



## The future of Dairy Cattle Nucleus Breeding

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### Introduction<sup>i</sup>

In the last century, reproduction technology has had a major influence on cattle improvement. The development and introduction of artificial insemination had the largest influence. AI made the dissemination possible of superior genetic material. But also, due to AI the progeny test (Robertson and Rendel, 1950) could be introduced which now for more than 50 years is the cornerstone of reliable and stable genetic progress. Multiple Ovulation and Embryo Transfer (MOET) was introduced about 25 years later and was used first to increase the number of sons per bull dam thus increasing genetic progress further (Cunningham, 1976). Nicholas and Smith (1983) were the first to describe a system in which MOET was used to create a true hierarchical breeding nucleus. A true hierarchical breeding nucleus is closed. All genetic progress is created within the nucleus. Firstly, genetically superior animals are brought together in the nucleus. Secondly, many offspring per dam are created at a young age, and sires and dams are selected based on the information of sibs (bulls) and own performance (dams). Genetic progress is disseminated to the general population by putting bulls from the nucleus to AI service. Whereas the true breeding nucleus is standard in poultry and pig breeding, it was never introduced in cattle breeding. Instead hybrid schemes (Dekkers and Shook, 1990) were propagated. Due to the open nature of dairy cattle breeding with progeny testing and international breeding value estimation, and due to the absence of structured crossbreeding, a closed breeding nucleus cannot compete. In an open hybrid nucleus, progeny tested sires from outside the nucleus are used, and also part of the nucleus is constantly replaced by superior animals from the outside population. It was this kind of open hybrid nucleus that was eventually introduced by several dairy cattle AI companies. Almost all commercial nucleus herds combine two factors: intensive use of reproduction technology at a young age and performance testing of potential bull dams in an unbiased environment thus leading to unbiased bull dam breeding values.

This paper will first give an overview of current dairy cattle nucleus schemes. Then, the Delta current nucleus of CRV will be described in some more detail. Finally the future of nucleus breeding given the introduction of genetic marker technology will be discussed.

### Current dairy cattle breeding nucleus schemes

Implicitly, when people in the industry talk about a nucleus, they always talk about a nucleus that is owned by an AI company. However, there are many more farmer owned nucleus herds than AI owned nucleus herds. In all major Holstein countries there are several breeders that use the best available bulls from around the globe, that intensively use reproduction technology at a young age, and that constantly keep the herd open by buying new material. Examples are the Comestar farm in Canada, Tir-An in Denmark, Willem's Hoeve and Southland in the Netherlands. Those farms have together sold hundreds of bulls to the AI industry world-wide.

The number of nucleus herds owned by AI companies is more limited. Genus in the UK established one of the first nucleus herds in the world. In the international bull rankings you can recognise the results of the Genus nucleus from the MOET prefix. The best result so far has been

MOET Lookout. The Genus nucleus herd continues to function today. Also in the UK but of later origin is the Cogent nucleus herd. In Denmark a nucleus was operated for many years. A few years ago, that project was ended. At about the same time, Svenks Avel in Sweden opened their Viken nucleus herd. The Viken nucleus still is awaiting results from progeny testing. In Germany, Nord-Ost Genetics established a nucleus in the 90's of the previous century. NOG work in close co-operation with the University of Kiel. The NOG nucleus differs from other nucleus herds because individual farmers remain ownership of the nucleus animals. But the critical parameters of a proper nucleus are full-filled: intensive reproduction at a young age and an open and unbiased performance test. In de US CRI successfully operates the Co-op nucleus herd that delivered already several high-ranking bulls.

### **The Delta nucleus Herd**

CRV operates its Delta nucleus since 1991. For 16 years already, the Delta nucleus is an important part of the CRV breeding programme. About 40% of the bulls tested by CRV originate from Delta. So far, more than 4000 animals have been tested in Delta. This resulted in more than 500 bull dams. The most famous one is Delta Esmeralda, the most influential breeding cow in the world. She is the direct dam of Delta Lava and Delta Novalis, two bulls that have a huge impact on the Dutch Holstein population. Today the top bulls Delta Canvas from the Netherlands, Mascol from Germany and V Eaton from Denmark trace back to Delta Esmeralda.

At the basis of Delta are 450 calves born each year. Fifty percent of those calves are from Delta, and 50% originate from elite European cow families. After selection, 225 young virgin heifers are used in the Delta heifer embryo program. From the 225 heifers, 1600 ET embryo's and 900 IVP embryo's are produced. Those 2500 embryo's are sold to Dutch and Flemish farmers with a buy-back contract. After some culling, 200 heifers are tested at the test station Delta Kollum. At Delta Kollum the 200 heifers are performance tested for 180 days of the first lactation. Milk production performance is recorded weekly. Conformation is scored 3 times during the 180 period. Due to the frequent recording, milk production and conformation breeding values can be estimated that are more reliable than the breeding values for cows in the general population. But more importantly, the breeding values from the Delta Nucleus are much more unbiased than the breeding values of commercial bull dams. The difference in bias between Delta bull dams and the other bull dams is around 10 KGs of protein.

Due to the accurate and unbiased performance test and the on average short generation interval, young bulls from Delta are more successful than young bulls from outside the nucleus. Averaged over a time period of 12 years, 7.5% of the tested Delta bulls were added to the CRV sire line-up, compared to 5.9% for the average CRV young bull. The fact that currently the three best selling bulls from CRV all originate from Delta (Delta Olympic[Addison\*Besne Buck], Delta Paramount [Jocko\*Fatal] and Delta Canvas[Sparta\*Celsius]) underlines the success of Delta.

### **Introducing genomic selection in the Delta nucleus**

Delta has been successful from the start because of the high quality of the performance test, the effective use of advanced reproduction technology, and the constant introduction of new bloodlines. Delta will continue to be successful, but for other reasons. The introduction of genomic selection will completely change nucleus breeding.

At this moment CRV applies genomic selection in the breeding programme based on 3000 genetic markers. In the second half of this year, the number of markers will increase significantly and genomic selection with 65% reliability will be possible. The optimal structure of the nucleus will change. Genomic selection with 65% reliability will be possible right after birth. All traits will have a reliability of 65%. For production, cell count and conformation the reliability of the genomic selection value right after birth will be 10 - 15% higher than the reliability of the estimated breeding value in conventional selection after the performance test. For longevity and fertility the genomic selection value will have a 35% higher reliability than the conventional pedigree index. The importance of the performance test will decrease. Strict selection can be applied right after birth based on the genetic markers. The genetic level of the bull dams selected will dramatically increase, especially for functional traits. And also among the sons of the bull dams there will be effective selection based on genetic markers, which further speeds up genetic progress.

### **Conclusion**

Current dairy cattle nucleus breeding schemes are successful because of the high quality of the performance test and the effective use of advanced reproduction technology. For CRV, the Delta nucleus is responsible for a major part of the active sire lineup. The introduction of genomic selection will change nucleus breeding in the near future. Performance testing will become less important. The success of the nucleus will depend on even more efficient use of reproduction technology allowing high selection intensities within the nucleus.

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