University of Nebraska - Lincoln
DigitalCommons@University of Nebraska - Lincoln

Historical Materials from University of Nebraska-Lincoln Extension

Extension

1989

EC89-264 B Artificial Insemination of Swine

Donald G. Levis
University of Nebraska-Lincoln, donlevis@hotmail.com

Follow this and additional works at: http://digitalcommons.unl.edu/extensionhist

Levis, Donald G., "EC89-264 B Artificial Insemination of Swine" (1989). *Historical Materials from University of Nebraska-Lincoln Extension*. 4648.
http://digitalcommons.unl.edu/extensionhist/4648

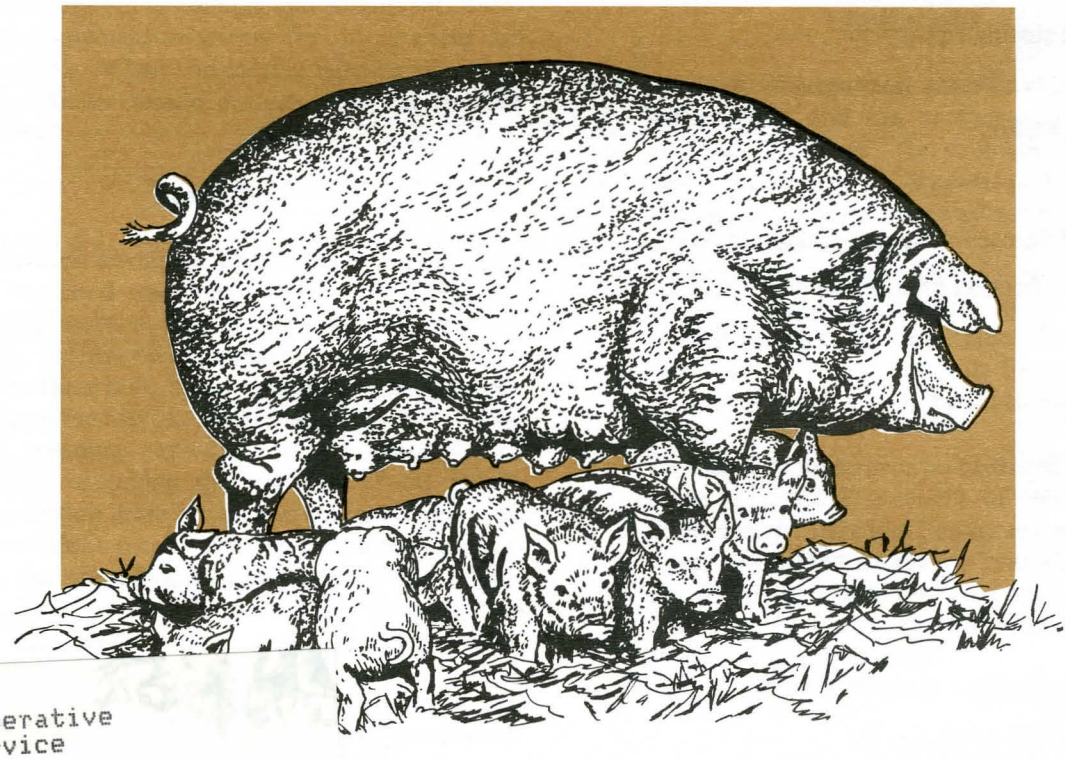
This Article is brought to you for free and open access by the Extension at DigitalCommons@University of Nebraska - Lincoln. It has been accepted for inclusion in Historical Materials from University of Nebraska-Lincoln Extension by an authorized administrator of DigitalCommons@University of Nebraska - Lincoln.

Nebraska Cooperative Extension EC 89-264-B

CYT
S
85
E7
no. 264
Copy 1

UNIVERSITY
of NEBRASKA

Artificial Insemination of Swine



Nebraska Cooperative
Extension Service
Extension circular
Received on: 12-12-95
University of Nebraska,
Lincoln -- Libraries

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

It is the policy of the University of Nebraska-Lincoln Institute of Agriculture and Natural Resources not to discriminate on the basis of sex, age, handicap, race, color, religion, marital status, veteran's status, national or ethnic origin or sexual orientation.

Contents

	Page
Benefits	3
Limitations	3
Boar anatomy	4
Sow anatomy	4
Collection room	5
Dummy sow	5
Training the boar	7
Collection of semen	7
Handling of semen	9
Semen evaluation	9
Extending semen	10
Inseminating sows	11
Cleaning and storing equipment	14
Records	14
Disease transmission	14
Summary	14
Appendix I. Microscopic semen evaluation	15
Appendix II. Location of equipment	18
Appendix III. Potential diseases transmitted	19

Artificial Insemination of Swine

Donald G. Levis, Extension Swine Specialist

Artificial insemination (AI) of swine is a relatively simple process almost any swine producer can accomplish with a minimum of training and equipment. Techniques and equipment necessary for AI in swine are readily available. When considering whether or not to use AI, a producer should evaluate both the benefits and limitations.

Benefits

- The greatest advantage of artificial insemination is the increased opportunity to use genetically superior boars, both within and between herds, regardless of size of operation.
- AI decreases both the number of ejaculations per boar and the total number of boars needed during peak breeding periods, and may remove the necessity of taking the sow out of the breeding/gestation crate for second insemination.
- AI provides a means to develop a closed herd, reduce the risk of introducing new disease organisms, breed large boars to smaller females, and save time when a large group of synchronized females are to be bred.
- AI helps detect boars that have marginal semen characteristics when semen is regularly examined; plus, AI provides a faster means to determine the genetic merit of a boar than does natural mating.
- AI allows crossbreeding programs in commercial herds to be easily practiced without a large investment in required breeds of boars, and encourages a good record keeping program. A greater awareness of the true reproductive status of the breeding herd will result in more effective selection of breeding stock.

Limitations

- Artificial insemination requires a higher level of management and can be time-consuming if not correctly organized. The producer must have the desire to make AI successful by being very thorough and paying close attention to detail in all phases of the program.
- AI requires that inseminations be done correctly and at the appropriate time during estrus to obtain a high farrowing rate and litter size. Heat detection must be done twice daily for best results.
- Undiluted, fresh semen should be used within two hours.
- Extended liquid semen can be stored for only three to seven days. The length of storage is highly dependent on individual boars and extender used. Also, storage temperature is critical.
- Fertility level (farrowing rate and litter size) of frozen semen is substantially lower than with fresh semen or natural mating.
- Sanitation of equipment is absolutely essential.

Anatomy and Physiology

The anatomy and physiology of the boar and sow are such that practically anyone, with a little determination and patience, can learn the techniques of collecting and inseminating boar semen. This is in contrast to cattle and sheep in which these techniques are more difficult to learn and to perform.

Boar Anatomy. The various anatomical structures and their functions are shown in *Figure 1.* The spiral portion of the boar's penis is pressure-sensitive; he can be collected by applying pressure on the spiral tip with the hand.

Sow Anatomy. *Figure 2* shows the various anatomical structures and function of the sow reproductive tract. When inseminating a sow, the insemination catheter is guided automatically into the cervix because the vagina tapers directly into the cervix. The folds or ridges of the cervix are in a corkscrew arrangement adapted to the spiral twisting of the tip of the boar's penis. When a boar's penis is locked tightly into the cervix, ejaculation commences because of the pressure. The insemination catheter can be gently twisted counterclockwise in between the folds for insemination.

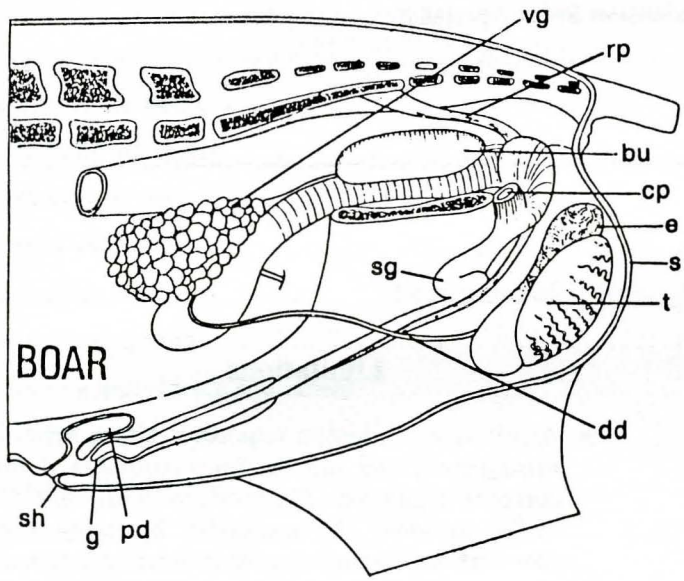


Figure 1. Boar reproductive system. (Adapted from Popeske, 1968, in *Reproduction in Farm Animals,* 3rd edition, E. S. Hafez, Editor, Lea & Febiger, Philadelphia, 1975.)

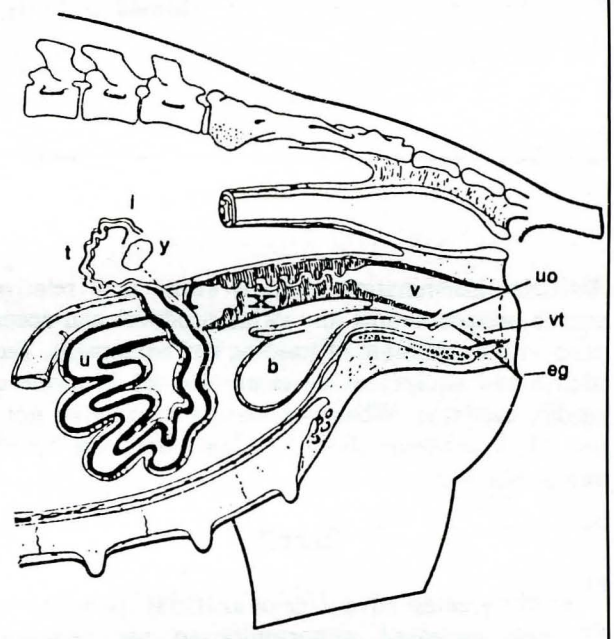


Figure 2. Sow reproductive system. (Redrawn from Ellenberger and Baum, 1943, in *Reproduction in Farm Animals,* 3rd Edition, E. S. Hafez, Editor, Lea & Febiger, Philadelphia, 1975.)

Structure	Function
Vesicular gland (vg)	Adds fluid to ejaculate.
Retractor penis muscle (rp)	Pulls penis back into body.
Bulbourethral gland (bu)	Produces gelatinous material.
Cruis of penis (cp)	Fastens penis to ischium bone of hip.
Epididymis (e)	Sperm maturation and storage.
Scrotum (s)	Protects and regulates temperature of testis.
Testis (t)	Contains seminiferous tubules that produce spermatozoa. Contains Leydig cells that produce testosterone.
Sigmoid flexure (sg)	Aids in erection.
Ductus deferens (dd)	Passageway for semen from testis to urethra.
Preputial diverticulum (pd)	Contains urine and semen which has an intense odor.
Spiral portion of the penis (g)	Aids in erection and delivers semen to sow cervix.
Sheath (sh)	Protects penis.

Structure	Function
Vulva (eg)	Visible portion of the external genitalia.
Vestibule (vt)	Tubular structure from urethral orifice which carries urine to exterior.
Urethral Orifice (uo)	Opening where urine enters vestibule.
Vagina (v)	Organ for copulation and passageway for fetus and placenta.
Cervix (x)	Barrier to dirt, bacteria, urine and other foreign material. Site of semen deposition.
Uterus (u)	Involved in sperm transport and fetal development.
Oviduct (t)	Site of fertilization (union of sperm and ovum).
Infundibulum (i)	Part of oviduct that catches ova.
Ovary (y)	Produces ova and the hormones progesterone and estrogen.
Bladder (b)	Collects urine.

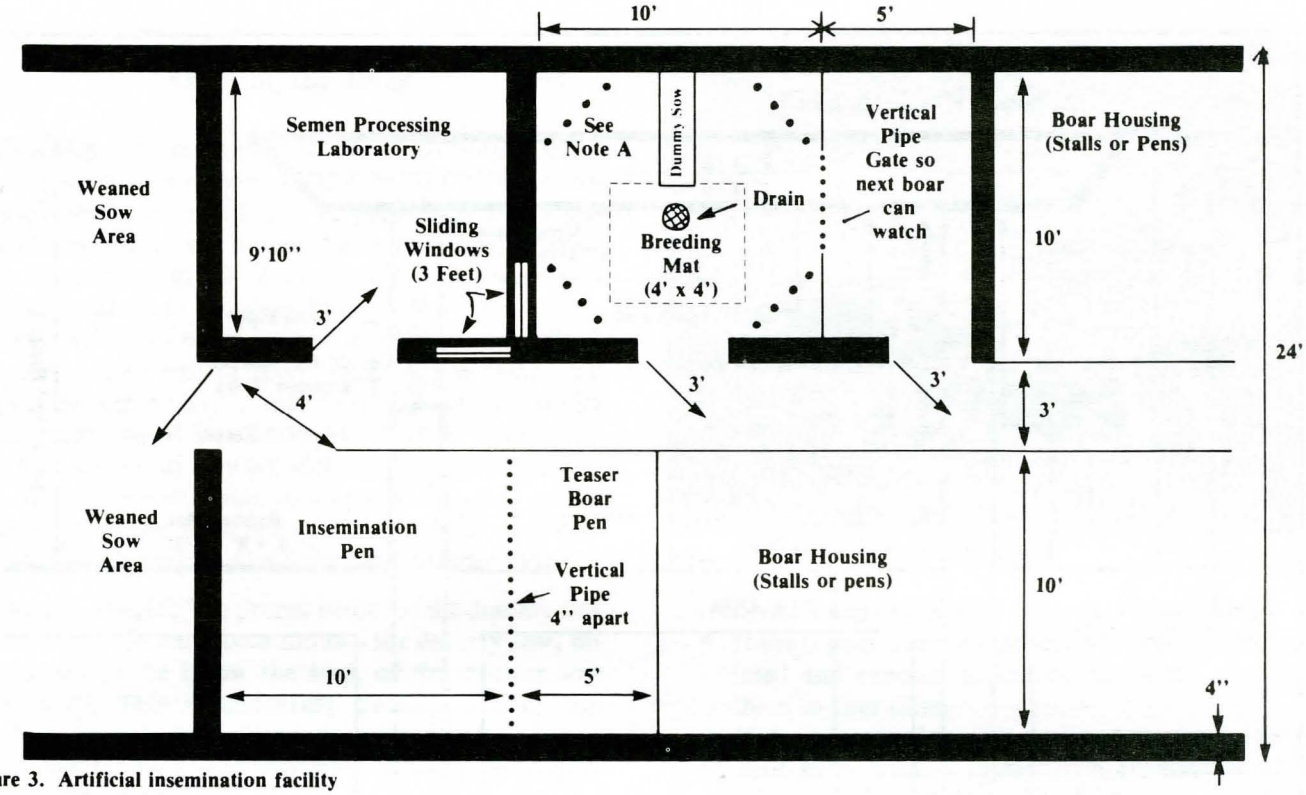


Figure 3. Artificial insemination facility

NOTES: A. 2" diameter pipe; 3'8" above floor surface; spacings o.c. = 7 1/2", 12", 12", 12", 7 1/2". (Herdsperson escape corners are 36" x 36" x 50 7/8")

Designed by: D.G.LEVIS

Collection Room

A room specifically designed to collect boar semen can be an important part of an artificial insemination program *(Figure 3)*. The room should consist of the following:

- The room should be at least 10' x 10' and have the noise level controlled. It is advisable to design the room so the next boar to be collected can watch the preceding boar.
- The floor should be constructed of non-slick concrete and easily washed. It is important that only the dummy sow have odors for attracting the boar.
- The room should be maintained from 70 to 80 °F during winter to help prevent cold shock or too rapid chilling of semen. The room should have good lighting and be well ventilated, but not drafty.
- The room should have a dummy sow placed where there is adequate space for the boar to move around the dummy. The dummy should be securely anchored so it cannot be turned over.
- The room should provide a means of escape for the herdsperson at each corner in case a boar becomes aggressive.

Dummy Sow

Figure 4 shows a simple plan for constructing a dummy sow. A dummy sow can be made to last longer by using one-half of a hot water tank for the body. The back of the dummy sow should not be wider than 14 inches (12 inches preferred), and should give comfort and support to the boar during ejaculation.

As ejaculation time is a long time, from five to 10 minutes, the boar may stop ejaculating early due to the lack of support or poor footing. Comfort can be provided by padding the dummy with a dozen burlap bags or some foam rubber and then covering it with a canvas.

The dummy should be comfortable and easy to mount for all boars; therefore, the height of the dummy should be easily adjustable by one person. The adjustment holes in the legs of the dummy can be one inch apart. When the proper height is reached, place the pins back into the holes because when the boar approaches, he will try to lift up the back of the dummy.

Some boars want to creep as far as possible up onto the dummy, which results in the penis getting into a S-bend during service. The boar should be prevented from creeping up too far by: (1) heading the dummy into a wall, (2) fastening an adjustable board to the front of the dummy, or (3) adjusting the height of the dummy so the boar's front feet are only two to three inches off the floor.

Proper footing is important when a boar mounts the dummy, so, be sure the floor surface is not slick. Rubber breeding mats provide excellent footing.

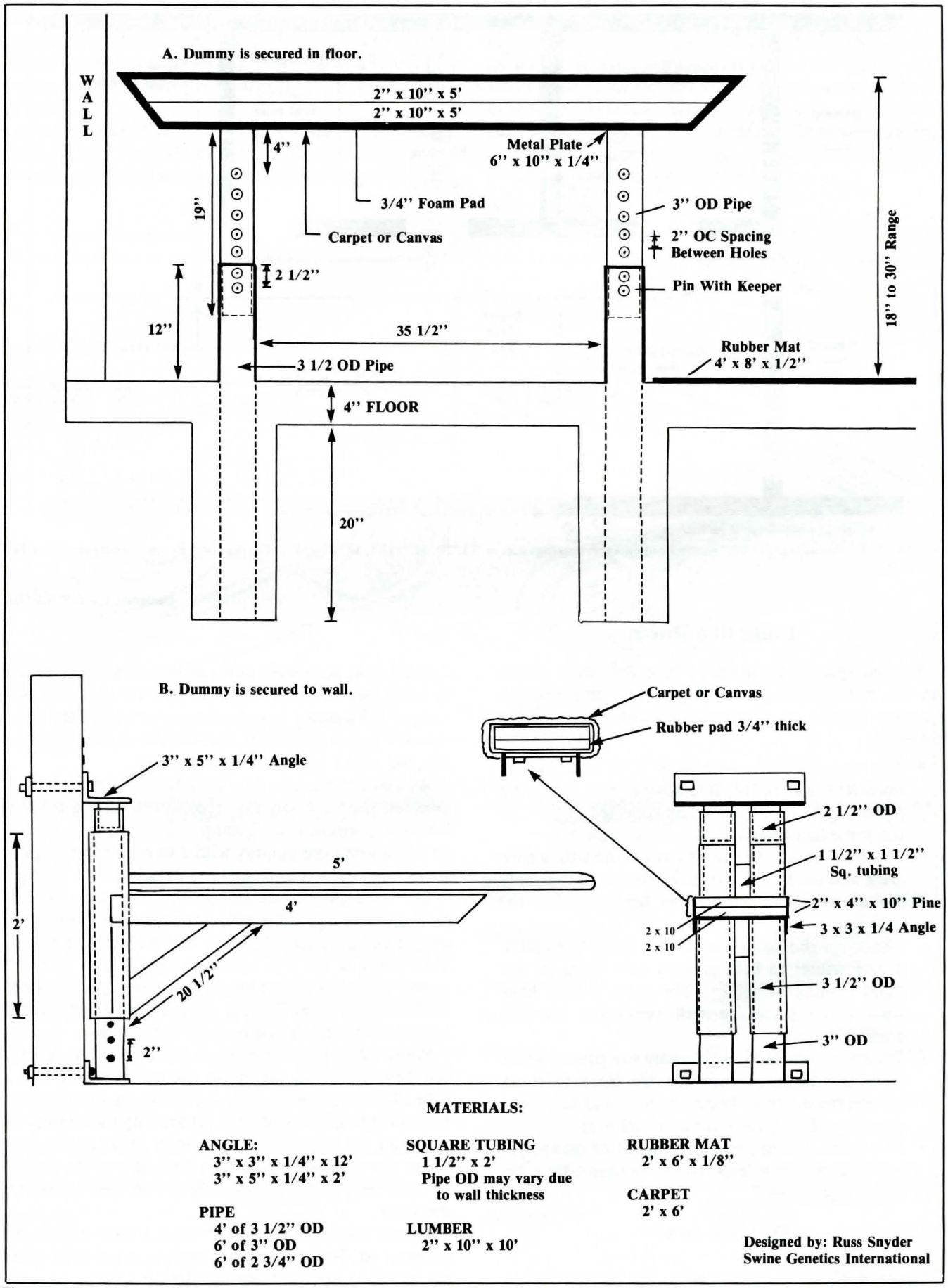


Figure 4. Dimensions for dummy sow.

Training the Boar

Boar Age. The percentage of boars successfully trained to mount a dummy sow varies by age of boar. An English study indicated that 92 percent of boars less than 10 months of age mounted a dummy sow, whereas only 70 percent of 10-18 month old boars were successfully trained to mount a dummy.

The majority of boars can be trained to mount a dummy sow within one to seven days. A few boars will mount the dummy sow at their first exposure, but others require coaxing. It is usually easier to train a boar that has had no sexual contact with females than one that has mated females. Some boars probably never can be trained to mount a dummy, although these are infrequent. Such boars are likely the "shy-breeder" type.

Dummy Height. The proper height of the dummy sow is important. When a boar mounts the dummy sow, his sheath should be below the back of the dummy sow *(Figure 5)*. This is important because a boar can ejaculate himself if he extends his penis and lays on top of it. That is why it is so important to make the dummy sow height adjustable.

Training Procedure. Training a boar for collection of semen requires patience when handling the boar. When training a boar to mount a dummy sow, always handle him quietly and with patience. A boar soon learns to anticipate his treatment in a certain location and situation. A boar mistreated in the collection area is not likely to respond to the dummy.

Every boar being trained to mount a dummy sow needs to be sexually stimulated before exposure to the dummy sow. The following technique is suggested:

- Pour urine, semen, or preputial fluid from a strange, mature boar on the rear of the dummy so a boar can smell it when he approaches the dummy. This technique will be necessary only until boars have been trained to mount.
- Stimulate the boar by exposing him to a strange boar or gilt adjacent to the collection area. When the stimulator boar or gilt is removed from the sight of the trainee boar, they should exit in a manner which leads the boar to the dummy sow.
- If the boar does not mount the dummy, he should be allowed to mount but not breed an estrous sow in the area of the dummy. After he has become stimulated by mounting, remove the sow from the area. Remember to have the sow exit next to the dummy.
- If the boar does not mount the dummy, and there is a boar already trained to mount the dummy, set up a procedure the following day where the trainee can observe another boar being collected from the dummy.
- Expose the trainee boar immediately to the dummy after collection from the trained boar.
- If the trainee does not mount, he should be stimulated and exposed to the dummy every day for three to four days.
- If the young trainee still does not mount, he may need to be trained to associate ejaculation with mounting. Collect the trainee from a sow standing adjacent to the dummy. After two or three collections this way, he may mount the dummy.
- If the young trainee still does not mount, he may be lifted off the adjacent sow and placed on the dummy after ejaculating 1 1/2 to two minutes.
- If the boar still does not mount, try placing the dummy into the boar's home pen. Stimulate the boar after placing the dummy into his pen.
- Once a collection has been made from the boar off of a dummy, the boar should be collected daily for one week, and then once or twice per week for a month. This procedure helps the boar associate the dummy with ejaculation. Once a boar is well-trained, one or two collections per month is probably sufficient.

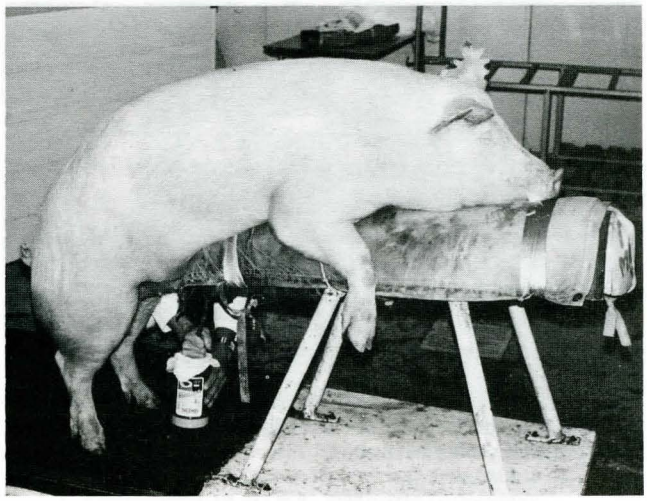


Figure 5. Boar mounted on dummy sow

Collection of Semen

Equipment. The equipment necessary for collecting semen *(Figure 6)* from a boar consists of: 1) disposable latex gloves, 2) a one pint, wide-mouthed thermos or a narrow-mouthed, plastic pint bottle covered with one inch of foam rubber, 3) cheesecloth or sterile gauze pads, 4) rubber bands to secure cheesecloth to collection container, 5) quart size plastic bag, 6) thermometer, and 7) paper towels.

Boar Stimulation. It may be beneficial to stimulate some boars before they are exposed to the dummy sow. This can be accomplished by exposing them to a strange boar across the fence or in an area adjacent to the collection area. Stimulated boars mount quickly and may produce more sperm cells during ejaculation. ***Caution. Be extremely careful when moving stimulated boars.***

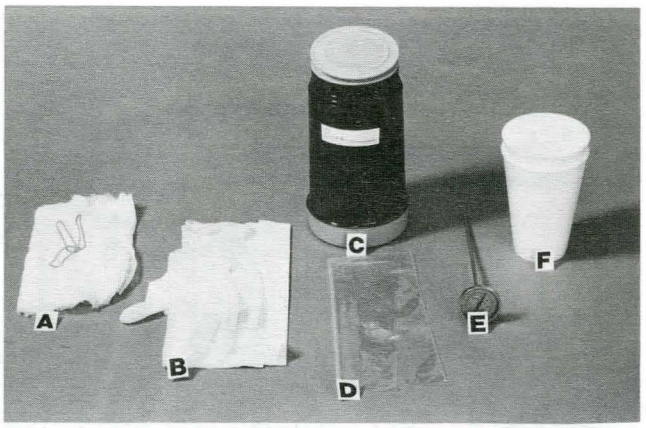


Figure 6. Equipment used for collecting boar semen: a. Sterile gauze and rubber band; b. Disposable gloves and paper towels; c. One-pint thermos; d. Quart-size plastic bag; e. Thermometer; f. Styrofoam cups (16 oz.)

Collection Procedure. When using the wide-mouthed, one-pint thermos shown in *Figure 6,* the bottom cap can be removed and 102 °F water poured around the glass-insulated shell. This procedure helps keep the semen warm during and after collection.

Before collection, place a double layer of cheesecloth (or sterile gauze) over the opening and secure with a rubber band. Leave some slack in the cheesecloth or sterile gauze so it will sag at least one-half inch into the top of the container. This filter removes the gelatinous material, dirt, and other foreign material during collection. After collection, remove the filter and cap the thermos.

With this method, **CAUTION** is advised when pouring semen out of the thermos. Be sure that *absolutely no water* leaks into semen.

To alleviate this problem, some producers put plastic bags inside the thermos before collecting semen. Plastic bags also help control bacterial contamination from the collection thermos.

An alternative to using a thermos is to collect semen in a large styrofoam drinking cup. Two cups need to be stacked together to prevent cold shock of semen *(Figure 6).*

The hand or "digital pressure" method, either with or without a glove, is the most widely accepted and most satisfactory method for collecting semen from boars. The objective of this method is to simulate the cervix in which the penis becomes interlocked during natural service.

Before attempting to collect a boar, ***clip the long hair*** on the sheath because it interferes with collection and may cause bacterial contamination. When collecting a boar, allow the boar to mount and make a few (three to four) pelvic thrusts. During the period of thrusting, seminal fluid and gelatinous material may be ejaculated.

Be sure your hand is warm before touching the penis. When the penis is partially extended, grip the penis with your fingers lightly at first and then firmly. Pressure must be firmly applied on the first and second ridges of the spiral portion. The stimulus for ejaculation is the pressure applied to the spiral portion of the penis *(Figure 7).* Some boars require what seems to be tremendous pressure to stimulate penal extension and ejaculation; others require only slight pressure.

The hand should be positioned so the little finger is near the tip of the penis. As the boar thrusts, the penis should be allowed to extend naturally. It is not necessary to pull.

Many times when the penis is pulled out and downward bacterial contaminated fluids are squeezed out of the preputial diverticulum. Therefore, do not place the penis in the collection container until the clear, watery fluid has been ejaculated.

With full extension, the boar will stop thrusting, obtain a rigid, "locked-on" position, and start ejaculating. The grip should not be loosened during ejaculation because relaxation of pressure on the penis will result in interruption of ejaculation and a return to thrusting by the boar.

The boar always should be allowed to complete the entire ejaculation process. The ejaculation process normally takes five to 10 minutes and produces 200 to 500 ml (gel-free volume) of semen.

Semen Fractions. Ejaculation starts after the thrusting motions are completed. The ejaculation process can be divided visually into four fractions.

- ***Pre-Sperm.*** The first part of the ejaculate (20-25 ml) is a clear, watery fluid with possibly a few gelatinous pellets. This fraction is always discarded.
- ***Sperm-rich.*** The second part of the ejaculate (40 to 100 ml) is a viscous-chalky, milky-white portion containing 80 to 90 percent of the total spermatozoa. Usually the boar emits only one sperm-rich fraction at a collection; however, some boars may ejaculate a series of two or three sperm-rich fractions which are interrupted by seminal fluid emission.
- ***Sperm-poor.*** The third part of the ejaculate (70 to 400 ml) consists of an opaque, chalky-gray fluid

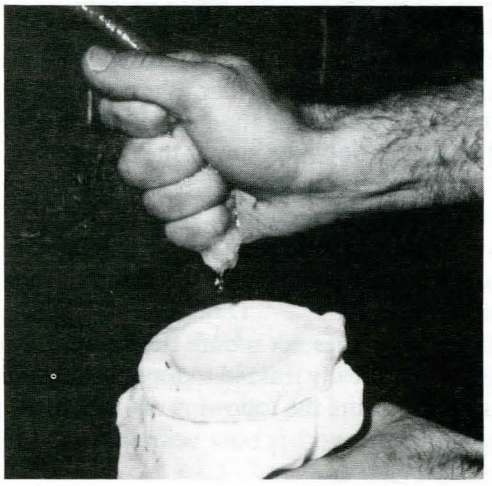


Figure 7. Pressure applied to spiral portion of penis

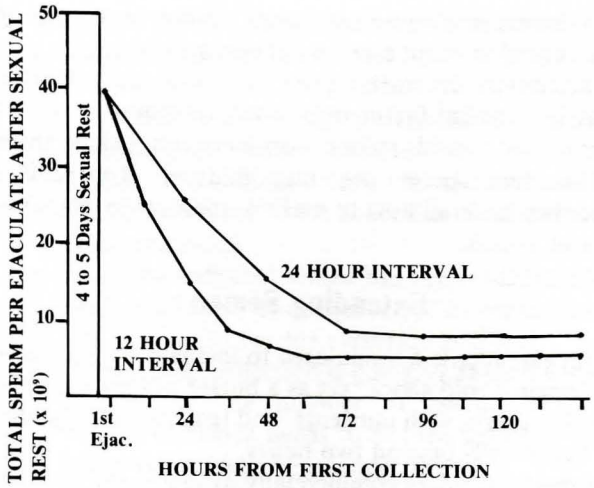


Figure 8. Sperm production at two collection intervals (mature boars, 12+ months old)

mixed with gelatinous pellets. The liquid portion of this fraction is normally collected; therefore, it provides a portion of the dilution volume needed when extending semen. If semen is to be stored and the volume of this fraction is large enough to cause the insemination dose to contain less than three billion live, motile sperm cells, it is not collected.

- *Gelatinous.* The fourth part of the ejaculate (20 to 40 ml) consists of a very sticky substance, which during natural mating plugs the cervix. This fraction always is filtered and discarded.

Collection Frequency. One of the most important parts of an artificial insemination program is the proper collection frequency. The number of sperm cells harvested and the volume of semen collected varies with breed, age, and collection frequency. If boars are collected daily *(Figure 8)* there is a rapid decrease in number of sperm harvested, and the number of inseminations per ejaculate is greatly reduced. *Table I* (see page 19) clearly shows the effect of collection interval on semen volume, sperm concentration, total motile sperm, and number of AI doses available per ejaculation. A similar effect on the above characteristics occurs regardless of boar age or breed.

How often a boar is collected depends on: 1) how many sows are to be bred each day, 2) whether sows are to be multiple bred to the same boar or two different boars, 3) whether fresh and/or stored semen is being used, and 4) the number of sperm cells being produced by a boar.

Adequate semen volume, sperm concentration, and doses per ejaculate are generally provided by boars collected every 48 to 72 hours.

Handling of Semen

The sensitive nature of the sperm cell makes it most important that semen receive the utmost care during collection and handling. Take the following precautions to insure the maintenance of fertility of the sperm cells and prevent low conception:

- Protect sperm cells from extreme heat or cold. Sperm cells are very sensitive to sudden changes in temperature. The collection equipment and all materials used in extending the semen should be at body temperature (102 °F). During cold weather collections should be made inside a building to protect the semen from the temperature.
- Prevent contact with water and harmful chemical agents. Wash and dry the dummy and the boar's underline if needed. Make certain that the collecting, extension, and inseminating equipment and utensils are washed, rinsed, and dried according to instructions.
- Avoid exposing semen to direct sunlight.
- Exposure to air should be minimal.
- Handle semen gently. Stir or swirl. Do not shake.

Semen Evaluation

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

Equipment. The equipment normally used when evaluating and extending semen *(Figure 9)* is 1) one graduated cylinder, 100 ml; 2) two beakers, 600 ml; 3) one thermometer; 4) pasteur pipets, 5 3/4 inches x 7.0mm o.d.; 5) one measuring pipette, 10 ml; 6) microscope (10x eyepiece; 10x and 40x objectives) and slides; 7) slide warming device; 8) stain; 9) a water bath to warm extender.

Additional equipment *(Figure 10)* used when determining sperm numbers include: 1) red cell test, bulk

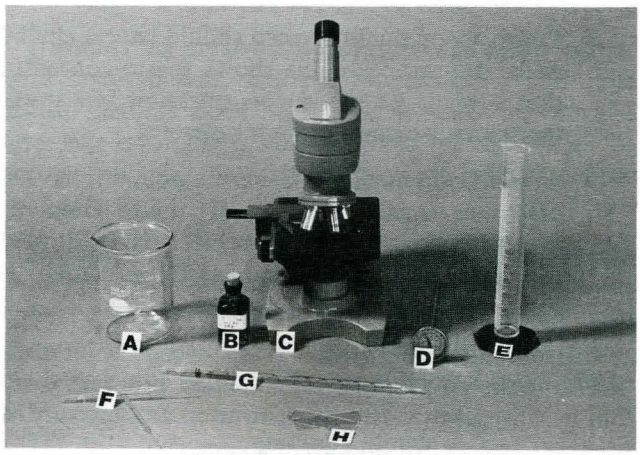


Figure 9. Equipment used for gross evaluation and extension of boar semen: a. Beakers, 600 ml; b. Stain; c. Microscope; d. Thermometer; e. Graduated cylinder, 100 ml; f. Disposable transfer pipets; g. Measuring pipette, 10 ml; h. Microscope slides

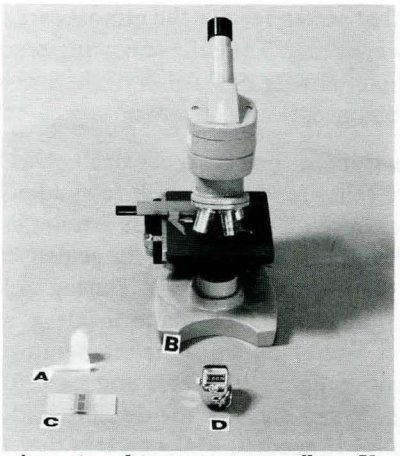


Figure 10.Equipment used to count sperm cells: a. Unopette, red cell test; b. Microscope and slides; c. Hemacytometer; d. Hand tally counter

pac, unopette; 2) hemacytometer counting chamber; 3) hand tally counter.

Evaluation Procedure

Semen evaluation should be conducted as rapidly as possible after collection to insure that the evaluation is representative of the sample as ejaculated and to preserve the original quality of the ejaculate. When evaluating semen, keep in mind whether the sperm-rich fraction or the sperm-rich plus sperm-poor fractions are being evaluated. There is a substantial difference between the two collections in terms of sperm concentration and color.

Gross Examination

- **Volume.** Semen volume should be measured in a prewarmed (102 °F) graduated beaker just prior to being extended or inseminated. The volume normally ranges from 40 to 100 ml for sperm-rich fraction, and from 110 to 500 ml for the sperm-rich plus sperm-poor fractions.
- **Color.** Good quality semen should have a chalky, milky appearance. This shows sperm concentration is high. As sperm concentration gets lower, the semen becomes more transparent.
- **Smell.** Good quality boar semen does not have an offensive smell; however, if fluids from the preputial diverticulum or urine have infiltrated, the semen will have a bad smell and should be discarded.

Microscopic Examination. A microscope is not essential to make an artificial insemination 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 200x up to 400x is needed. Accurate sperm counting requires additional equipment.

A hemacytometer (instrument shown in *Figure 10* that is used to count numbers of sperm cells) 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. *Appendix I* describes in detail how to make a microscope examination of semen.

Extending Semen

An extender is a liquid used to increase volume, protect against cold shock, act as a buffer against high pH, provide sperm with nutrients, and lengthen the viability of sperm cells beyond two hours.

Semen extenders commercially available are presented in *Appendix II.* These extenders can be stored in dry or frozen form until needed. Freezing into cubes or in plastic 125 cc (4 oz.) bottles is a good storage method convenient to use.

Procedure. When using any type of boar semen extender, the extending work should be done in a warm (68-70 °F) room to prevent cold shock to sperm.

Semen to be used for immediate use (within three hours). The average ejaculate from a mature boar collected at 48-hour intervals usually contains a sufficient number of sperm to inseminate five to six females each with three billion motile sperm cells. Usually semen can be extended at a ratio of one part strained semen to three parts extender without any problems. If the number of required inseminations is less than four at the time of processing, do not extend the ejaculate beyond the known number. It is recommended that 80 to 100 ml total volume be inseminated to maximize conception. Any commercial extender can be used to extend the semen to the desired volume.

Before extending the semen, measure the temperature of the ejaculate with a thermometer, and raise or lower the temperature of the extender to within two degrees of the semen. The extender is added to the semen by slowly pouring it down the side of the container. Gently, but thoroughly, mix the two.

If four females are to be inseminated with 100 ml of fresh extended semen, a total volume of 400 ml of extended semen is needed. If the ejaculate contains 100 ml, then 300 ml of extender is added to obtain the required 400 ml for four females. The extended semen now is ready for insemination.

Storing Semen as a Liquid. Artificial insemination with fresh, extended semen should be practiced routinely on a swine operation before using stored liquid semen. Some of the commercial extenders being used for storing boar semen are Kiev, Beltsville Thawing Solution, MR-A, Modena and Insema Aid. Semen is extended in the following manner:

- When using semen extender which has been

frozen, remove the estimated volume of extender from the freezer the previous night so it will be at room temperature the following morning.

- Just prior to collecting the boar(s), check to be sure all equipment used for evaluating and extending semen is available and in an orderly fashion.
- Leave the semen in the collection container while being evaluated.
- After the collected semen has been evaluated and considered to be of adequate quality for insemination it is ready for the extension process.
- If the semen collection is going to be used without determining the number of sperm cells, the volume of semen needs to be measured for calculating the volume of extender needed.
- Measure the temperature of both the extender and semen. Raise or lower the temperature of the extender to within two degrees of the semen.
- Place the calculated volume of semen in the plastic insemination squeeze bottles.
- Add the required volume of extender to the semen by letting it run down the inside of the bottle. If the dilution is more than 1:3, add one-half of the extender and wait 10 minutes before adding the last half.
- Label the semen bottles to indicate boar identification, plus date and time collected.
- If semen is to be stored, it should be allowed to cool to room temperature (70° to 75°F), which takes about two hours. Do not leave semen in a lighted area.
- Semen temperature should be lowered at a rate of one degree per hour. Cooling semen too rapidly causes damage to the sperm. Semen should be placed in a small, topless styrofoam box prior to being put in a refrigerator or a commercial liquid semen storage unit set to maintain the correct temperature for the extender used. Most extenders require a storage temperature of 60 to 65°F. Since temperature varies greatly among refrigerators, check ahead of time to be sure the appropriate temperature can be maintained. The best method to store semen is to purchase a commercial thermostatically controlled liquid semen unit which keeps the temperature between 60.8 to 64.4°F *(Figure 11)*. A high-low thermometer should be kept inside either cooling method.
- Semen bottles should be carefully swirled one to two times daily to resuspend sperm cells and to prevent sperm heads from sticking together.
- Semen can be successfully stored three to seven days (depending on extender used); the highest fertility occurs prior to three days of storage.

Maximum Sperm Utilization. The three semen characteristics that need to be evaluated when extending semen for maximum utilization are volume, sperm concentration and motility. Each insemination dose should contain a minimum of three billion live, motile sperm cells. *Table II* (see page 19) shows an example of how to make the appropriate calculations for maximum sperm utilization.

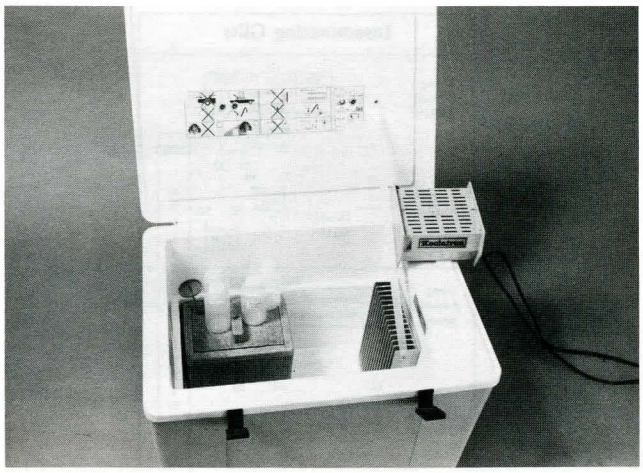


Figure 11. Fresh semen storage unit with power adapter

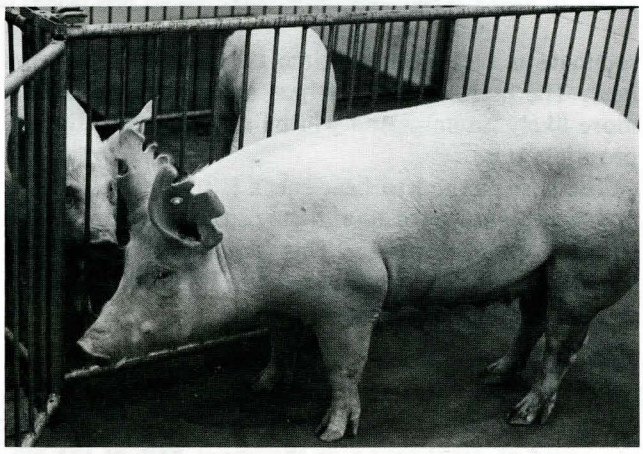


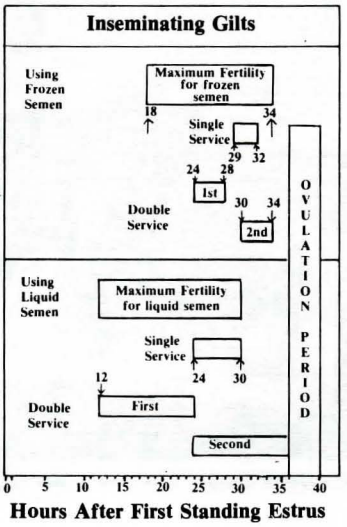
Figure 12. Sow expressing estrus

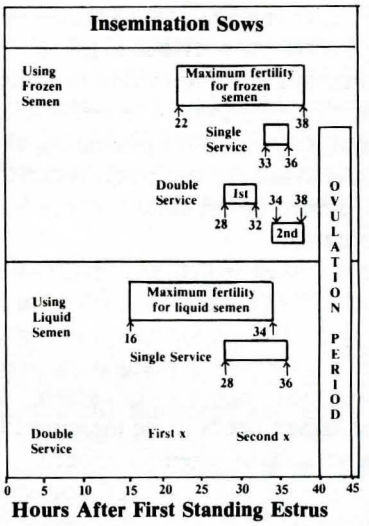
Inseminating Sows

Inseminating the sow is the simplest and easiest procedure involved with artificial insemination. The most critical factor in achieving maximum farrowing rate and litter size is to inseminate females at the right time. To accomplish this, the inseminator must practice proper heat detection.

Estrous Detection. Estrous detection is a simple technique, provided it is done correctly. The normal estrous or heat cycle of pigs is 20 to 22 days in length, but it can range from 18 to 25 days. The average length of standing heat is one to two days for gilts, and two to three days for sows.

The most positive sign that a female is in estrus is the mating stance. This is when the female stands immobile, arches her back, and cocks her ears in response to a boar or back pressure test *(Figure 12)*. This may or may not be accompanied by vulval swelling. The best time to in-





Reference: AI Manual, Swine Genetics International Ltd.

Figure 13. Period of maximum fertility and optimum time (hours) to breed sows and gilts after first standing estrus.

seminate is based on the time the female first shows heat. The more frequently heat detection is done, the more likely insemination will be carried out at the appropriate time.

The best method to heat check is to not allow close boar-sow contact for one to 1 1/2 hours before actual time of heat checking. This separation causes the females to quickly exhibit a strong immobilization response when encountering a boar.

Time of Insemination. The main objective is to time the insemination so the maximum number of active sperm cells meet the maximum number of viable ova at the point of fertilization in the upper half of the oviduct. Maximum ovulation occurs about 30 to 36 hours for gilts, and 38 to 44 hours for sows after first found standing.

For best results, ova should be fertilized as soon as they reach the site of fertilization. The life of a sperm cell is about 24 hours, but a sperm cell has to undergo biochemical changes for about two to three hours before it is capable of fertilizing an ova.

The period for maximum fertility and the optimum time for insemination is different between sows and gilts. Time of insemination is also different when using liquid semen and frozen semen *(Figure 13)*.

Even though we know the approximate time of ovulation with respect to when the female came into standing estrus, we do not know the exact time standing estrus began. For this reason it is recommended that insemination be done at two different times during estrus to insure that one insemination provides viable sperm near the time of ovulation.

Liquid Semen. Since the optimum time to inseminate females often occurs during the night, it is obvious that some deviation from the schedule is necessary. With twice-daily estrous detection it is recommended that gilts be bred at 12 and 24 hours, and sows be bred 24 and 36 hours after first standing estrus. With once-daily estrous detection it is recommended that both sows and gilts be bred every day they stand. If females are in estrus longer than three days, discontinue insemination.

Frozen Semen. Frozen sperm decreases in viability after six hours in the female reproductive tract, so, frozen semen should be inseminated closer to the time of ovulation. Twice-daily heat detection should be the rule, and time of insemination should be performed according to the company directions provided with the frozen semen.

At this time frozen semen is not equal to fresh, extended semen. On the average pregnancy rates are 25 percent lower and litter size is likely to be one to three pigs less per litter.

Equipment. The only equipment needed *(Figure 14)* for artificially inseminating a female is: 1) polyethylene semen squeeze bottle (100 ml); 2) insemination catheter (disposable plastic spiral catheter, plastic swine inseminating tubes, or rubber hog breeding spirette); 3) K-Y jelly; 4) rubber tubing, 5) paper towels, 6) styrofoam box to put semen bottles in for delivery to insemination area.

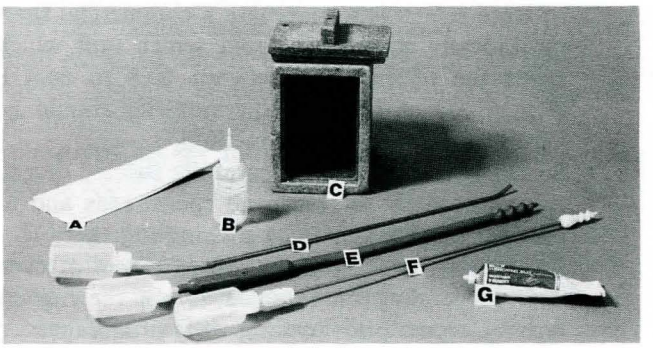
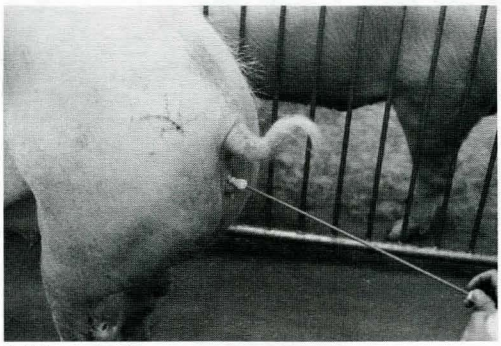
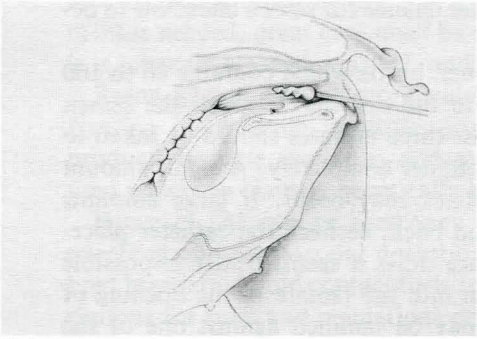


Figure 14. Equipment used for inseminating females: a. Paper towels; b. Plastic inseminating bottles, 100 ml; c. Styrofoam box, 5 1/4" x 7 1/4" x 6 1/2"; d. Disposable plastic inseminating catheter with bent end, requires rubber connecting tube; e. Nondisposable rubber catheter; f. Disposable plastic spiral catheter; g. K-Y lubricating jelly

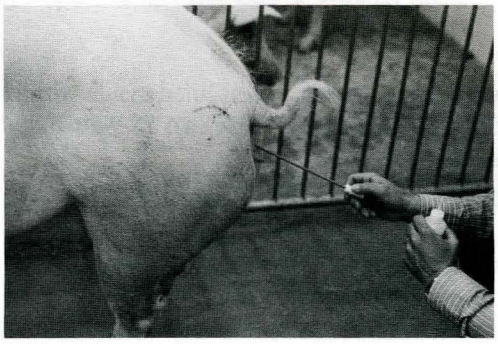


1. Live animal

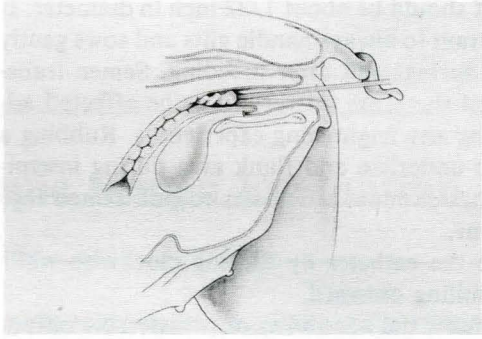


2. Drawing

Figure 15.Insemination catheter entering vagina

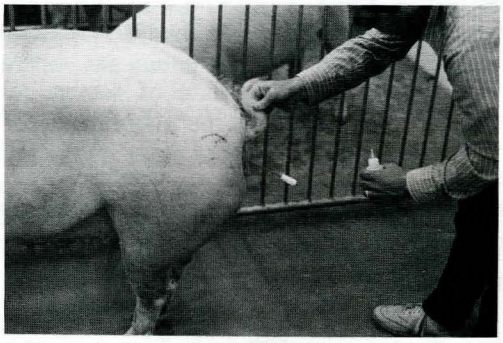


1. Live animal

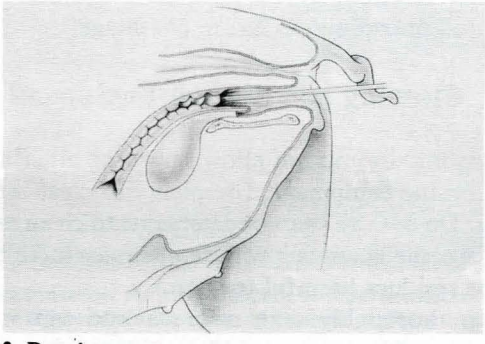


2. Drawing

Figure 16.Insemination catheter entering cervix



1. Live animal



2. Drawing

Figure 17.Insemination catheter "Locked-in" cervix

Drawings courtesy of National Hog Farmer, Fall '88, and Medical Illustrations Department at Purdue University.

Insemination Procedure. Follow these steps when inseminating a female:

- Bring the female to be inseminated to an area where she can smell, see, and/or hear a boar. Apply back pressure to bring about an immobile stance.
- Clean the vulva with a clean paper towel, dampened as necessary.
- Lubrication (K-Y Jelly) of the catheter is necessary when using the rubber catheters, but may not be necessary when using the disposable plastic catheters. Slowly insert the catheter into the vagina, keeping the tip pointed upward to prevent entrance into the ureteral orifice *(Figure 15)*. The catheter should slide easily through the vagina until it reaches the cervix *(Figure 16)*. The cervix is usually eight to 10 inches inside the vulva, but could be deeper in larger 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 catheter cannot be pushed forward any further, begin to turn the catheter ***counterclockwise*** until it will not turn any further (three to four revolutions). Pull the spiral-tipped or spirette catheter back gently towards you to ensure it is properly locked in place *(Figure 17)*. Occasionally, when using a rubber hog breeding spirette, a female will not clamp down on the spirette. This occurs mostly in sows, or if the female is not in heat. The diameter of the plastic bent-tip type of catheter is small enough that the female tract cannot grip it. Consequently,

there is a greater chance for semen backflow to occur.

- Attach the semen bottle which contains 80 to 100 ml of semen to the catheter. Deposit the semen slowly. At least three minutes should be taken to empty the container completely. A small amount of semen runback may occur. If large amounts continue to run back, recheck the catheter placement. There are times it seems nearly impossible to force semen into the female — the opening of the catheter may be jammed against one of the cervical pads or ridges. Work the catheter around and continue. Check the opening of the squeeze bottle; it should be about 1/32 inch in diameter. It is important to always handle gilts and sows gently before, during, and after breeding. Semen transport (and therefore fertility) may be affected adversely by any frightening experiences. Rubbing a female's underline and flank area during insemination has stimulated females to pull semen into the uterus.
- Remove the catheter by turning clockwise while gently pulling outward.
- To eliminate the possibility of transferring pathogenic organisms from female to female, it is recommended that a new catheter be used for each insemination. This is absolutely essential in purebred operations to insure parentage.

Cleaning and Storing Equipment

Following use, do not allow semen or other material to dry on 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 minutes.

When rubber catheters are used, it is desirable to purchase or make a steel container for sterilizing, storing, and transporting catheters *(Figure 18)*. Rubber catheters need to be hanging or laying flat when sterilized. Do not boil in tap water as this will leave a mineral deposit on the equipment.

If you are not able to boil the equipment, a temporary sterilizing method is to rinse thoroughly with 70 percent alcohol. **Do not depend** on the alcohol for continued use since some organisms are immune to its effects. Disposable equipment is recommended to minimize the chances of a breakdown in sanitation, i.e., plastic catheters, insemination bottles, and plastic bags in the collection thermos.

Equipment used for processing and extending semen should be stored in a small, clean cabinet where the temperature can be kept close to 102°F. A small cabinet

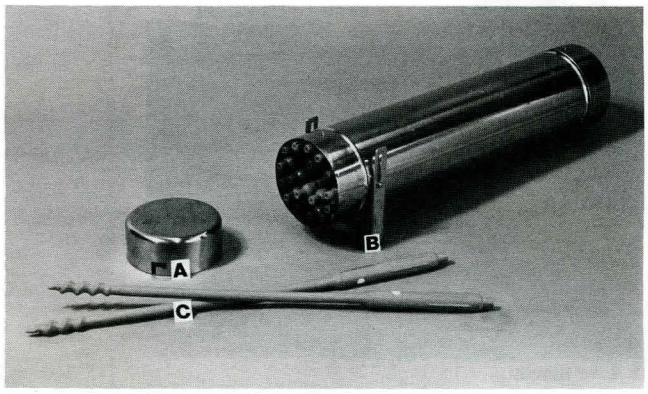


Figure 18. Container for sterilization, storage, and transport of 20 rubber catheters: a. Container cap; b. Stainless steel container; c. Rubber catheters

(24" x 24" x 18") with a shelf lined inside with one inch of styrofoam and wired to use two 25-watt bulbs works satisfactorily.

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. Through records irregular cycle lengths, anestrus and other reproductive problems 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 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 one or two degrees can result in a 60-80 percent decrease in total number of viable sperm for several weeks. The normal body temperature is approximately 102°F — plus or minus one degree F.

Disease Transmission

There is the potential that pathogenic organisms can be transported in both liquid and frozen semen. However, there is less probability of new pathogens moving into a herd with semen transfer than with live boars, provided the boars being used for semen collection have been quarantined, isolated, and tested periodically for a wide variety of organisms.

The disease organisms that can be potentially transmitted in boar semen are shown in *Appendix III.*

Summary

Swine managers must have a genuine desire to use artificial insemination and must be willing to pay attention to all the small details to make it work successfully. Managers must be able to determine estrus accurately.

An AI program should be initiated slowly and should progress as the producer's ability, know-how, and technique improve. A suggested five-step program:

1. Use fresh, non-extended semen.
2. Use fresh, extended semen.
3. Use cooled, extended semen.
4. Use commercially purchased liquid semen.
5. Use commercially purchased frozen semen.

Good equipment and facilities are a must. A small, clean pen inside a building is highly desirable for collecting boars. A clean, warm place is needed for handling and extending the semen. While a minimum of equipment is needed, great care must be exercised to see that it is properly cleaned, washed, and dried.

Swine AI will be used more widely as techniques for freezing boar semen improve, estrus synchronization products become available, and a records program is used widely to identify genetically superior sires.

However, AI can be used very effectively in many purebred and commercial operations at present. Purebred breeders should contact their respective breed associations for rules and regulations on registration of animals sired by AI.

APPENDIX I. Microscopic Semen Evaluation

Semen should remain in the collection container during the microscopic evaluation phase. This allows the temperature to gradually decrease, and helps prevent damage to sperm cells by light and air. **Before removing any semen sample for evaluation, thoroughly mix semen by gently swirling the container.**

I. *Motility* — expressed as percent moving cells. These cells may be moving in any direction and at any speed.
   A. Place a drop of thoroughly mixed raw semen on a pre-heated (98 °F) microscope slide and place a cover glass over it.
   B. Observe the concentrated sample for swirling motion at low power magnification (100x). If the sample is highly concentrated and active, you will see a boiling motion.
   C. Place a drop of thoroughly mixed raw semen on a pre-heated microscope slide and add a drop of physiological saline solution (PSS = 0.9 percent NaCl). Mix the two with a stirring rod and place a cover glass over it.
   D. Observe at 100x to get an overall view.
   E. Switch to 200x or 450x and observe for moving cells by differentially counting 10 sperm, distinguishing between moving (live) and immotile (still) cells. Then quickly move to another area of the slide and count 10 more. Do this 10 times and then total the number of live and dead cells. Number of live cells will then be the percent motility.

II. *Percent Forward Movement* — Expressed on a scale of 1 to 4, with 4 being the best. **Forward** is the key word. Movement in any direction other than forward is not considered. Some sperm swim rapidly in circles, some backwards, and others beat their tails rapidly without forward motion. Only forward counts. This evaluation can be made on the same slide on which the motility estimate was made.

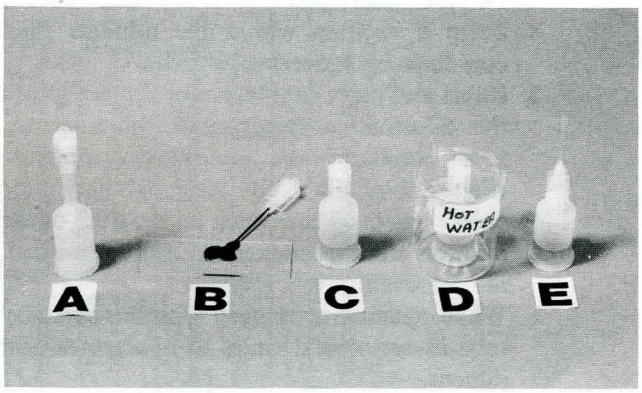


Figure 19. Procedure for using Unopette to count sperm cells: a. Open dilution fluid container; b. Immerse capillary tube in semen (semen colored for clarity); c. Place capillary tube in dilution fluid container; d. Place Unopette in hot or cold water; e. Invert capillary tube. (See Appendix I for details)

III. *Morphology* — Expressed as percent normal cells
   A. Stain the cells with a Rose-Bengal solution [3g powdered Rose-Bengal, 1 ml Formalin (40 percent), 99 ml distilled water].
   B. Place a small drop of thoroughly mixed raw semen and stain one-half inch from one end on a microscope slide and mix thoroughly. After mixing, the slide used to draw out the film should be lowered at a 45-degree angle to the horizontal slide containing the sample and moved forward until the sample is spread even-

ly across the end of the angle slide. The angle slide should be pulled backward until the semen sample spreads out on the horizontal slide. Allow time for the preparation to dry.

C. Count 10 cells in 10 different fields. This is expressed as percent.

D. Abnormal forms — coiled tails, bent tail, cytoplasmic droplet, headless, tailless, short tail.

IV. *Concentration* — Number of sperm cells per unit volume of semen

A. Thoroughly mix semen sample by gently swirling container.

B. Dilute sample as follows:

1. Open dilution fluid container with pointed end of plastic cap used to protect capillary tube during shipment *(Figure 19a)*.
2. Place three or four drops of thoroughly mixed semen on a microscope slide and immerse at an angle the capillary tube of Unopette in semen until tube is full *(Figure 19b)*.
3. Hold capillary tube horizontal and carefully wipe excess semen from the outside of tube. Do not touch open end of capillary tube.
4. Form a vacuum within the dilution fluid container by squeezing on sides.
5. Insert and place capillary tube in the fluid of the dilution container and siphon semen from capillary tube by releasing pressure *(Figure 19c)*. Carefully rinse capillary tube several times by squeezing on the sides of the dilution fluid container to insure all sperm are removed.
6. While opening is plugged with the capillary tube invert several times to mix semen and diluent.
7. Place reservoir in hot or ice water for one minute to kill sperm *(Figure 19d)*.
8. Remove and invert capillary tube *(Figure 19e)*.
9. DISCARD a few drops of diluted semen by squeezing reservoir.

C. Prepare hemacytometer by:

1. Place cover glass over the ruled field of a hemacytometer.
2. Touch the tip of Unopette capillary tube to the angle formed by the cover slip and counting chamber and let one or two drops of the diluted sperm run under the cover glass *(Figure 20)*. **DO NOT let suspension run over into the well surrounding the counting chamber.** Allow the cells to settle for three to five minutes before starting to count.

D. Counting sperm.

1. Locate the counting area under low power (10x) of the microscope and then switch to high power (45x) for counting.
2. Count sperm in five large diagonal squares *(Figure 21)*, which is a total of 80 small squares. Pay attention only to the sperm head, not the tail. Within each large square, count all sperm not touching the triple-lined border; plus, count those touching the top and left triple-line boundary.

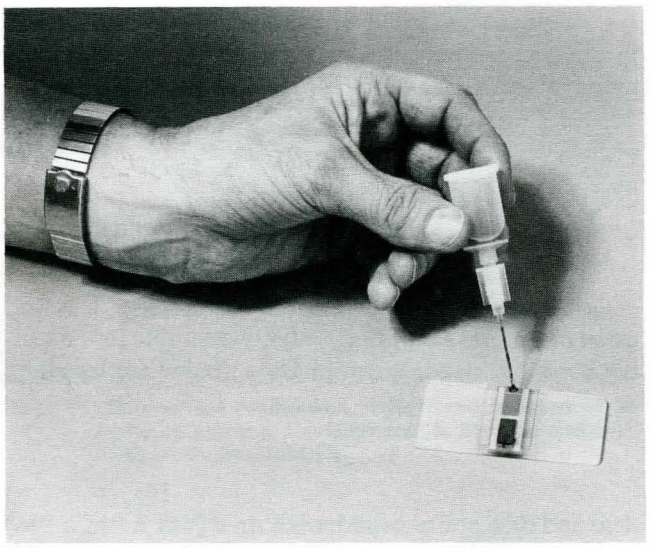


Figure 20. Placing semen on hemacytometer (See Appendix I for details)

E. Calculating sperm cell concentration and total sperm per ejaculation.

1. Add seven zeros to the total number of sperm cells counted in the five diagonal squares. This is the concentration of sperm cells per milliliter of collected semen.
2. The total sperm cells per ejaculate is determined by multiplying the sperm concentration times the milliliters of gel-free collected ejaculate.

F. Example:

1. 100 ml of gel-free ejaculate was collected.
2. 20 sperm were counted in the 5 diagonal squares.
3. 20 sperm + 7 zeros = 200,000,000 sperm/ml.
4. $\frac{200{,}000{,}000 \text{ sperm}}{\text{ml}} \times 100 \text{ ml} = 20 \text{ billion sperm}$

G. Cells other than sperm cells. Disease organisms and phagocytes in the semen may indicate the presence of an infection in the reproductive tract.

V. Semen characteristics of TOTAL EJACULATE (sperm rich plus sperm poor) — The following semen characteristics vary with breed, age, and collection frequency of boar.

Gel-free volume: 110 to 500 ml.

Sperm concentration: 150 to 300 million/ml.

Total sperm/ejaculate: 20 to 120 billion.
Forward motility: 65 to 85 percent.
Morphologically normal sperm: 80 percent.
Color:

1. Chalky, milky appearance — high concentration.
2. Opalescent, watery — **CAUTION:** Concentration is substantially reduced.
3. Pink — Contaminated with blood; **DISCARD.**
4. Yellow - Contaminated with preputial secretions, urine or pus; **DISCARD.**

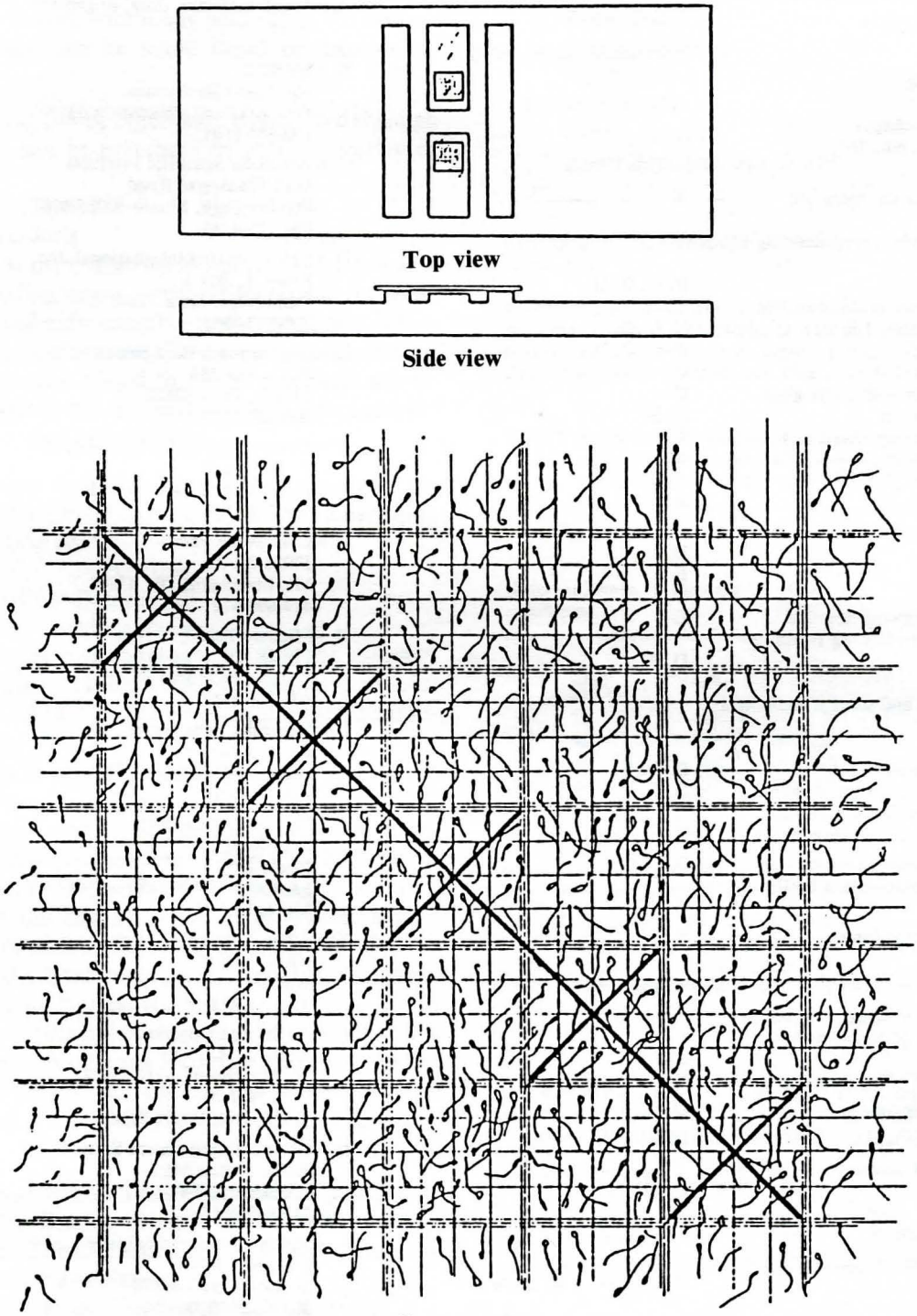


Figure 21. Hemacytometer and center grid

APPENDIX II. Location of Equipment and Supplies

Item	Source
I. Collection equipment	
Dummy sow	Homemade (see *Figure 4*)
Thermos bottle	
Cheesecloth	A (see code below)
Rubber gloves (latex)	
Rubber bands, No. 16	
Paper towels	
Dial-type liquid thermometer	B
II. Semen evaluation and processing equipment	
Microscope	B, C, D, H
Microscope slides and cover slips	C, H
Graduated cylider, 100 ml	B, C, H
Beaker, 600 ml	B, C, D, H
Unopette, Red Cell Test, Bulk Pac	C
Hemacytometer with cover glass	C
Hand tally counter	C, H
Measuring pipette, 10 ml	C
Rose Bengal Dye	N
diSPo Transfer pipets (Pasteur type)	C
Formalin, 40%	A
Semen extenders:	
Kiev-Merck	D, I
Insema Aid	E
Modena	D, I
Beltsville Thawing Solution	E
Styrofoam box (thawing frozen semen)	D, E
III. Insemination and storage equipment	
Catheters:	
Rubber, nondisposable	B, D, E
Plastic with spiral tip, disposable	D, E
Plastic inseminating pipettes, with bent end, disposable	E, F, I
Polyethylene squeeze bottle	B, E, I
Polyethylene wide-mouth bottles, 125 ml	C
Rubber connector tubing	B
Lubricants:	
K-Y jelly	A, B
Storage Unit for liquid boar semen	
Koolatron (p34A) and power adapter	E
Minitub and power adapter	D
Sterilizing equipment	D
Liquid nitrogen tanks	D, E
Styrofoam box (transporting semen to sow area)	D, E
IV. Location of semen	
Frozen semen	D, E
Liquid semen	D, E, I, G, J, K, L, M

V. Location of equipment and supplies.

A = Local hardware, drug, or grocery store

B = NASCO
901 Janesville Avenue
Fort Atkinson, Wisconsin 53538
800-558-9595

C = American Scientific Products
1210 Waukegan Road
McGaw Park, Illinois 60085-6787
800-323-4515

D = Swine Genetics International, Inc.
Route 1, Box 3
Cambridge, Iowa 50046
800-247-3958

E = International Boar Semen
P. O. Box 538
Eldora, Iowa 50627
800-247-7877

F = Contential Plastics Corporation
P. O. Box C
Delavan, Wisconsin 53115
800-323-1056

G = Cole Swine Farms
17006 SR 37
Mt. Blanchard, OH 45867
419-694-4121

H = Midland Scientific, Inc.
1202 South 11th Street
Omaha, Nebraska 68108
402-346-8352

I = Nebraska Boar Semen, Inc.
Route 2, Box 114
Beatrice, Nebraska 63810
402-228-0274

J = Stoney Creek Farms
Boar Stud
Route 2
Farmland, IN 47340
317-468-6099

K = Schenck Breeding Farms
RR 1, Box 67
Waynetown, IN 47990
317-234-2552 or 234-2234

L = Birchwood Genetics
Route 1, Box 130
W. Manchester, OH 45382
513-678-9125
Toll free (800) 523-2536

M = Genetic Improvement Services
Route 3, Box 246
Logansport, IN 46947
219-859-3613

N = Sigma Chemical Company
P.O. Box 14508
St. Louis, MO 63178
800 - 325-3010

APPENDIX III. Potential Diseases Transmitted

Although the potential for disease transfer in semen is not absolutely known with many pathogens, the following classification can be made based on current research.

A. Diseases that can be potentially transmitted through semen but can be prevented by periodic testing of boars:

Leptospirosis	Brucellosis
Tuberculosis	Pseudorabies

Transfer of these diseases in semen can be prevented by isolating boars, periodically testing for these diseases, and only using the boars for semen collection (no natural services). The broad spectrum antibiotics normally added to semen extenders are effective against the bacteria causing leptospirosis, brucellosis, and tuberculosis.

B. Diseases that could be potentially transmitted via semen, although the common mode of transmission is via the oral route:

Parvovirus
Enterovirus
Mycoplasma

Since both parvovirus and enterovirus are common in adult swine, it is important to immunize females before breeding whether by natural or artificial insemination.

Mycoplasmas have been isolated from swine semen on rare occasions. The primary isolates have been M. hyorhinis and several mycoplasmas not recognized as pathogens in swine. Boars with high serum titers to M. hyopneumoniae, indicating prior infection, have not had it isolated from semen. Semen may be contaminated during collection due to aerosolized organisms if precautions are not taken. Even if semen is infected, it is doubtful that it will introduce Mycoplasma infection into recipient animals. A greater concern is contamination of the inseminator's clothing and his equipment, so, the greater risk of transmission is direct animal exposure.

C. Disease organisms that ***should not be present*** in semen ***IF collection is performed under sanitary conditions.*** These diseases are normally spread via oral or fecal transmission.

Bordetella bronchiseptica (atrophic rhinitis)
Hemophilus pleuropneumoniae (HPP)
Hemophilus parasuis (HPS)
Treponema Hyodysentesiae (dysentery)
Transmissible Gastroenteritis (TGE)
Rotavirus
Swine influenza
Erysipelas
Pasteurella
Campylobacter
Eperythrozoon suis (EPE)

Reference for Appendix III: AI Manual, Swine Genetics International, Ltd.

Mention of a trade name, propriety product, or specific equipment does not constitute a guarantee or warranty by the University of Nebraska and does not imply its approval to the exclusion of other products that may be suitable.

Table I. Influence of collection frequency on semen volume, sperm concentration, total motile sperm and number of AI doses per ejaculate

Interval Semen Collected (hr)	Volume (ml)	Sperm Concen. (x 10^6 /ml)	Total Motile Sperm (x 10^9)	AI Doses per Ejaculate
24	116	125	9.7	3.2
48	166	145	16.1	5.4
72	181	150	27.2	9.1
96	221	220	37.0	12.3
120	256	220	45.1	15.0
144	251	200	38.7	12.9
168	239	210	38.1	12.7

16 to 18 month old Welsh boars (Anim. Breed. Abst. 52:817, 1983)
Each dose contains three billion sperm cells.

Table II. Required calculations for maximum sperm utilization

Ejaculate volume:	200 ml	Sperm concentration of ejaculate:	350 million
Sperm motility:	90%	Desired sperm cells per insemination dose:	3 billion
Insemination volume:	100 ml		

$$\frac{200 \text{ ml} \times \frac{350 \text{ million}}{\text{ml}} \times 90\% \text{ Motile}}{3 \text{ billion per dose}} \div 1000 = 21.0 \text{ doses}$$

$$21 \text{ doses} \times \frac{100 \text{ ml}}{\text{dose}} = 2100 \text{ ml total volume of semen}$$

$$2100 \text{ ml} - \frac{200 \text{ ml}}{\text{semen}} = 1900 \text{ ml of extender}$$

Dilution ratio = 1 ml semen to 9.5 ml extender