Manipulation of reproduction in animals

Introduction

Animals are an important source of high protein in food, leather and fibre which we humans have been using since ancient times. In India, milk products and milk have become an inherent part of civilization. Even in a small festival, demands of milk products and milk increases as several food items and milk based sweets are prepared. However, the milk demands could not keep pace with milk production. To meet these milk demands synthetic milk and milk products were sold in the market illegally. Due to excessive use of synthetic milk, it was reported that several infants have lost their lives.

Compared to plants, the production of food from animals is not very expensive and not very exhaustive. The most common farm hoofed animals are sheep, cattle, goats and pigs, but the management of these animals is expensive due to their expenses on nutrition, shelter and management. Biologically, there are several similarities yet animals differ from plants mainly in their reproductive system such as number of gametes i. e: Ova, completion of life cycle and production of various products.

Through biotechnological methods discovered, there has been an improvement in:

1. The reproductive system of animals,
2. Their milk products and
3. Milk proteins.

In Animals, fertilization takes place which is the fusion of two gametes (ova, from females and sperms, from males). Thus fusion takes place of two nuclei

from two gametes. This is how sexual reproduction maintains the genetic traits of organisms. The demand of animal products is increasing due to the progressive population; hence there is a need to increase the number of animals using biotechnology because the process of increase in number of animals naturally, is slow.

Naturally, a female mammal produces a single egg in a month (except pigs). Moreover, ruminant females can conceive only once in a year. Biotechnology helps to reduce the gap between the demand and supply.

Artificial Insemination

A Spermatic animal produces millions of sperms everyday, thus theoretically, he can inseminate females to produce many offspring’s. This capacity of males needs to be utilized with the help of new technologies for artificial insemination.

Artificial insemination has been the most effective factor in increasing the productivity of cattle. However, to ensure the effective use and productivity of artificial insemination, the breeder has to ensure that the ovulation of all the female in herd is at the same time, whereas if the breeder waits for the ovulation of a single female and then artificially inseminate her then the economic significance will get reduced. Hence, the technology of artificial insemination can be used to inseminate a number of females by a single male.

a) Semen and its storage: Methods have been developed to obtain semen from male by ejaculation. The ejaculated semen is collected and diluted. The sperm motality and their number per milliliter are examined. In about 0. 2ml

Bull semen contains some 10 million motile sperms. This diluted sperms may be used fresh within a few days or cryopreserved at -192 ^{o} C with liquid nitrogen. This cryopreserved semen can be easily stored and also is transported across the states and countries. Hence, cryopreserved semen from a single male has the capability of inseminating many females of a country or other countries e. g.: a single ejaculate from a bull is sufficient to inseminate of about a 500 cows.

b) Ovulation Control: It is difficult to find out the rut (sexual heat) in many animals as it lasts only for a few hours and mostly occurs at night. After ovulation (which is indicated by the rut) females are inseminated. If herds of females are inseminated at the same time then it would be economical, easy and a much simplified management. But this practice will be effective only when almost all the females ovulate at the same time, however practically getting the rut synchronized is not possible. Moreover, ovulation can possibly be bought about in around 80% of the females using hormones such as progesterone and/or prostaglandin. These are the hormones which regulate the ovulation cycle of female and thus result in total synchrony of the rut.

c) Sperm Sexing: The gametes, sperms in males and ova in females are produced in testis and ovary respectively. Both sperm and ova contain half of the chromosomes as compared to somatic cells. An ovum contains autosomes and one X chromosome. Similarly, autosomes and one Y chromosome is present in a sperm. In animals sex is determined genetically by sex chromosomes. Females have two X chromosomes whereas males will have an X and a Y chromosome.

The demand of females is more in dairy industry as they have more desirable characteristics. The livestock industry also prefers animals of only one sex. The X and Y chromosomes can be detected through artificial insemination technology and thus the sex of the progenies can be determined accordingly.

A fluorescent dye (Hoechst 33342) stains X and Y chromosomes with different intensities. This is how these two chromosomes can be separated by using fluorescent activated cell sorter also known as FACS. The FACS converts a suspension of sperms into microdroplets where each droplet consists of a single sperm cell. These individual microdroplets passes through a laser beam where at different intensities there are deflected into separate collection tubes as the fluorescence of dye is measured electronically. The sperms separated by using FACS hve recently been used and pre-sexed calves have been produced though invitro fertilization technique. Moreover, FACS is very expensive and slow. It takes about 24hrs to process one semen ejaculate, whereas the sperm cannot remain viable for a long time. Therefore, more refinement in technique is required for its use on a large scale.

Embryo Transfer

The first case of developing pregnancy in rabbits through embryo transfer is known in literature during around 1890. The same method was used in goat and sheep in 1930’s. Cases of embryo transfer were reported after 1950 in cattle’s (BIOTOL series, 1992). High cost, technical difficulties and limited supply of embryo from superovulated donors are some difficulties make embryo transfer method less widely used. the womb of the foster mother

(recipient) simply acts as incubator to the embryo and does not make any genetic contribution to the offspring

Moreover, ruminant female carries a single pregnancy at a time as only one single egg is produced and fertilized with the male’s sperm. Therefore, there is a chance of increasing the number of ova (egg) production at a time and transfer of the fertilized eggs i. e. embryo into the uterus of a less important foster mothers other than original female in farm animal.

a) Multiple Ovulation (superovulation): The ovarian cycle of ruminant females is such that only one single ova is released at a time. In different animals, the time of ovulation differs like16 days in sheep and goat, 21 days in cows and horse. Circulation of gonadotropic hormone leads to normal ovulation but the number of egg production increases by increasing the concentration of the hormone. About 8-10 eggs are ovulated at a time in a well managed cattle, the number of eggs may increase upto 60. However, all these things depend upon various factors such as nutrition, health, breed of animals and the environment in which they live.

The current practice of multiple ovulation and superovulation has been reviewed by Price (1991). This technique has been widely used in goats, deer’s, sheep, cattle, and horses. He has given emphasis to certain points such as:

1. general selection for increase in the size of the litter isuseful only in sheep.
2. superovulation is induced by gonadotropic hormone in sheep, goats and cattle but the response varies.

3. the litter size in sheep can be increased by immunizing them against ovarian steroid hormones.

Therefore, in farm animals the FSH i. e. follicle stimulation hormones of different molecular forms should be characterized.

The females are induced for superovulation after injecting the gonadotrophin hormone. About 20 ovarian follicles are induced during the follicular phase i. e. second phase of oestrous cycle. The ovarian follicles grow and gets filled with fluid. These fluid filled follicles are known as antral follicles. Normally, only a single follicles develops and releases a single egg after maturation. The follicles, before ovulation appears to be large sized eg. 15mm in cattles. By laproscopy, immature oocytes are surgically recovered from the follicles of the donor females.

To develop synchronized oestrous in females which are to be superovulated, are frequently injected with prostaglandin F2alpha (PGF2alpha). After 10 days of oestrous these females are injected with FSH hormone for 4 days. Thereafter , PGF2alpha treatment is implemented.