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Artificial Insemination Techniques and Equipments of Cattle

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Abstract: 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 rationale of conception. Artificial insemination (AI) is an important technology for improving animal production. Through reliable use of AI, herd genetics can be advanced at a rapid rate. While AI is a technology that enables the dissemination of selected male genetics, embryo transfer (ET) is a technology that enables the dissemination of selected female genetics and, by using ET, frozen embryos can be moved around the world at significantly reduced costs compared to movement of adult animals. 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. AI is widely practiced in cattle and semen is collected from selected bulls in a hygienic environment. One obvious factor which determines degree of success of AI is the quality of the semen used. A careful selection of bulls ensures high quality specimens both from the reproductive and physical point of view. The technique of inseminating a cow is a skill requiring adequate knowledge, experience and patience.

Key words: Artificial Insemination · Cattle · Equipments · Techniques

INTRODUCTION

Artificial insemination (AI) is the manual placement of semen in the reproductive tract of the female by a method other than natural mating. It is one of a group of technologies commonly known as "assisted reproduction technologies" (ART), whereby offspring are generated by facilitating the meeting of gametes (spermatozoa and oocytes). ART may also involve the transfer of the products of conception to a female, for instance if fertilization has taken place in vitro or in another female. Other techniques encompassed by ART include the following: in vitro fertilization (IVF) where fertilization takes place outside the body; intra cytoplasmic sperm injection (ICSI) where a single spermatozoon is caught and injected into an oocyte; embryo transfer (ET) where embryos that have been derived either in vivo or *in vitro* are transferred to a recipient female to establish a pregnancy; gamete intrafallopian transfer (GIFT) where spermatozoa are injected into the oviduct to be close to the site of fertilization in vivo; and cryopreservation, where spermatozoa or embryos, or occasionally oocytes, are cryopreserved in liquid nitrogen for use at a later stage [1].

AI is widely practiced in cattle and semen is collected from selected bulls in a hygienic environment. Two types of semen are commonly used: Liquid or room temperature (RT) semen and Deep frozen (DF) semen usually distributed in containers filled with liquid nitrogen which helps to keep the semen in deep frozen condition. Artificial insemination (AI) is a key technology that can be used for improving animal production. Through consistent use of AI, herd genetics can be advanced at a rapid rate using semen from sires selected based on expected progeny differences (EPDs) or selection indexes targeted to improve various traits including weaning weights, growth rates, slaughter weights, milk production, physical type as well as maternal longevity and production efficiency.AI has been used in the majority of domestic species, including bees and also in human beings. It is the most commonly used ART in livestock, revolutionising the animal breeding industry during the 20^{th} century [2].

AI is the first great biotechnology applied to improve reproduction and genetics of farm animals. It has had a vast impact worldwide in many species, particularly in dairy cattle. The acceptance of AI technology worldwide provided the momentum for developing other

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technologies, such as cryopreservation and sexing of sperm, estrous cycle regulation and embryo harvesting, freezing, culture and transfer and cloning. New, highly effective methods of sire evaluation were developed. The history of development of AI is reviewed, mainly in dairy cattle, in which the impact on genetic improvement and control of venereal diseases has been greatest. Other species briefly included are swine, horses, sheep, goats, dogs, rabbits, poultry and endangered species. Major landmarks in AI development are cited, along with the people most closely associated with these developments.

Many of these pioneers helped to develop a new generation of reproductive physiologists and biotechnologists. A bit of the flavor of the times is included, along with the historical facts. Many of the references will take the reader back to an era before electronic networks were available, so these citations of classical studies will not be found with the press of a key on the electronic keyboard [3].

AI is a technology that enables the dissemination of selected male genetics; embryo transfer (ET) is a technology that enables the dissemination of selected female genetics. In this way, productive genes carried by dams can be more rapidly spread within a population by having less valuable dams carrying offspring of elite females instead. In addition, through the use of ET, frozen embryos can be moved around the world more easily and safely compared to movement of postnatal animals [4]. The main objective of this paper is to review artificial insemination techniques and equipments of cattle and to and understand advantages and disadvantages of AI

History of Artificial Insemination: 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 and then used it to sexually excite the stallion causing him to ejaculate. The semen was introduced into the mare resulting in conception. Undocumented tales exist of Arabs obtaining sperm from mated mares belonging to rival groups and using the sperm to inseminate their own mares. However, the story starts with recorded history, where facts are available to document noteworthy achievements. Consequently, the story is related chronologically. The developments that made AI the most important animal biotechnology applied to date include improved methods of male management and semen collection, evaluation, preservation and insemination. Detection of estrus and control of the estrous cycle in the female also were important. The development of AI is a remarkable story of tireless workers dedicated to the pursuit of knowledge, to the replacement of fiction with facts and the application thereof. Dairy cattle will be emphasized because AI has had the greatest genetic impact in that species. Other species overviewed include swine, horses, sheep, goats, dogs, rabbits, poultry and endangered species [2].

Artificial Insemination: 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. Artificial insemination allows for maximum use of the most valuable breeders and, at the same time, for significant increase of breeding advance. 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. High reproductive performance is an essential requirement to ensure maximum livestock production and satisfactory economic return. AI promotes genetic and economic gains through the use of superior genetic bulls [2].

Despite the technological advances of AI programs, the implementation of AI programs based on estrus detection is hampered mainly by postpartum anestrous and estrus detection (ED) failure [5]. These difficulties are aggravated when working with *Bos indicus* breeds because they exhibit estrus of shorter duration than *Bos Taurus* or with high producing dairy cows because milk production is inversely proportional to estrus duration and reproductive performance of dairy cows [6].

AI is the first generation of ART, which has been in use for more than 200 years. As a modern technology, AI with fresh or frozen semen has been the most successful and efficient reproductive technology in animal production for the last six decades. The primary reason for implementing AI is to gain access to sire genetics that would be too expensive to get from a live bull. It has been suggested that AI and other forms of ART could be useful for genetic conservation and preservation of rare breeds. Many of these technologies have been successful to some degree in a research setting, but none have produced results sufficient to effect population-wide improvements in genetic management [7].

Semen Collection: One clear factor which determines degree of success of AI is the quality of the semen used. In most domestic animals, semen is collected by means of an artificial vagina, for example, bull after allowing the

male to mount either an estrous female or a phantom. The artificial vagina consists of a lubricated liner inserted into an outer jacket, the space between the two being filled with warm water. The force can be increased by adding air. The ejaculate is deposited into an insulated collecting vessel attached to one end of the liner [1].

Selection of Bull: A careful selection of bulls ensures high quality specimens both from the reproductive and physical point of view. This includes requirements concerning physical fitness, condition of genital organs, semen and sexual behavior. The physical fitness of a bull is evaluated in the standing position and in motion on hard ground, both in young and in mating specimens. Special attention should be paid to the position of thoracic limbs, pelvic limbs and the hoof build. Pelvic limbs are of basic importance for copulation efficiency because during mounting they take over the weight of the bull. Physical fitness is also necessary to evaluate. An analysis of the jump on adummy female or a teaser is therefore performed [8].

Semen consists of spermatozoa contained in a watery fluid known as seminal plasma that represents the combined secretions of the different accessory glands, such as the seminal vesicles, bulburethral gland and prostate. The relative contributions of these different glands vary between species [9].

Bulls are ready for semen collection and freezing procedures after they have passed a complete physical examination, the required health tests and a breeding soundness evaluation [10].

Artificial Vagina (AV): This method is used almost exclusively in AI centers for practical reasons and because it produces physiological semen samples. Bulls for semen collection require an AV temperature of 42 - 50°C. AV pressure is also an important factor for obtaining ejaculates of optimum quality [10].

Transrectal Massage: This technique requires two people, one to do the massage and one to collect the semen. The bull is held in a chute. After removal of feces from the rectum, a longitudinal back and forth massage is applied mainly over the ampullae, drawing semen toward the pelvic urethra. The semen collector must collect the cloudy fluid into a warm receptacle as it dribbles from the penis or prepuce [10].

Electro Ejaculation: Electro ejaculators are designed to stimulate the pelvic sympathetic and parasympathetic nerves with pulses of low voltage and amperage to induce penile erection and ejaculation [1].

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 [10].

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 [8].

Heat detection is often the most limiting factor in an AI program. Proper timing of insemination depends largely on effective heat detection and is critical to achieve high conception rates. A working knowledge of estrous synchronization is also valuable for most AI programs. Because of the challenge of heat detection, estrous synchronization protocols involving a fixed-time insemination have been developed. In the absence of using an estrous synchronization protocol, many producers rely on the "AM/PM rule" to decide when to AI cattle. According to this rule, females first observed in heat in the morning should be inseminated that evening. Similarly, females first observed in heat in the evening should be bred the next morning. Proper heat detection is important when using the AM/PM rule. Waiting until the next day to breed a female observed in heat in the morning is too late for good results [10].

The goal of any synchronization program is to group animals so they enter into the same physiological state as simultaneously as possible. Artificial insemination (AI) is a reproductive method that allows cattle producers to use sires that have superior genetics at an affordable price.

Part of a successful AI program is estrus synchronization, which typically involves administering a series of hormones to induce a group of cows or heifers to be fertile at a chosen time period, which makes it easier to determine when the cows are in heat. The most common failure of estrus synchronization and AI programs is poor attention to detail. Make sure that the shelter extends far enough beyond the semen handling and cattle insemination areas so blowing precipitation will not cause problems [1].

Ai Supplies and Equipments: Supplies and equipment needed or useful for AI programs include these:

- Bull semen
- Semen storage tank
- Liquid nitrogen
- Insemination rod
- Electronic thawing device or insulated water bath
- Plastic obstetrical sleeves
- Thermometer
- Obstetrical lubricant
- Timer
- Paper towels
- Straw-cutting device
- Record-keeping supplies
- Future trends in AI

It is extremely probable that the use of AI in livestock will continue to increase. AI not only facilitates more effective and efficient livestock production, but can also be coupled to other developing biotechnologies, such as cryopreservation, selection of robust spermatozoa by single layer centrifugation and sperm sex selection [1, 11]. Advantages and disadvantages of artificial insemination

AI in animals is originally developed to control the spread of disease, by avoiding the transport of animals with potential pathogens to other animal units for mating and by avoiding physical contact between individuals. The use of semen extenders containing antibiotics also helped to prevent the transmission of bacterial diseases [1]. The advantages and disadvantages of AI are.

Advantages:

- AI helps prevents the spread of infectious or contagious diseases, that can be passed on when animals are in close contact or share the same environment;
- The rate of genetic development and production gain can be increased, by using semen from males of high genetic merit for superior females;
- It enables breeding between animals in different geographic locations, or at different times (even after the male´s death);
- Breeding can occur in the event of physical, physiological or behavioral abnormalities;
- AI is a powerful tool when linked to other reproductive biotechnologies such as sperm cryopreservation, sperm sexing;
- AI can be used in conservation of rare breeds or endangered species.
- One bull can be used to inseminate many cows
- Selective breeding is possible (according to the farmers' objectives)

Disadvantages:

- Some males shed virus in semen without clinical signs of disease ("shedders").
- Some bacterial pathogens are resistant to the antibiotics in semen extenders or can avoid their effects by forming bio-films;
- There has been a decline in fertility in dairy cattle and horses associated with an increase in AI;
- The focus on certain individuals may result in loss of genetic variation.

CONCLUSIONS

From this review concluded that artificial insemination (AI) is the first important and great biotechnology applied to improve reproduction and genetics of farm animals in the world either for dairy cattle or beef production. Artificial insemination techniques require adequate knowledge and experience. The most important factor which determines degree of success of AI is the quality of the semen used; the semen quality is poor artificial insemination is failed. Heat detection is often the most limiting factor in an AI program. Artificial insemination requires different equipments; without any equipment it is not possible. Artificial insemination is important even the potential bull is died because the semen is collect before the bull death. Therefore, artificial insemination is the best method to improve the livestock genetics due to this reason any participant like researcher and higher education organization should be done new innovation about artificial insemination techniques; to improve technician skill and give short and long training for farmer to detect the heat stress.

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