THE ROLE OF DNA ANALYSIS IN THE BREEDING OF ANIMALS

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Everybody is talking about DNA in the fields of animal breeding. We were given the opportunity to write a piece on DNA associated techniques as used in the animal breeding industry.

> GENETICS IS ABOUT HOW INFORMATION IS STORED AND TRANSMITTED BETWEEN GENERATIONS

When asked to write something about DNA parentage and genomics, the key is to keep it simple and easy to read. Being a farmer's son myself, I know that concepts need to be explained and fancy words do not add value if they are meaningless – all the fancy words can be found in numerous articles when you Google the concepts of DNA parentage and genomics.

I am grateful for the opportunity to approach the DNA-based services from a different perspective. Well good news, DNA at its core is really simple, based on 4 nucleotides, represented by A, T, C and G. This is where the simplicity ends, because one can only imagine the combinations and modifications necessary for these 4 nucleotides to serve as the blueprint for our life and life as we know and experience it every day. In an attempt to oversimplify the role of DNA parentage and genomics, it will be compared to the construction industry that most of us are familiar with (See Figure 1 A).

Imagine you are a developer and your next development needs to be the grandest one yet. You visit Nguni Architects where you listen to proposals and you are really interested in combining 2 proposals from 2 team members (one male and the other female, as luck would have it) to give you that grand design that would be the best yet. The plan on paper needs to become a reality and you are off to different building contractors. You have a choice of good (most expensive), average (market related) and bad (least expensive) contractors – all working from the same blueprint. The process and outcomes are illustrated in Figure 1A.

Figure 1 B - No more imagining, you are a Nguni breeder and you select (based on your experience and information at hand) a specific bull and cow combination to generate your best offspring yet. Genomic analysis of the DNA from the calf (the calf's genetic blueprint) reveals that the combination of genetics from the sire and the dam was indeed excellent.

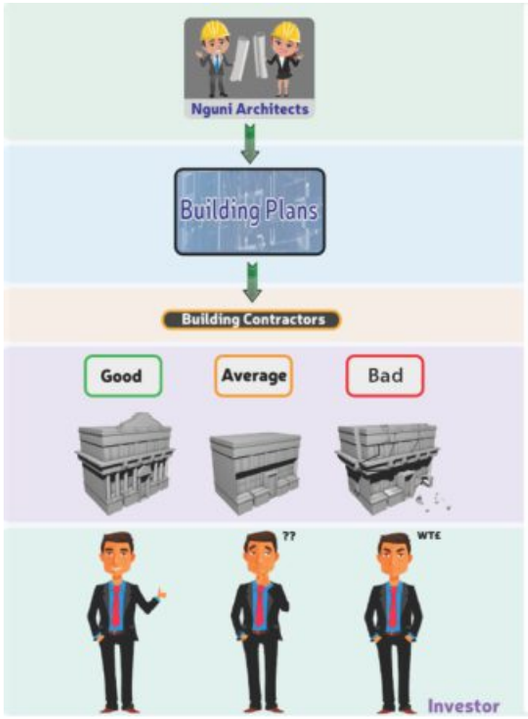

Figure 1A

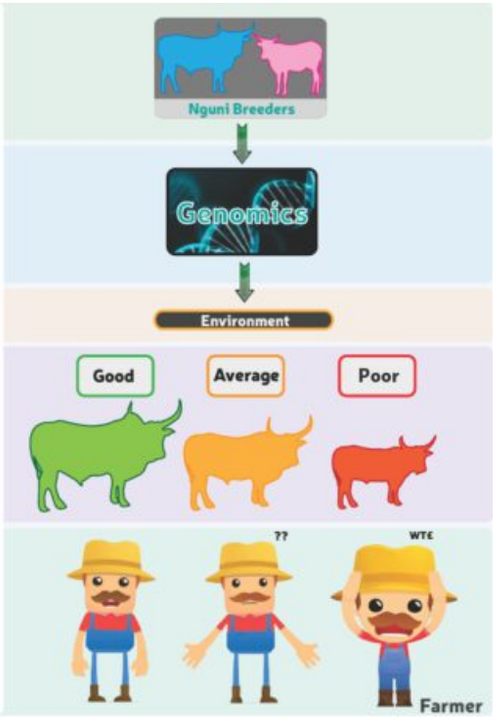

Figure 1B

On paper you now have a calf with genetic potential exceeding all previous records. This genetic potential needs to become a reality and you are off raising the animal in the hopes of unlocking this genetic potential. You have a choice of good (most expensive), average (market related) and bad (least expensive) environmental conditions – all working from the same genetic blueprint. The process and outcomes are illustrated in Figure 1 B. Below are a few questions (Q) and answers (A) to provide more information

Q: What role does DNA parentage play in modern animal breeding practices?

A: DNA parentage in cattle is based on specific regions that were proven to be inherited from the sire and the dam in such a way that you can detect the regions in the offspring. The industry standard looks at 12 of these regions. This allows, with high accuracy, confirmation of the pedigree of the offspring, ensuring that the breeding occurred as planned.

It is important to know that the most accurate results are obtained when both parents and the offspring are genotyped on DNA level. Genotyping all dams and the herd sire has a financial impact, so very often only the sires are tested against the offspring. This is the reason why Clinomics includes the 12 industry standard markers as well as 6 additional markers to increase the accuracy of the results.

It is also important to remember that more markers are better, since all parentage results list sires/dams that qualify as the parent(s) of the offspring and more markers will significantly reduce the inclusion of parent(s) qualifying by chance.

Q: What role does genomics play in modern animal breeding practices?

A: Genomics are, among other things, used to determine the genetic potential of an animal. These are based on association studies between genetic markers and well-recorded traits.

The majority of these traits are significantly influenced by the environment. This once again emphasizes the importance of thorough and accurate recording of information (animal traits and the environment). Without accurate records, no accurate associations can be made and the small differences on DNA level between animals remain just that: small differences on DNA level between animals.

Q: What is the difference in DNA parentage and genomics as a service?

A: There are 2 mainstream approaches towards DNA parentage at the moment, microsatellites and SNPs. At Clinomics we make use of microsatellites for DNA parentage where we look at 18 markers (including the 12 recommended by the International Society of Animal genetics – ISAG) for routine parentage in cattle. ISAG also has a SNP panel (comprising of 100 SNPs as the core panel) for routine parentage. Both the microsatellites and SNP approaches are affordable and allow for comparable highly accurate DNA parentage results.

There is currently only one major player in the animal genomics market. Illumina, individually and through its partnerships, offers different genomic profiling chips ranging from a low density chip (looking at approx. 8 000 SNPs) to the high density chip (looking at approx. 777 000 SNPs at a time) for genomic analysis.

Cost associated with these chips is significantly more than the parentage analysis, but it yields significantly more information. The SNP chips have been validated for a whole range of different breeds and have been well studied.

Q: What role does the environment play on the realization of genetic potential?

A: Environmental impact on unlocking the genetic potential of offspring is well documented and described in literature. A simple example commonly used: An animal may have a genetic tendency toward a certain weight. But the animal's actual weight is influenced by environmental factors such as food availability and consumption. Environmental effects can also occur much earlier than expected.

A study on white tail deer was published indicating the maternal effect on offspring.

One of the conclusions was that the growth of offspring born from white tail females that were subjected to sub-optimally environmental conditions, remained stunned even though all the offspring were given access to the same quantity and quality of feed. The stunned growth was only reversed during the second generation after giving the pregnant females access to optimal environmental conditions.

We, at Clinomics, believe in solving problems and creating trust. Trust in accurate and reliable results not only exists between Clinomics and the breeder, but that very same trust is instilled between breeder and buyer giving the buyer peace of mind in knowing that the animal bought does in fact have the pedigree as sold. ■

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