24 Artificial Insemination

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Objectives

- Discuss the importance of artificial insemination training
- Discuss heat detection and its aids
- Discuss methods of artificial insemination
- Introduce methods of semen handling

Many producers of purebred and commercial beef cattle can profitably utilize artificial insemination (AI) on virgin heifers, on the cow herd, or both. Success with AI requires attention to detail in all areas of herd management. One of the single most important factors affecting the success of a program is the attitude of the manager. They must be focused on making AI work, and must instill this into each link in the management chain. The weakest link sets the level of success of the operation. Should any aspect of management become sub-par, AI conception rates will be reduced, most likely to the extent it will cancel many of the benefits. Many managerial decisions relative to feeding, facilities, fences and corrals, equipment, and sire selection will be necessary. A sound health program and good nutrition are requirements of any breeding program but are absolutely essential for AI. More labor and skill are needed especially in the initial phases of the program.

Learning AI

Without adequate training, valuable AI equipment and semen can be seriously damaged. To ensure high fertility, frozen semen requires very special storage and handling. Adequate training is essential to minimize risk of injury to either a valuable animal or to yourself. AI training schools are available from several semen suppliers. The objective of these schools is to teach the skills required to handle semen, inseminate cows, and manage a successful AI program.

Three basic areas of instruction should be provided by AI training schools.

Insemination technique. AI technique is the ability to skillfully and accurately place semen at the proper location within the reproductive tract using sanitary and correct techniques. It is developed through live animal practice.

Semen handling. The ability to properly handle, thaw, and prepare for semen insemination, according to the recommendations of semen-producing organizations is also developed through practice.

Reproductive management. Management training includes the importance of heat detection, herd health, and total herd management for the development and continued success of an AI program.

The National Association of Animal Breeders (NAAB) is an association of companies that service the AI business. NAAB has recommended minimum standards for AI training schools. Address inquiries to:

Technical Director
National Association of Animal Breeders
P.O. Box 1033
Columbia, MO 65205

A potential student should ask if a school being considered meets the following recommendations:

1. Six hours of live cow insemination practice completed over a minimum of three separate sessions.
2. At least two cows per student per course, with each student having access to a minimum of ten practice cows.
3. A maximum of eight students per instructor.

An AI training school and supervised training is just the beginning. After attending school, continuous practice is necessary to fully develop the required skills.

Heat Detection and Beef AI Programs

The most limiting factor in AI programs is the proper detection of cows or heifers in estrus. Estrus, or heat, is that period of time that occurs every 18 to 24 days in sexually mature, non-pregnant female cattle when they are receptive to mounting activity by bulls or other cows. In beef cattle operations where AI is the means of breeding the females, the herdsman must recognize and interpret a cow's heat signals. Proper timing of the AI is necessary to accomplish a high percentage of conceptions in the cows that are bred artificially.

Considerable amounts of research have been conducted on the various factors contributing to the efficiency with which cows are detected in heat. The key factor is the skill of the human performing the heat detection. With an AI program, people assume the same responsibility as the bull for accurately detecting heat and the proper timing of insemination. Thus, the dilemma for the inseminator is determining which cows are in a standing heat and when that heat occurs.

A cow is fertile only when an egg has been released (or ovulated) from the ovary. This occurs about 10 to 14 hours after the period called standing heat ends. Because sperm need time in the cow's reproductive tract before they are capable of fertilizing the egg, insemination should be made several hours before

ovulation. This means that for highest fertility, cows or heifers should be inseminated in the latter two-thirds of heat or within a few hours after having gone out of heat. This represents approximately 12 to 18 hours after the cow first comes in standing heat.

Heat Detection Efficiency

Heat detection efficiency (rate) is defined as the percentage of eligible cows that are actually seen or detected in heat. Several methods of calculating the efficiency with which heat is detected are available. A detection rate of 80 to 85% should be achievable. The detection rate can be measured by the 24-Day Heat Detection Rate Test, which is a test that the producer can implement to self-evaluate the heat detection efficiency (or inefficiency).

For cows to be included in the test, they should be those eligible to have heat cycles, that is, at least 50 days post-calving for beef cows, not pregnant, and free of reproductive disorders such as cystic ovaries, pyometra, or other reproductive tract infections. Cows must have adequate body condition to cycle (Chapter 15). The goal is a group of cows most likely to display estrus in the next 24 days. Some of these cows will in fact be serviced during that interval, which will exclude them from the next 24-day list. At the end of the 24-day period, the number of cows detected in heat is divided by the total number of cows eligible to have estrous cycles. If the producer observed 50 cows but only 15 were detected in heat in 24 days that is a 30% detection rate, which is not too good! If the producer finds 40 or more cows in heat during the 24 day test period for 80% or better detection rate, then a good AI program is possible.

A second method of self-evaluation of heat detection can be performed by keeping an accurate record of heat dates. The average interval in days between detected heats is divided into the expected interval or 21 days. For example, if the average interval between detected heats for all eligible cows is 25 days, then the detection efficiency would be computed at 21/25, or 84%.

Heat Detection Requires Observation

The surest sign of estrus is that the cow or heifer permits other animals to mount her while she remains standing. Therefore, the most productive means of determining which cows are in standing heat is to observe the cattle carefully for about 30 minutes at least twice per day. More frequent observation may also be beneficial when practical. Estrous synchronization will aid in accurate heat detection and shorten the number of days that heat detection must be done. Learn more about estrous synchronization in Chapter 23 or OSU Fact Sheet F-3163, Estrous Synchronization of Cattle.

The best times of day to observe cattle for heat detection are early in the morning and at the last daylight in the evening. Heat detection while cattle are eating at feed bunks or hayracks is difficult. Hungry cattle are often more interested in the feed than each other. Table 24.1 describes the percentage of cows showing signs of heat at different times of the day.

Table 24.1 –Cows showing heat by time of day.

Time	Percent cows showing heat signs
6 a.m.-noon	22%
Noon-6 p.m.	10%
6 p.m.-midnight	25%
Midnight-6 a.m.	43%

Source: Hurnik et al.

By far the largest percentage of cows exhibits signs of estrus at the least convenient time for accurate heat detection (midnight to 6 a.m.). This is a major cause of heat detection inefficiency. Many of the cows that experience a standing heat from midnight to 6 a.m. can be observed as having secondary signs of heat at the time of normal heat detection on the previous evening. The secondary signs of heat include:

1. A willingness to mount other cows, even though neither cow may be willing to stand for the mount.
2. Roughened tail head or mud on the rump, which is evidence that other animals have tried to mount her.
3. Restlessness, which may be indicative of a cow about to exhibit heat (cows in pre-heat may bawl more than usual, head butt, pace the fence, sniff, or lick other cattle).
4. Clear stringy mucus discharge that may be hanging from the vulva or smeared on the pin-bones or rump of a cow about to have or in estrus. Bloody mucus often appears two to three days after estrus has occurred and should be recorded in order to closely watch for heat in 17 to 21 days.

Aids to Heat Detection

Several aids to heat detection are available for producers with AI programs. These aids include chin-ball markers placed on androgenized cows or deviated gomer bulls. This is a device similar to a ballpoint pen that is strapped on the underneath side of the chin of an animal expected to mount cows or heifers in heat. The ink in the chin-ball marker leaves colorful streaks on the back or rump of a cow that has been mounted or was attempted to be mounted. Another commercially available aid to heat detection is the Kamar™ heatmount detection. This device is glued to the rump (just forward of the tailhead) of cows suspected to be in heat in the near future. Prolonged pressure (at least 3 seconds) from the brisket or chest of mounting animals will turn the originally white detector to red. Using the heatmount detector will be more effective in those pastures with little or no low-hanging tree limbs, brush, or backrubbing devices since false readings can occur.

An economical heat detection aid is used at many U.S. dairies. This method is called tail chalking and involves only the small expense of an oil-based, sale barn paint stick. The paint stick is available at many farm and livestock supply stores and comes in a variety

of colors. Orange is often the color of choice, especially with producers who are colorblind. The chalk (or livestock paint) is rubbed on the tailhead of cows to be heat detected. The chalk should be placed from the imaginary line between the hook or hip bones back to and including the corner where the tail begins its vertical descent.

Some producers choose to chalk in a narrow strip in summer months (after shedding has occurred) and wider bands on winter hair coats. Most tail-chalking veterans put the chalk in a strip two to three inches wide. The length is important because of the different contact points possible when the cow is mounted. In the spring, when cows are shedding, it is imperative that the area be currycombed so the applicator will deposit chalk instead of just rub off winter hair.

Beef cattle producers can tail-chalk cows, at about 50 days after calving while the cows are crowded in a long working chute or alley. Replacement beef heifers could be expected to have a high percentage of cycling animals when they are about 13 to 14 months of age and weigh approximately 65% of their expected mature body weight.

Reading the chalk strip is not hard but does require close observation and some practice. When a cow is just coming into heat and is being ridden but will not stand, the chalk will be slightly smeared. Also, it will often have some of the riding animal's hair in it and the hair and chalk will be ruffled forward, with a feathered appearance. When those conditions are spotted, write down the cow's number and watch her even more closely.

When she is in standing heat and being ridden repeatedly, the chalk will be mostly rubbed off. This cow may have been in standing heat during the previous night. The cow should be watched to see if she does in fact allow other animals to mount her. If so, then she is in standing heat. If the cow is not observed in standing heat but barn records indicate that it is 18 to 24 days since she was last observed in heat or bred, then it is time for the cow to be bred. The rubbed off chalk indicates that she has been in standing heat since last observation and would be a good bet to inseminate.

The oil-based chalk is relatively rain resistant and unlikely to be rubbed off in brush. After a week to ten days, it will take on a flaky, crusted appearance as it dries. Some AI technicians choose to re-chalk cows when the chalk becomes weathered and dried but no signs of riding have been apparent.

Occasionally, a cow will lick off the chalk. Usually, the obvious lick marks on the hair of the tailhead indicate that she had not been ridden.

Tail-chalking and other heat detection aids are tools to aid good heat detection. However, these tools should not be expected to replace the trusted method of spending a half-hour in the morning and a half-hour in the evening each day carefully observing the cattle. Read OSU Fact Sheet F-4154, Heat Detection Aids for Beef and Dairy AI.

The Timing of AI

Maximum fertility for AI occurs when cows are bred near the end of standing heat. Ovulation occurs about 12 hours after the end of standing heat. The 12-hour lead time allows the sperm cells to go through a process known as capacitation by the time the egg is released. Fertility decreases slightly when cows are bred a few hours on either side of this target, and decreases markedly when breeding occurs more than 12 hours away from the end of standing heat.

A guide that has proved to work well for timing AI is called the a.m./p.m. rule (Table 24.2). At the end of the morning heat detection period, animals detected the prior evening are bred; at the end of the evening heat detection period, those observed that morning are bred. In some situations, once-a-day AI must be employed wherein all animals detected in the prior 24 hours are bred. Acceptable pregnancy rates for beef heifers can be achieved with AI between one and 36 hours after the onset of estrus. The usual practice of inseminating cattle approximately 12 hours after first observed standing heat is very adequate. For example, cattle found in estrus in evening and bred the following morning (a.m./p.m. rule). When the onset of estrus is accurately determined by electronic heat detection, AI of heifers at 16 to 20 hours after the onset of standing heat may optimize pregnancy rate (Wettemann et al.).

Table 24.2. Using the a.m./p.m. rule for cow's first show of estrus.

1st show estrus	Should be bred	Too late for best results
Morning	That evening	Next day
Evening	Next morning	After 3:00 p.m. next day

Semen Handling

The quality of frozen semen when it arrives at the farm or ranch is determined by the bull and organization that processed it. Once it arrives, producers must take proper steps to ensure its viability. Frozen bull semen can be stored indefinitely if it is constantly maintained at very low temperatures. The critical temperature is approximately –112°. Semen that is exposed to temperatures warmer than –112° even for a short period of time may be damaged. The extent of damage depends upon how long the semen is exposed to the elevated temperatures. Although it is easy to maintain frozen semen at a safe temperature, it also is easy to destroy it in a few moments of carelessness.

Tank Management

The semen storage tank (Figure 24.1) is a large vacuum-sealed metal bottle with an extremely efficient insulation system. Because of the vacuum bottle construction, the temperature can remain at –320° (liquid nitrogen temperature) as long as at least

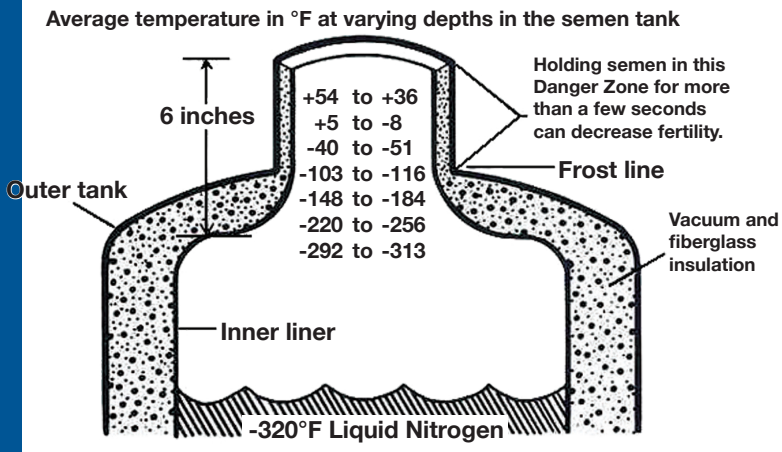

Figure 24.1 – Cross-section diagram of liquid nitrogen tank used to store semen. Adapted from American Breeders Service.

two inches of liquid nitrogen are present. Technical advances in design and construction have produced storage tanks with a liquid nitrogen holding time of six to nine months.

Although semen storage tanks are well constructed, they are still susceptible to damage from mishandling. Semen tanks should be kept in clean, dry, well-ventilated areas. Avoid excessive movement of the tank. The inner chamber, which contains liquid nitrogen, is suspended from the outer shell by the neck tube. Any abnormal stress on the neck tube caused by sudden jarring or an excessive swinging motion can crack the tube. This results in an outer chamber vacuum loss.

To increase holding time, keep the tank in a cool location away from direct sunlight. Avoiding drafts from furnaces and outside air also helps prevent excessive nitrogen evaporation. However, make sure there is sufficient ventilation in the room to prevent possible suffocation caused by excessive nitrogen gas in the air.

Protect the tank from corrosion by keeping it elevated above concrete or wet floors using boards or pallets. Pick a location that is safe from children and vandals, but do not hide the tank. It must be placed where it can be seen daily and where it can be monitored routinely for nitrogen level.

Finally, always be watchful for a lid that is left off and for frost or sweat on the tank. Give particular attention to the neck and vacuum fitting. Frost indicates that the vacuum insulation has been lost and liquid nitrogen has been or is evaporating rapidly. If this has happened, use a wooden yardstick to measure the amount of liquid in the tank. If the tank contains liquid nitrogen the semen must be transferred to a good tank immediately. Should the tank be empty of liquid nitrogen it is doubtful that the semen is viable so it should be evaluated before it is used.

Retrieving Semen

In the typical farm semen tank, dangerous temperatures exist in the upper half of the neck tube (Figure 24.1). Exposure to these temperatures can occur when trying to locate a specific unit of semen or when transferring semen from tank to tank. Thermal injury to sperm is permanent and cannot be corrected by returning semen to liquid nitrogen. To minimize thermal damage, do the following:

1. Identify which canister contains the desired semen. A semen inventory that keeps track of the location of each bull prevents unnecessary searching.
2. Remove the canister from its storage position to the middle of the tank. Raise the canister just high enough in the neck region to grasp the desired cane of semen. Keep the canister tops no higher than the frost line, or keep the tops of the canes no higher than two to three inches from the tank's top.
3. Grasp the desired cane, and immediately lower the canister to the tank floor. Keep the cane as low in the tank as possible while removing the unit of semen. Use tweezers to remove the straw. If the straw is located in the upper goblet, bend back the top tab of the cane to a 45° angle. This will keep the straw from bending or breaking. The straw should be removed within 10 seconds from the time the canister is raised into position.
4. Immediately after the unit of semen is immersed in water, return the cane to the canister by raising the canister up over the cane. Return the canister to its storage position. Anytime it takes more than eight to 10 seconds to locate a particular cane, the canister should be lowered back into the tank to cool completely. Never return a unit of semen to the tank once it has been removed from the cane.

Thawing Procedures

The correct thawing recommendation for semen in straws is not the same for all AI organizations. For optimum results, follow the specific recommendations of the semen processor. However, almost all organizations now recommend warm-water thawing of straws for 10 to 60 seconds.

Breeders may use semen from various AI organizations, but practice only one thawing procedure. The National Association of Animal Breeders recommends that, when in doubt, 90° to 95° for a minimum of 40 seconds should be used as a universal thawing recommendation.

A major concern with warm-water thaw is the danger of cold shock when the straw is mishandled after thawing. Cold shock is the permanent injury to sperm caused by a sudden decrease in semen temperature after thawing. It occurs when semen is thawed and then subjected to cold environmental temperatures before reaching the cow.

The severity of damage depends on rate and span of temperature drop. If precautions are taken to prevent cold shock, the advantage of warm thaw will be realized.

Here are some thawing tips:

1. Always keep insemination equipment clean, dry, and warm.

2. Use a thermometer; do not guess the temperature. Check the thermometer for accuracy at least every six months with a reference thermometer.
3. Use an insulated water bath designed for thawing semen or a one-pint wide-mouth Thermos that is deep enough to immerse the entire straw. Recently, electronic thawing devices have been developed that maintain water temperature accurately between 95° and 98°. These are convenient to use when breeding many cows at one time.
4. Never thaw more than one unit of semen at a time. Cows are bred individually, so units of semen should be thawed individually.
5. Gently shake the straw as it is taken from the tank to remove any liquid nitrogen that may be retained in the cotton plug end of the straw.
6. Time the thaw with a watch to avoid guessing. When possible or practical, use thawing recommendations of the AI organization from which the semen was processed. When not possible, use NAAB's recommendation for 90° to 95° for a minimum of 40 seconds.

During Insemination

One of the most frequent chances for semen damage is during transport to the cow. After thawing, the semen temperature must be maintained as close to 95° as possible. Handling thawed semen and preparing the insemination rod should be done in a sheltered, heated area.

Proper steps for handling are:

1. While the semen is thawing, warm the insemination rod by rubbing it briskly with a paper towel. In cold weather, place the warm rod within clothing so it will be close to the body and maintain warmth.
2. After the semen is thawed for the required time, dry it thoroughly with a paper towel and protect it from rapid cooling.
3. Adjust the air space in the straw to assure that no semen is lost when the end of the straw is cut off. This can be done by slightly flicking the wrist while holding the straw at the crimp sealed end.
4. Transfer the straw to the rod and cut the tip of the crimp-sealed end of the straw squarely and through the air space. Only sharp scissors or a specially designed straw cutter should be used. Make sure to cut the straw square to achieve a good seal with the sheath.
5. Wrap the assembled insemination rod in a clean, dry paper towel, and tuck it within your clothing for transport to the cow. Do not place the rod in mouth or carry it uncovered in hand.
6. Inseminate the cow within minutes after the semen has been thawed. The period of time between removing the semen from the tank and depositing the semen in the cow should not exceed 15 minutes.

Semen Transfer

When transferring semen between tanks, follow these tips:

1. Have the tanks side by side and as close as possible. If possible, fill the tanks with nitrogen before transfer.
2. Have the appropriate canister in each semen tank in the center position.
3. Transfer the canes quickly (within 3 to 5 seconds).
4. Never touch the units of semen with bare fingers.

It is essential that frozen semen be handled and thawed carefully and properly to obtain optimum results. It also is important to deal only with reputable, well-established AI organizations. Their semen has been processed under standard, controlled conditions that are evaluated routinely.

Insemination Process

Although not part of the female genital tract, the rectum or terminal portion of the large intestine is an important organ to become familiar with. An arm inside the cow will be working through this thin-walled tube.

The rectum is 10 to 12 inches long and very stretchable. That is important because it is through the rectum that the cervix will be manipulated.

The anus serves as a valve between the rectum and the outside. It is made up of a circular purse string muscle located directly under the skin. It surrounds the very end of the rectum. The anus is stretchable so a hand and arm can easily slip into the rectum.

Circular muscle contractions move along the rectal wall toward the outside. When strong, these contractions may block hands from moving forward and make it difficult to manipulate the genital organs through the rectal wall.

Semen Placement

The insemination process is quite straightforward. However, since relatively few sperm cells will be used, their placement is critical. The semen should be placed in the body of the uterus just in front of the cervix (Figure 24.2). The proper site can be recognized by the change in tissue consistency from firm and hard in the cervix to soft and spongy in the uterus. To achieve the highest possible fertility rate, semen should be deposited at the very front end of the cervix. The internal or front end of the cervix is often called the anterior cervical os. Depositing semen at this location requires the use of a special device called Cassou pipette, or AI gun. The recto-vaginal insemination process is used. The inseminator places a hand in the rectum and manipulates the reproductive tract so that the gun passes through the vagina, is manipulated through the cervical rings, and is held at the internal opening of the cervix for semen deposition. In adequately restrained cattle, this will take 30 seconds to two minutes. At first, however, passing an insemination syringe might not be

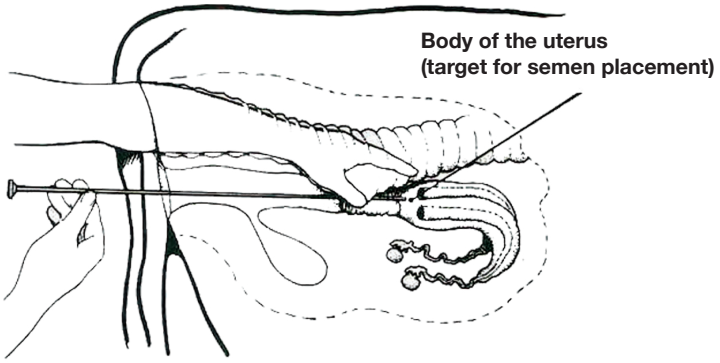

Figure 24.2 – Proper placement of insemination gun to deposit semen in the body of the uterus. Adapted from American Breeders Service.

easy because natural obstructions might be encountered on the way to the target. Beware of obstacles. The front end of the vagina forms a circular blind pouch where it joins the backward projecting cervix. This blind pouch is usually from 0.5 to 1 inch deep, surrounding the entire dome-shaped back end of the cervix.

Other obstacles will be met once inside the cervical canal. Firm, finger-like projections arranged in three to four circular rings extend into the canal. These cause the passageway to be crooked and contain blind pockets or dead ends. The circular blind pouch of the vagina and the winding cervical canal with its dead ends are the two major stumbling blocks for anyone learning how to artificially inseminate.

Next to estrous detection, semen placement error by the technician is most likely to affect fertility. Correct semen placement is very difficult to confirm in the field. It is impossible to check pipette placement as it changes too easily. Postmortem tracts or examining culled cows inseminated with dye can be used to check semen placement after slaughter. Studies using dye deposition followed by slaughter have shown that up to 70% of cows are inseminated incorrectly. The dye was placed in the vagina, posterior cervix, uterine horn, or bladder. The target for semen deposition is the anterior cervical os, a difficult site to find. Inexperienced inseminators often do not pass the pipette far enough or they pass it too far into the uterine horns. Since the body of the uterus is only one to two cm in length, pipette passage 1 to 2 cm into the uterus results in most of the semen entering only one horn, effectively reducing conception. Semen deposition is often made too rapidly, and semen takes the avenue of least resistance. If one horn is not as open as the other, it does not receive enough semen. Inseminators should take time while breeding a cow and depositing the semen as it only takes a few extra seconds to make sure semen is deposited correctly. The plunger should be depressed over a five-second period, allowing the semen to flow slowly and evenly, divided between horns. In non-pregnant cows, walls of the uterus are soft and spongy. Inseminating syringes should never go beyond the front end of the cervix because it is too easy to poke into or through the uterine wall. This could cause infection and perhaps even fatal peritonitis.

Sanitary Technique

Wash hands often. Inseminating cows is an invasion into the delicate uterine environment that is very conducive to growing bacteria. Bacteria on hands could be transferred to the inseminating gun during the loading procedure. If carried into the uterus during insemination, these organisms could thrive and grow rapidly resulting in metritis and infertility.

Using Technicians

Professional technicians are more successful at insemination than inexperienced owners or managers. Inseminators should periodically attend AI courses to improve or correct techniques. Selection of a qualified inseminator is an important element in the success of the AI program. While the insemination process is simple to understand, it requires considerable manipulative skill. Semen-selling companies conduct three- or four-day training programs, which will provide individuals with sufficient skill to begin inseminating. However, recently trained individuals generally experience lower conception rates until they have inseminated a number of animals. Regular practice at inseminating is required to maintain high conception rates. In many localities, AI companies have trained inseminators who provide insemination service for a reasonable fee. Cattle operations where AI is routinely used often have a well-trained individual who may be available as a technician. Those deciding whether to hire a trained technician or to train a member of the farm team should weigh the considerable cost of a reduced conception rate during the learning process against the fees paid to a trained technician.

Conclusion

When used properly, AI can be a profitable engagement for producers. The manager's attitude is important to the success of any AI program. AI requires someone who has been trained and who has performed AI many times in order to be successful and profitable.

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