Techno Pot – The genetics game

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Introduction

Genetic advancement in the dairy cattle population has relied on two processes, use of the top genetic merit bulls and the selective rearing of calves of high genetic merit as replacements. Artificial insemination has remained the main vehicle for dispersal of favourable genes. This technology has served us well over the many years and as semen technologies have improved, it has continued to be the method of choice for dairy farmers worldwide to improve the genetic quality of their stock. In almost all genetic improvement programs the male is used as the vehicle to disperse favourable genes; the reason being, the male is capable of producing a large number of sperm cells which can be used to produce a number of progeny.

The Genetics game

The equations that contribute to genetic improvement are

Contribution of a sire to genetic improvement

= Number of progeny per sire x Genetic superiority of the sire

The number of progeny per sire depends upon:

= number of cows inseminated to the sire x proportion of cows calving to the insemination

The superiority of the sire depends on the presence of either one or a combination of favourable genes within its own genetic make up. The speed with which these genes are established depends on the extent to which they are found in the general cow population and the opportunity to mate with a sire with a similar set of favourable genes. These favourable genes can be detected either by a conventional progeny test scheme or a unique gene based test.

Breeding for production traits has been very successful in New Zealand (Figure-1). About 75% of this genetic improvement has come about due to an efficient progeny test scheme and the remainder is due to the efficient use of artificial insemination.

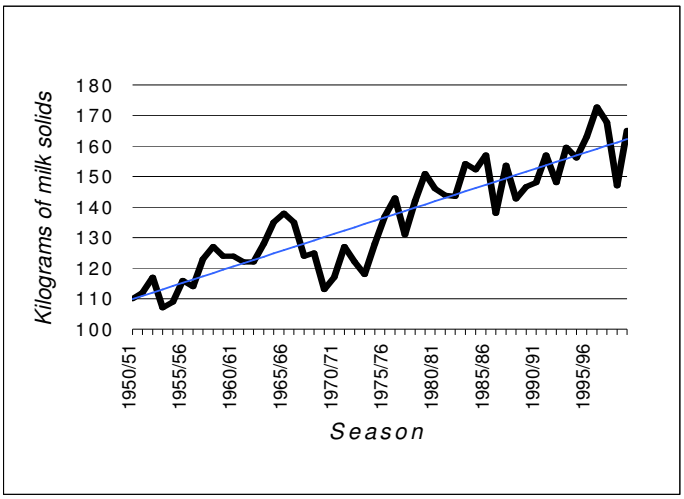

Figure: 1 Changes in per cow milk production of milk solids in New Zealand. Figures are representative of the time a progeny test scheme has operated in New Zealand

Reproductive technologies

Artificial insemination has remained the single most effective bio-technology to establish the favourable genes. The main ingredients for its widespread application are:

- It is simple
- It is economical
- It is successful.

Progress in other assisted reproductive technologies has the ability to rapidly generate offspring but they will have to match up to AI in being simple, economical and successful.

Long Last Liquid semen has contributed significantly towards the efficient use of bulls in New Zealand dairy herds. The potential number of inseminations from individual bulls is significantly increased with the use of this technology. Although the shelf life of the product is less than frozen semen, this product complements our seasonal mating system. Figure-2 shows the potential number of semen doses possible in a calendar year from individual bulls in New Zealand compared with International production standards. This liquid semen technology has stood us in good stead and will continue to be the main method of establishing favourable genes from progeny tested bulls.

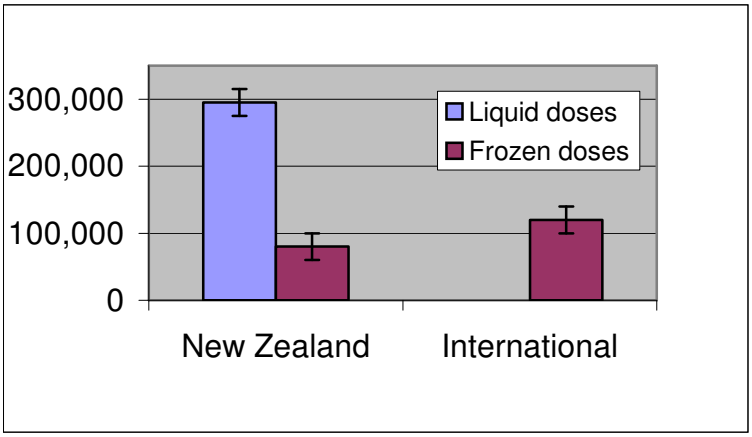

Figure 2: Potential semen dose comparison

The horizon is changing. LIC along with Fonterra has a significant investment in Bio-technology programs that are aimed at gene discovery. The first genes from this research and development programme have already hit the market in the shape of Quantum and Optimum. The Quantum gene has two alleles F and P and the favourable P allele has a positive influence on protein yield and volume with a corresponding negative effect on milkfat. The Optimum gene also has two alleles A and T with the favourable T allele having a positive influence on milk solids, with a negative influence on milk volume.

More genes are expected to be discovered through this bio-tech programme and the main targets besides production traits are health (mastitis, immune function, lameness, condition score) and fertility trait related genes. Unique genotypes that are suitable for specific farming types such as Once A Day milking are also being investigated. It is quite likely that some of these genes will be rare and therefore we will need founder animals, which carry these genes. The transfer of these rare genes into the general population is more efficiently done using alternative reproductive technologies such as MOET (Multiple Ovulation and Embryo Transfer), TVR / IVP (Trans Vaginal Recovery and In Vitro Production of oocytes) and cloning. Once we obtain a sufficient founder population, AI can be used as secondary technology along with *sexed semen* to rapidly establish these genes in the general cow population.

The main goal of any reproductive technology is to rapidly transfer to the commercial population the genetic progress identified or contrived in a nucleus population. The use of technologies such as MOET or TVR / IVP facilitate this process and are increasingly being used by both breeders and breeding companies such as LIC.

In the last twenty years a dozen or more approaches to sexing semen have been proposed. However, only one technique has been proven to be reliable and practical. This procedure measures the DNA content of individual sperm. The X sperm (female) have 3.8% more DNA

than the Y sperm (male) and based on this difference, the cell sorter separates these populations of X and Y sperm. There are considerable economic advantages to sexing sperm. However, significant impediments such as the speed of the sexing process and the prohibitive cost associated with the machinery and intellectual property will restrict widespread commercial application. The use of sexed semen for specific applications such as bull breeding and establishing male or female founder animals from a breeding scheme has merit but routine application in AI will be possible after more research and development and easier access to the intellectual property.

Summary

The future for semen technologies is secure and their role in routine gene dissemination will continue. Other reproductive technologies will be used for specific applications such as bull breeding and establishing founder animals of rare genotypes.