



Artificial Insemination in Dairy Cattle¹

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Artificial insemination (AI) is a process by which sperm are collected from the male, processed, stored and artificially introduced into the female reproductive tract for the purpose of conception. AI has become one of the most important techniques ever devised for the genetic improvement of farm animals. It has been most widely used for breeding dairy cattle and has made bulls of high genetic merit available to all.

HISTORY OF AI

The history of AI is interesting. Old Arabian documents dated around 1322 A.D. indicate that an Arab chieftain wanted to mate his prize mare to an outstanding stallion owned by an enemy. He introduced a wand of cotton into the mare's reproductive tract, then used it to sexually excite the stallion causing him to ejaculate. The semen was introduced into the mare resulting in conception.

Anthony van Leeuwenhook, inventor of the microscope, first observed human spermatozoa under magnification. This finding led to further research. Spallanzani is usually considered the inventor of AI. His scientific reports of 1780 indicate successful use of AI in dogs.

In 1899, Ivanoff of Russia pioneered AI research in birds, horses, cattle and sheep. He was apparently the first to successfully inseminate cattle artificially. Mass breeding of cows via AI was first accomplished in Russia, where 19,800 cows were bred in 1931. Denmark was first to establish an AI cooperative association in 1936. E.J. Perry of New Jersey visited the AI facilities in Denmark and established the first United States AI cooperative in 1938 at the New Jersey State College of Agriculture.

The AI industry has grown tremendously in the United States since its beginning. In 1970, USDA reported that 7,344,420 dairy females were bred artificially, 46% of the female dairy cattle population.

ADVANTAGES AND DISADVANTAGES OF AI

The greatest advantage of AI is that it makes possible maximum use of superior sires. Natural service would probably limit the use of one bull to less than 100 matings per year. In 1968, AI usage enabled one dairy sire to provide semen for more than 60,000 services. Exposure of sires to infectious genital diseases is prevented by use of AI which reduces the danger of spreading such diseases. Time required to establish a reliable proof on young bulls is

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reduced through AI use. Other advantages include early detection of infertile bulls, use of old or crippled bulls and elimination of danger from handling unruly bulls.

There are a few disadvantages of AI which can be overcome through proper management. A human detection of heat is required. Success or failure of AI depends on how well this task is performed. AI requires more labor, facilities and managerial skill than natural service. Proper implementation of AI requires special training, skill and practice. Utilization of few sires, as occurs with AI, can reduce the genetic base. The AI industry and dairy cattle breeders should make every effort to sample as many young sires as possible.

COLLECTION, EXTENSION AND STORAGE OF SEMEN

One obvious factor which determines degree of success of AI is the quality of the semen used. Much has been learned about factors affecting semen quality and methods of evaluation and means of maintaining quality through lengthy storage. The commercial AI industry has a tremendous responsibility to sell only high quality semen. Unquestionably, they are fulfilling this obligation.

Collection of Semen

Several methods of obtaining semen have been developed. The artificial vagina method is most widely used today for the collection of bull semen. The bull is allowed to mount a teaser cow and ejaculates when the penis is directed into the artificial vagina. The artificial vagina consists of a firm cylindrical tube with a thin-walled rubber lining. The jacket formed is filled with warm water. A rubber funnel connected to a collection receptacle is attached to one end of the cylinder. When the jacket is properly filled and the artificial vagina lubricated and properly applied, this method of semen collection is highly successful.

Cleanliness must be practiced to avoid contamination and deterioration of semen quality. Proper and careful treatment of the bull is essential to bring about adequate pre-collection stimulation which

will increase quantity and quality of semen obtained.

Obviously the collection of semen from a bull is a specialized skill and should be attempted only by those with the proper equipment, training and experience. Adequate facilities for controlling the bull and teaser animal must be maintained so that danger of injury to personnel as well as the animals is minimized.

Semen Extension

The main reason for extending (diluting) semen is to increase the number of females serviced from one ejaculation. A normal ejaculate from a dairy bull will contain 5 to 10 billion sperm which can be used to inseminate 300 to 1000 cows if fully extended.

There are several good semen extenders. Those made from egg yolk or pasteurized, homogenized milk are two of the most widely used. A good extender not only adds volume to the ejaculate but favors sperm survival and longevity. Dilution rate depends on quality of the ejaculate--number of sperm cells, percent alive and mobility. As few as 12 million sperm per insemination have given good conception rates.

Penicillin and streptomycin are added to semen extenders. These antibiotics inhibit bacterial growth and reduce danger of spreading diseases such as vibriosis.

Semen Storage

The discovery that bull semen could be successfully frozen and stored for indefinite periods has revolutionized AI in cattle. In 1949, British scientists discovered that addition of glycerol to the semen extender improved resistance of sperm to freezing. Glycerol acts to remove water from the sperm cell prior to freezing and prevents the formation of cellular ice crystals which would damage the sperm. There are two methods of freezing and storing semen: dry ice and alcohol (-100 degrees F) and liquid nitrogen (-320 degrees F). Liquid nitrogen is preferred because there is no evidence of fertility deterioration with age. Fertility gradually declines in semen stored in dry ice-alcohol.

Frozen semen can be stored indefinitely if proper temperature is maintained. A recent report told of a calf born from frozen semen stored for 16 years. Fresh, liquid semen can be successfully stored for 1 to 4 days at 40 degrees F.

Semen is usually stored in glass ampules. Other methods appear promising, particularly the French-straw. Several AI organizations have gone to this method exclusively.

Artificial coloring is frequently added to semen extenders in order to distinguish one breed from another. Complete identification of the bull is required on each individual semen container.

ARTIFICIAL INSEMINATION TECHNIQUES

The technique of inseminating a cow is a skill requiring adequate knowledge, experience and patience. Improper AI techniques can negate all other efforts to obtain conception. Semen must be deposited within the tract of the cow at the best location and at the best time to obtain acceptable conception rates.

Early methods of AI involved deposition of the semen in the vagina, as would occur in natural mating. Those methods are not satisfactory. Fertility is low and greater numbers of sperm are required. Another method which gained popularity was the "speculum" method. This method is easily learned, but proper cleaning and sterilizing of the equipment is necessary, making it more impractical to inseminate than with the rectovaginal technique which is the most widely used AI method today.

In the rectovaginal technique a sterile, disposable catheter containing the thawed semen is inserted into the vagina and then guided into the cervix by means of a gloved hand in the rectum. The inseminating catheter is passed through the spiral folds of the cow's cervix into the uterus. Part of the semen is deposited just inside the uterus and the remainder in the cervix as the catheter is withdrawn. Expulsion of the semen should be accomplished slowly and deliberately to avoid excessive sperm losses in the catheter. The body of the uterus is short; therefore, care should be taken not to penetrate too deeply which

might cause physical injury. In animals previously inseminated, the catheter should not be forced through the cervix since pregnancy is a possibility. Since research data show little variation in conception rates when semen is placed in the cervix, uterine body or uterine horns, some people recommend incomplete penetration of the cervical canal and deposition of semen in the cervix.

The rectovaginal technique is more difficult to learn and practice is essential for acceptable proficiency but the advantages make this method of insemination more desirable than other known methods. With practice, the skillful technician soon learns to thread the cervix over the catheter with ease. If disposable catheters are used and proper sanitation measures are followed, there is little chance of infection being carried from one cow to another.

Timing of Insemination for Maximum Conception

A frequent question concerning AI is: What time during estrus should cows be bred for greatest chance of conception? Since estrus may last from 10 to 25 hours there is considerable latitude in possible time of insemination. Much research work has been conducted on this subject.

Controlled investigations were conducted by Trimberger and Davis at Nebraska in 1943. These and other studies show that conception rate is lower when cows are bred prior to midestrus or later than 6 hours after cessation of estrus (standing heat in this case). Maximal conception is obtained when cows are inseminated between midestrus and the end of standing estrus, with good results up to 6 hours after estrus.

A practical recommendation for timing of insemination is given in Table 1.

Success in insemination timing is dependent upon a good heat detection program. In large herds, this means assigning individual responsibility for heat detection and a continued education program for labor. A successful heat detection program and subsequent proper timing of insemination will pay dividends in increasing reproductive efficiency.

Table 1. Proper timing of insemination.

Cows showing estrus	Should be Inseminated	Too late for good results
In morning	Same day	Next day
In afternoon	Morning of next day or early afternoon	After 3 p.m. next day