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Introducing sheep genomic technologies and the Information Nucleus

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Rising costs and greater emphasis on quality and consistency are squeezing profits in all agricultural industries. The lamb and sheep meat supply chains are no exception. Improving productivity and quality through better genetics is an important strategy for producers and processors and the Australian lamb industry has made remarkable progress since the early 1990s. There are however new opportunities based on DNA-based technologies that have the potential to take the industry to the next level of genetic improvement. This series of four papers reports back to the lamb industry on progress made over the last five years and provides some insights into the new technologies, potential changes in sheep breeding and the implications for the lamb supply chains.

Using DNA profiles to predict breeding values

For some time geneticists have been aware that, while single genes can control some traits such as horn/poll, most aspects of animal production and health are determined by the effect of hundreds, or thousands, of genes. It is therefore necessary to take account of the whole genome (all of the DNA) to predict production traits.

In order to match the pattern of DNA differences with production and health traits it is necessary to make measurements on a very large resource flock. By measuring all aspects of production and health, as well as obtaining a DNA profile, it is then possible to generate equations that predict breeding values for any of the measured traits based on analysis of the whole genome using SNP markers. This process is summarized in Figure 1 below showing the cycle of measurement to deliver the prediction equations and then using these equations to estimate breeding values for young rams.

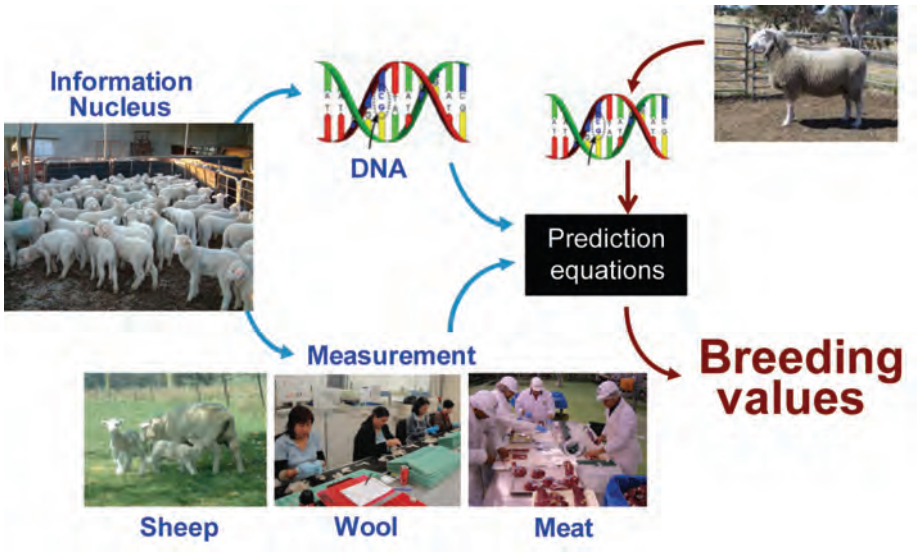

Figure 1 Diagram showing information Nucleus data on phenotypes and DNA being used to produce prediction equations for predicting breeding values

The Information Nucleus Program

Based on the concept outlined above, the Sheep CRC established the Information Nucleus Program as its central focus. Details of the Program are summarised in Figure 2 below. This shows the process of selecting rams that were then tested across eight sites with a wide range of measurements made on farm and on the carcasses. To date measurements have been made on around 18,000 animals with all data flowing back through to a central database. The information is then analysed to produce improved accuracies of standard genetic parameters as well as a range of new breeding values based on analysis of DNA profiles. All information from the Program is reported to industry through LAMBPLAN and MERINOSELECT via Sheep Genetics.

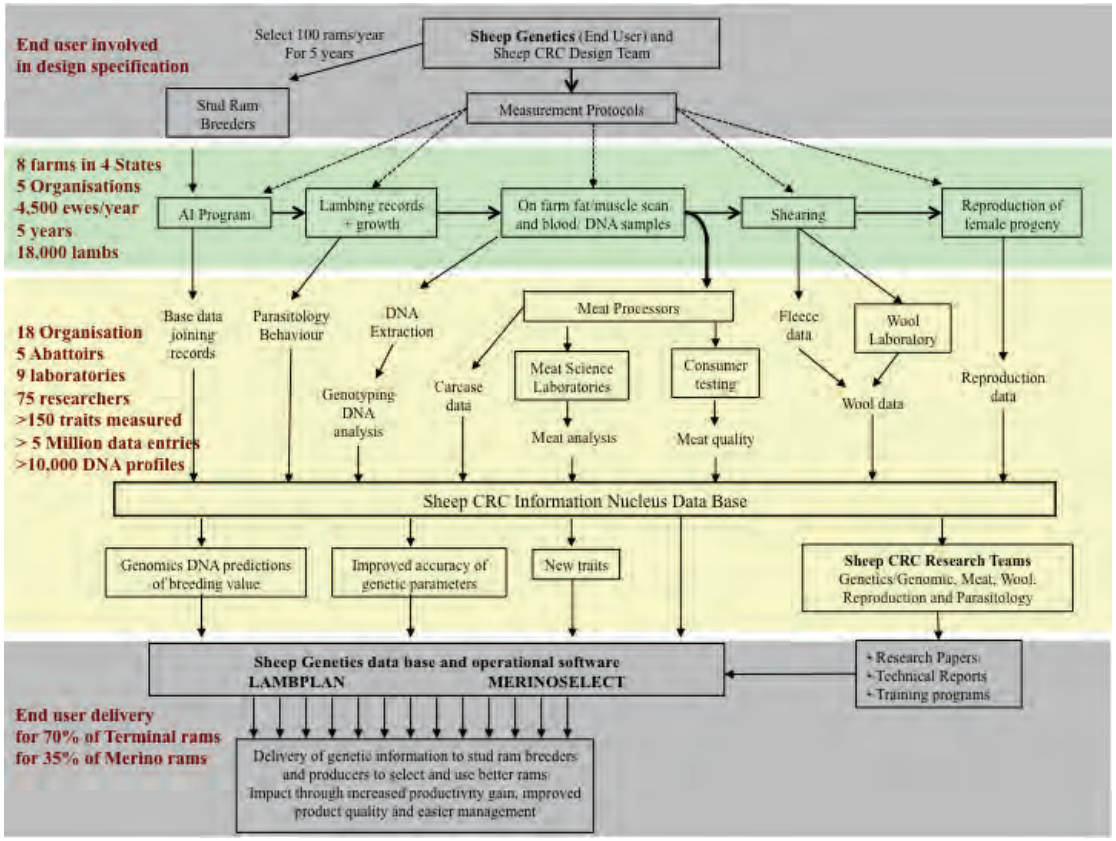

Figure 2. Overview of design, sampling, measurement and analysis in the Information Nucleus Program

What are the implications for the Australian lamb industry?

The essential benefit of being able to predict breeding values from DNA analysis is the ability to select animals earlier in life. Genomic predictions of breeding values is particularly important for traits that are difficult or impossible to measure on farm such as meat eating quality. The genomic predictions do not replace the need for performance and pedigree information. The three sources of information need to be used together.

The practical implications can be summarised as follows:

- Better balance in the selection of terminal sires for eating quality attributes as well as the conventional traits for growth and lean meat yield;
- More balanced selection in Merinos for the dual function of wool and meat production in the modern Australian sheep industry; and
- The development of new designs for breeding programs that may generate economies of scale while improving the rate and balance achieved from genetic selection.

Costs and benefits

The costs of genomic predictions are determined by the price of DNA testing and the expense of maintaining accurate predictions using DNA profiles. One thing is clear - the price of DNA testing is continuing to fall. The price of the standard 50k SNP chip analysis has halved in the last three years and there are prospective technologies being developed that are likely to further reduce in the next two to three years. The costs of maintaining accurate predictions relate to the need for ongoing measurement of a resource flock for those traits difficult or impossible to measure on farm. This will continue to be a major expense. Spreading these costs across all those who benefit from the new technologies and improved genetic gain, is a challenge for the entire industry.

The benefits are associated with the ability to select for new traits that will drive long term profitability. These include the meat eating quality parameters that are critical to maintaining prices and high demand for Australian lamb. It is also expected that accurate predictions of breeding values for reproductive performance and parasite resistance will be available within two to three years and being able to predict those traits will deliver major benefits.

It is important that the costs and benefits of the new technologies are understood by all sectors of the supply chain. While the industry scale benefits through improved efficiency and product quality are easy to define and more than justify investment in the technology, the wide spread use of the new technologies will rely on ways of equitably sharing the costs and benefits of maintaining accurate predictions through the supply chain.

Conclusions

The use of new genetic and genomic technologies in the sheep industry will provide the basis for the next generation of change and improvement. How effectively these technologies are used will determine how much profit they generate for the sheep industry. We need to understand the costs and benefits for all sectors of the supply chain and collaborate effectively to get the most out of the benefits that the new technology offers.

The design of more efficient ways of collecting information and using the new tools may lead to significant changes in the sheep industry. The coming years are likely to be challenging and exciting.