ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 5, Issue 2, August 2015

Multiple Ovulation Embryo Transfer (MOET) - Nucleus Breeding Scheme: A Review

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Abstract--The main aim of animal breeder is to improve the productivity per animal genetically in the shortest possible time with the little cost. The rate of genetic improvement had been low in developing countries like India because of many reasons like non availability of sires of high genetic merits in required numbers, lack of infrastructure facility for artificial insemination (AI), small size of farmers herd, high cost of data recording and data processing. Principles of genetic improvement of livestock form the basis of different types of selection programs such as progeny testing and nucleus breeding schemes. These may operate within individual herds among a group of cooperative farmers. MOET-ONBS breeding scheme is an alternative to traditional breeding system for genetic improvement of livestock.

Key words- **Artificial insemination, MOET, Nucleus breeding scheme.**

I. INTRODUCTION

In small holder sector where no progeny testing and Artificial Insemination facility exist, breeder should adopt cooperative/group breeding system. In these, number of interested farmer record their herd, select the best female and send them to one unit forming nucleus. This nucleus could be managed by farmers committee and was kept open for highly productive females. Selected males were used as replacement in the cooperating farms. So, the maximum rate of gain was achieved when 5- 10 % of total number of breeding animals was kept in the nucleus. The group of farmers was agreeing to pool their high performing animals. The best males were kept for breeding in nucleus while other selected males were given to the base herds for breeding. So, improvements were quickly spread throughout the group. The nucleus remains open to animals from the base herds, the best females from the latter being admitted periodically and compared with those in the nucleus. Usually, only females were transferred from the base to the nucleus since sire selection will not be practicable in base herds due to managerial reasons. The main advantage in the nucleus schemes was genetic superiority of sire replacements coming into the base herds from nucleus was far greater than what was achievable in each of the base herds. These nucleus breeding system propagate to improve livestock. The nucleus breeding systems may be closed or open depending on the direction of gene flow. With the development of cooperative group breeding system there was interest in open nucleus breeding system in sheep industry (Roden, 1994). In India a breed of livestock was kept at organized/institute farm known as organized herds and kept by farmers known as commercial herds or village herds which were very small to extend of 1-2 animals per farmer but collectively the village herds constitute more population of animals of a breed. An organized herd under progeny testing system programmes was treated as single herd but under nucleus breeding system the herd was divided in 2 groups *viz*., Nucleus and Test herd (multiplier). The nucleus herd was constituted of elite females of total herd. The aim is to maximize the genetic gain in nucleus herd to pass on to multiplier herds and village herds. Thus, the genetic gain achieved in nucleus herd was passed on from nucleus to multiplier then to village herds. As flock size is small and variety of cooperative effort can be made for establishing a sizable nucleus population so that 2-3 % annual genetic progress achieved.

Nucleus breeding scheme

A typical breed structure consists of 3 tiers in the shape of pyramid. Nucleus tier consist of herds that breed their own male and female replacement. But in some cases, they may be occasionally importing a sire/dam from another nucleus herd. A nucleus herd has created which entirely used for production of males for breeding in the population. So, the nucleus herd has constituted of elite females of high genetic merit and size of about 10-15% top ranking females of total herd. Nucleus breeding system which may be closed or open depends on direction of gene flow. Once the breed structured established, the replacement stock for nucleus population were either bred entirely within nucleus in which nucleus has closed and genes can only move in one direction from nucleus to base. Otherwise, replacement may be selected from both nucleus and base born animals in which case nucleus said to be open and there were two way flow of gene (Roden, 1994).There are two types of nucleus breeding scheme A) Closed Nucleus Breeding Scheme (CNBS) and B) Open Nucleus Breeding Scheme (ONBS)

A) Closed Nucleus Breeding Scheme (CNBS)

There was one way flow of genes, downward from top to bottom. This means that the only source of collective genetic progress in the commercial at the top of the pyramid in the nucleus populations. As no genes flow into nucleus tier, rate of inbreeding increased and overall genetic gain change this system called as closed nucleus

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system (Nicholas, 1987). The time taken in transfer of genetic progress from nucleus herd to lower herd known as improvement lag which can be reduced by adopting any of two practices viz., a) transferring of males and females of nucleus herd directly to the commercial herds and b) keeping the males and females in the lower herd for short time before replacing them with younger stock. Closed nucleus breeding system was mainly used in pig and poultry to avoid the risk of introducing diseases in the nucleus flock (Tomar, 2009). The main reason was that in pig and poultry breeding, nucleus herds and flocks were usually maintained under strict quarantine with the aim of excluding as many diseases as possible. Opening these nucleus populations to regular importations from other herds would involve a high risk of introducing diseases.

B) Open nucleus breeding Scheme (ONBS)

Gene flow were both way *viz*., downward from nucleus to other lower herd (multiplier and village) and upward from lower to upper herd (nucleus) by introduction of superior animals from other herds. Therefore, the superior animals from village (commercial) herds were introduced into nucleus herd. This reduces the rate of inbreeding in nucleus herd and increases the genetic progress as superior animals are available with farmers. This systems mostly used in cattle, buffalo, sheep and goat (Nicholas, 1987). In these, sire breeding nucleus herd established to breed replacement sires for itself and the associated herds. Female replacements were reared in both the nucleus and base herds and there was transfer of females in both directions at regular intervals. The nucleus remains open to introduction of new gene from the surrounding area (Dixit and Sadana, 1999).The most popular form of open nucleus breeding system involves a group of breeders approving to cooperate in the formation and subsequent running of an open nucleus in return for a regular supply of breeding stock males from nucleus for use in their own herds. These were called as cooperative breeding systems (Nicholas, 1987). The ONBS can be useful in the developing countries like India where herd or flock size was small and annual genetic progress can be expected. Efficiently designed open nucleus system can lead to a 10-15% increase in annual response to selection and significant reduction in the rate of inbreeding in the nucleus when compared with the closed nucleus breeding system (Nicholas, 1987). Open nucleus breeding system having the shortest generation interval. So, shortest generation interval had the highest expected genetic gain (Meuwissen, 1991) and for getting high expected genetic gain in dairy industries ONBS has been used. As there was gene flow both ways, the rate of inbreeding gets reduced. ONBS is better than closed nucleus system (Meuwissen, 1991). The principal factors that influence the effect of an open nucleus system were nucleus size in relation to base population and migration rates between herds. These nucleus size and migration rates are the main part of open nucleus system which influences the genetic gain (Roden, 1994).

Advantages of ONBS

It is important in genetic improvement programmes of livestock and to increase the overall rate of genetic gain. It reduces rate of inbreeding in nucleus herd and increased in genetic progress and that because of better-quality animals are selected. ONBS can increase overall rate of genetic improvement in population when compared with closed nucleus system. This was because of elite mating in nucleus gives higher proportions of genetically excellent progeny leading to faster genetic gains. Nucleus would be an ideal population for gene engineering research and development.

MOET Nucleus Scheme

MOET is a composite technology and includes super ovulation, estrus synchronization among recipient, Artificial Insemination of donor, short-term in *vitro* culture of embryos, embryo recovery from donor, embryo transfer into recipients. There is still considerable scope for improvement and appropriate research on all these component parts (Tervit *et al.*, 1990). MOET nucleus schemes involve creating a nucleus herd of elite males and females, intensive selection and testing in the herd, selecting elite males and females at early age based on family information i.e. performance of their sisters and half-sisters referred to as sibling test and not on the performance of their progenies as in the case of the Progeny Testing Programme or on their parents as in the case of pedigree selection, thus the generation interval is considerably reduced. Although the accuracy of selection under sibling test is lower than progeny testing, the benefits of reducing the generation interval make up for the loss of accuracy. The genetic responses under a well run ONBS could be as high as conventional progeny-testing programme. As selection and testing is done within a herd under controlled environment the greater degree of control on intensity of selection, generation interval and accuracy of selection is possible. The increased genetic response in these schemes is largely due to reducing the generation interval while less accurate selection. These schemes require a much smaller number of recording in dairy cattle than in conventional breeding programmes and could replace the need for expensive progeny testing.

II. TYPES OF MOET NUCLEUS SCHEME

1. Juvenile MOET Scheme

Selection of bulls and cows is done at early age before first breeding using not only information of dam (record on her dam, her full sibs and her half sibs) but also of the sire (record on his dam, his full sibs and his half sibs).The generation interval in this scheme is less i.e. 2 years

2. Adult MOET Scheme

Selection of bulls and cows is done after the first lactation record. The selection of male and female is done on different criteria. Males are selected on the basis of

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full sibs, half sibs and dams record. Females are selected on the basis of full sibs, half sibs, dam's record and their own lactation records. The generation interval in this scheme is longer than Juvenile Moet Scheme i.e. 3.75 years.

3. Hybrid MOET Scheme

Females are selected on the basis of first lactation record while breeding males are are selected on the basis of progeny testing. (Nicholas and Smith, 1983)

III. BENEFITS OF MOET TECHNOLOGY

Obtaining more offspring from valuable females, obtaining offspring from infertile females, exporting or importing animals as fresh or frozen embryos, testing for mendelian recessive traits, introducing new genetic material into specific pathogen-free farms, increasing the population of rare or endangered breeds or species (Seidel Seidel, 1981). MOET schemes (Nicholas and Smith, 1983) allow genetic progress required for successful breeding programmes (Bichard, 1996). Meuwissen (1991) showed increased in female reproduction rate through the use of MOET. MOET-ONBS was more advantageous over closed system to increase the overall genetic gain. ONBS with MOET was superior to maximum annual genetic improvement by 62 per cent (Dixit and Sadana, 1999). It provides degree of control on genetic changes i.e. intensity of selection, generation interval and rate of inbreeding. If these controlled, then high rate of genetic progress may be achieved.

IV. CONCLUSION

Multiple Ovulation Embryo Transfer-Open Nucleus Breeding System (MOET-ONBS) is the best system in the developing countries like India for genetic improvement in dairy animals. ONBS would be best medium to introduce newer animal biotechnologies such as embryo sexing, embryo cloning and gene transfer. MOET -ONBS have been shown to yield higher rate of genetic gain as well as accuracy of selection and lower rate of inbreeding and generation interval. It offers two way gene flow and also suggests conservation of animal genetic resources. Open nucleus systems can operate effectively with multiple ovulation embryo transfer procedures for maximum genetic progress in farm animals.

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