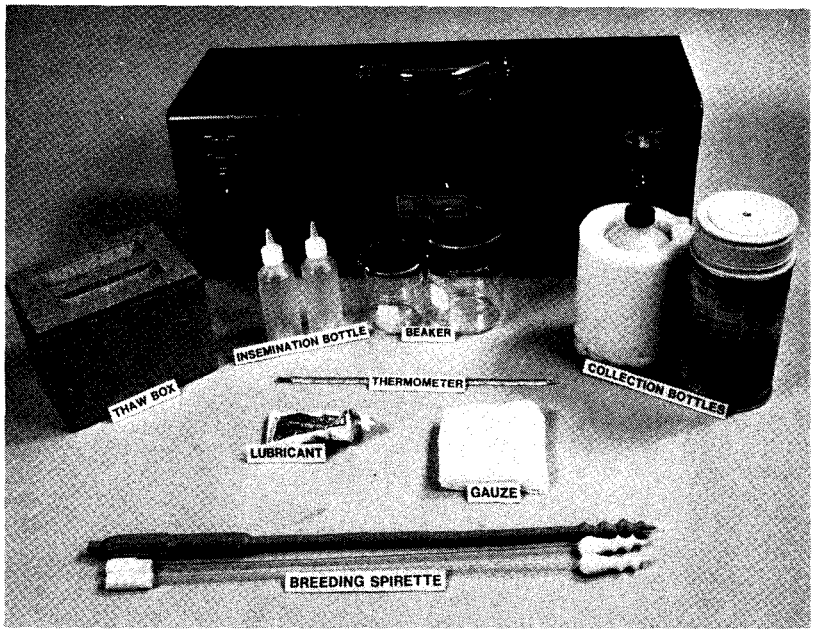

Figure 4.
Equipment used in AI.

equipment, a temporary sterilizing method is to rinse thoroughly with 70% alcohol. However, do not depend on the alcohol for continued use since some organisms are immune to its effects. Use of disposable equipment is encouraged to minimize the chances of a breakdown in sanitation, i.e., catheters, insemination bottles, and plastic bags in the collection thermos and styrofoam thaw box.

Commercial Semen

Frozen semen is available, as is liquid semen, in the United States and Canada. However, before obtaining semen from Canada, be sure the shipment is cleared with customs and with the Animal and Plant Health Inspection Service (APHIS). Check the records accumulated for each sperm-donating boar being considered. Your choice is just as important as if you were buying him for a permanent replacement. Evaluate the usual data regarding boar performance, but more importantly, evaluate data on his conception rates, litter size, and his progeny's performance whenever available. Remember, the sperm of some boars do not survive well during the freezing and thawing process; therefore, it is important to check the performance record of the boar before using him.

Records

A certain amount of record keeping is advisable. Records of female identification and the dates in standing heat are valuable in scheduling breeding and in determining the volume of semen required at the next breeding period. In addition, through records, irregular cycle lengths, anestrus, and other reproductive problems will become more evident, allowing corrective measures to be taken. A record including date of semen collection and strained volume should be maintained for each boar. These records may also include notes of the type and duration of any sickness the boar may experience. Anything that causes body temperatures to go up as little as 1-2°F. can result in a 60-80% decrease in total number of viable sperm for several weeks. The normal body temperature is approximately 102°F.—plus or minus 1 degree F.

Summary

To introduce new genetic material into your herd at a minimum risk of disease and to increase the use of a particular sire, the pork producer should consider an AI program. Providing a viable possibility for herd improvement, an AI program will require greater managerial input but will result in greater awareness of any reproductive problems in the herd. A minimum of specialized equipment is needed to carry out a successful program. One of the best uses of AI is in bringing new genetics into the herd using commercial semen and semen collected on the farm for expanded use of fewer but superior boars. If a few simple suggestions are followed, AI will yield conception rates and litter size equal to or better than natural service using fresh semen. Use of frozen semen is likely to yield less favorable results. AI training courses are available through many state Extension service shortcourses and boar studs. Supplies are becoming more widely distributed by boar studs and other suppliers. Be certain to follow directions for use of equipment and extenders as closely as possible to maximize pregnancy rates. Don't be afraid to ask questions no matter how insignificant.
