Use of Assisted Reproductive Technologies for Livestock Development

Vikrama Chakravarthi. P and N. Sri Balaji*

Natural Remedies Pvt. Ltd,
Bangalore-100, Karnataka, India
* Corresponding author e-mail: nbalaji@naturalremedy.com

Abstract

Genetic improvement of farm animals is a prime concern over the years for researchers. Several reproductive technologies have been employed to achieve this. Assisted reproductive technologies like Artificial insemination, Superovulation, In vitro Fertilization, Embryo Transfer have been introduced to overcome reproductive problems, to increase the offspring from selected female's and to reduce the generation intervals in farm animals. The progress achieved during the last few years in the assisted reproductive technologies field has been phenomenal. Artificial Insemination (AI) is the most effective method being used for the genetic improvement of animals. Reproductive capacity and efficiency has been improved tremendously since the introduction of artificial insemination. The development of cloning using various cells from the animal body has created opening of a fascinating scientific arena. These technologies have been propounded as saviors of indigenous livestock breeds. These alternative reproductive techniques are available not only for manipulation of reproductive processes but also proven to be powerful tools in curbing the spread of vertically transmitted diseases. The successful reproductive technologies such as AI and Embryo transfer need be applied on a large scale, emerging biotechnogies such as MOET, IVF and Cloning provides powerful tool for rapidly changing the animal populations, genetically. This advanced reproduction technologies will definitely play an important role in the future perspective and visions for efficient reproductive performance in livestock.

Key words: Oestrus Synchronization, AI, Cloning, MOET & IVF

Introduction

Livestock sector is one of the growing industries which contribute major income to the dairy farmers across the country. Today this sector contributes around 25 % of Agricultural GDP. For the successful growth of this sector the dairy animal must be productive in its life term in order to yield maximum returns to farmer. Failure of reproduction can leads to great economic loss in livestock industry. The majority of this loss occurs because cows do not become pregnant during a defined breeding season. High reproductive efficiency in livestock is economically a very desirable characteristic but it s suboptimal due to 1) Failure of Oestrus cycle/Anoestrus.2) Infertility 3) Poor detection of Oestrus cycle.

In order to make the animal as better productive population, the science has given so many novel reproductive techniques viz. Synchronization of Oestrus, Multiple ovulation (Super ovulation), Embryo transfer, Invitro fertilization and Cloning which are all important potential tools for reproduction improvement in livestock.

Accurate detection of oestrus is one of the keys for successful reproduction and can be performed by close observation of the animal for oestrus signs or using teaser bulls or use of ultrasound technique or measurement of hormonal levels. The detection of oestrus is somehow not possible in case of buffaloes rather than cattle due to the common condition called 'silent heat' which is more pronounced in former. So, regulation of oestrus is one of the potential tools for overcoming this kind of reproductive problem.

Oesturs Synchronization

Synchronization of oestrus is one of the ways to regulate the oestrus signs detection. In oestrus synchronization the manipulation of the bovine oestrus cycle results in standing oestrus in majority of animals, within a short period of time. It is a very effective method to increase the proportion of animals that are bred at the beginning of the breeding season. If the oestrus synchronization protocol needs to be successful then it requires to synchronize the follicular waves and/or luteal regression.

Synchronization allows increased use of artificial insemination with the use of sires having superior germplasms. Oestrus is synchronized by using

PGF2a, GnRH and controlled Intravaginal Drug (Progesterone) Releasing device (CIDR).

There are no. of methods have been followed for the Oestrus Synchronization Programme. The following methods are commonly used in India.

1) Using PGF2a Injection: Here, two injections of PGF2a should be given at 11 days apart in cyclic females. Detection of estrus is not usually required before or after injections. All cyclic animals will respond to the second injection regardless of what stage of the oestrus cycle they were in when the first injection was administered.

2) Oestrus Synchronization using GnRH-PGF2a-GnRH protocol: In this method, the cyclic animals irrespective of any day of oestrus cycle were subjected to GnRH-PGF2a-GnRH protocol of oestrus synchronization. This protocol program calls for an injection of GnRH on day 1 followed by an injection of PGF2a on day 8 and a second injection of GnRH on day 10. The insemination recommended on day 11. The advantage of this program is it encourages oestrus in non cyclic females that are atleast 30 days postpartum.

3) Oestrus Synchronization using CIDR: The basic protocol involves placing the CIDR (Controlled Internal Drug Release -Progestin impregnated plastic devices) into the vagina for seven days and giving an injection of PGF2a on day 6 of implantation and observing the occurrence of oestrus on day 8.

Advances in Artificial Insemination

It has been practiced on a worldwide scale for more than half century years. It is still the major technology available for improvement of farm animal's reproductive efficiency. The opportunity for genetic improvement through progeny testing and breeding programmes would be extremely limited without AI for widespread dissemination of semen from superior sires at a reasonable cost. Reports from several species suggest that seminal plasma contains factor that may influence male fertility. These studies are generally based on comparisons of seminal plasma composition between males of differing fertility or the isolation of factors from seminal plasma that facilitate or inhibit sperm capacitating, fertilization or related events. Fertility associated antigen in seminal plasma appear to be value in predicting small differences in relative fertility among males. In recent years with the technological breakthrough and emerging concepts, fertility associated antigen in semen are focused to enhance the fertility. Bulls with identical semen quality in terms of physical assessment vary in actual fertility. The capability to identify bulls on the basis of fertility potential could result in higher pregnancy rates, leading to larger calf crops. Sperm collection and AI have been improved by the advent of sperm sexing, or selection of sperm carrying an X (Female) or Y (male) Chromosome. It is possible now to predetermine the sex of calves with 85%-95% accuracy by sexing sperm (Garner, 2001). Development of an effective and simple method for producing animals of the desired sex is economically desirable for livestock producers.

Multiple Ovulation and Embryo Transfer (MOET)

A cow normally produces only one egg per oestrus cycle (which lasts 21 days) and the gestation period is 40 weeks. On average, a cow produces only 2-3 calves in her lifetime. Thus, without intervention, the rate at which a particularly desirable cow can be used to improve the genetic status of a herd is slow. Smith (1988a,b) introduced the concept of MOET and demonstrated how well designed MOET programmes could led to increased selection intensity and reduced generation intervals, resulting in improving genetic gains. Embryo transfer is now commonly used to produce artificial insemination sires from high proven cows and bulls (Bondec, 1989)

Recent advances in techniques for embryo transplantation are revolutionising the rate of genetic improvement. The essential stages are as follows:

- Donor cows of good pedigree animals are treated with hormones (FSH and LH) to increase the number of eggs released at ovulation - multiple ovulation (MO).
- Then the cows are artificially inseminated using semen from a proven bull.
- After 6-7 days the embryos are flushed out non-surgically, using a catheter placed into the uterus. This is possible because, in cattle, there is a delay in embryos becoming implanted in the uterine wall. On average, 4-7 embryos are collected.
- The embryos may then be implanted into recipient cows whose oestrus cycle is at the correct receptive stage-usually as the result of hormonal manipulation.
- Embryos may be frozen and stored, using techniques similar to those applied to semen, (though precise control of the regime is somewhat more critical).

Significant progress has been made in methods of recovery, storing and implanting cattle and buffalo embryos (including hormone applications) in several countries of the world. It has been initiated and about 10 % genetic gains are achieved in cows. In India MOET and protocols of ET technology are being standardized in cattle, buffalo, sheep, goat, camel and other species of animals. Embryo transfer has the potential to bring about genetic improvement twice as fast as AI alone.

Invitro Fertilisation (IVF)

The first IVF followed by birth of offspring was achieved in the rabbit (Thibault, 1954). The first calf after IVF was born during 1981. Here, unfertilized eggs are fertilized in the laboratory and cultured for a few days until they have developed into early embryos. These are then transplanted, using a special long syringe, into the uterus of the recipient cows that are at the correct receptive stage of the oestrus cycle. The technique has been greatly improved, now. Obviously, it is possible to choose the egg and semen from high quality parents. The recovery of eggs from the oviduct requires surgery. The eggs to be used may be fully mature ones, recovered after ovulation, from the oviduct of a super ovulated cow.

Cloning

Animal Cloning is the process by which an entire organism is reproduced from a single cell taken from the parent organism and in a genetically identical manner. This means the cloned animal is an exact duplicate in every way of its parent; it has the same exact DNA.

Cloning happens quite frequently in nature. Asexual reproduction in certain organisms and the development of twins from a single fertilized egg are both instances of Cloning.

The biggest breakthrough in cloning came in 1996, when Ian Wilmut and his Colleagues produced the sheep by using a cultured adult somatic cell with an enucleated oocyte. The main application of cloning is for expending the use of genetically superior animals. Such animals of high merit, male or female can be selected for cloning based on any desirable trait, including milk production, growth, feed efficiency or disease resistance.

Cloning process involves removing the chromosomal DNA from mature oocytes and replacing it with a cell from the donor animal to be cloned. The donor cell is then fused with the enulected oocyte and activated either chemically or within an electrical pulse to induce activation and reprogramming of the somatic cell genome to that of an embryonic genome. Reconstructed cloned embryos are then cultured and viable embryos are transferred to synchronized recipients which carry the live cloned offspring, until parturition.

References

1. Bondoc O.L. (1989): *Anim.Breed.Abst*.57: p 819-829.
2. Garner, D.L. (2001): *J.Androl.*22: p 519-526.
3. Smith C. (1988a): *Theriogenology*.29: p 203-212.
4. Smith C. (1988b): *World Anim.Rev*.65: p 2-10.
5. Thibault C (1954): *Comptes Rendus de la Societe de biologie*, 9-10: p 789-790.

* * * * * * * *