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New genomic technologies – opportunities for the Australian lamb industry

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Summary
There are real opportunities for the Australian lamb industry arising from the genomic tools that are now becoming available. They are in three areas:

- Being able to simultaneously breed for improved lean meat yield and aspects of product quality such as tenderness, flavour and nutritional composition.
- Being able to accelerate genetic progress, especially on the maternal side, for traits such as lambing rate and parasite resistance.
- Being able to significantly reduce the overall cost of making rapid genetic improvement.

Exploiting these will require a combination of innovation by individuals and industry collaboration.

The basic question – what's the value proposition?
Genetic improvement involves finding animals with the best genes for a particular job, or set of jobs, and breeding from them. Ideally, this should be done at the lowest cost, highest accuracy and as early in life as possible.

For several decades, the Australian lamb industry has tackled these challenges very effectively, using a combination of pedigree data supplied by stud breeders plus records of animal performance supplied either by the breeder or from accredited measurers (scanners, fleece and worm labs).

Tools being developed from R&D into genomics – the study of what genes impact performance – are now ready to be added to the armoury of breeders and producers. These tools are all ultimately based on taking a sample of tissue from the animal (such as blood or hair/wool), and 'reading' the DNA – deciphering the actual gene sequence of the animal. This is currently done for a sample of all the actual genes, but within 1-2 years the full sequence will be read at a reasonable cost.

Having performance records for large numbers of animals for which we also have the DNA result – usually referred to as a *reference population* – is what makes the ability to read the DNA useful. An excellent example of this approach is the Information Nucleus, which has been a core of the Sheep CRC, and is now in transition to industry management.

Such a record, supplemented by a sample of blood or hair/wool taken at any age, removes the need for recording the performance of every animal whose genetic merit we want to determine, and allows us to make a selection in very young animals.

The critical factors that determine whether the test is valuable or not are:

- *How accurate is it for the trait(s) we are interested in?*
  This depends entirely on the size of the reference population. The Information Nucleus has generated sufficient data that we now have tests with useful accuracy for a wide range of traits in the major Australian sheep breeds.

- *What does the test cost?*
  The cost of DNA testing has come down enormously over the last 10-15 years, and tests of useful accuracy are now available in the $50-100 range, and likely to come down more.

Together, these factors mean that genomic or DNA tests are now a practical proposition for Australian sheep breeders.

Let's explore how they might be useful for the lamb industry in a little more detail.

What lamb traits might DNA testing be most useful for?
Selection through LAMBPLAN has generated substantial progress in growth rate, leanness and muscling – all important in the growing lamb – and modest progress in lambing rate and parasite resistance in the dam breeds.

However, selection for leanness and muscling carries with it the risk of reducing eating quality. So the recent development of DNA tests for intramuscular fat % – a key driver of lamb tenderness – and the soon to be available tests for nutrient content (omega-3s, iron, zinc and so on) are additional benefits.

At the same time, we now have DNA tests for lean meat yield.

Together, these will allow faster progress for lean meat yield **while at the same time** ensuring that we maintain or improve eating quality and the nutrient composition of Australian lamb.

In the maternal traits, we are close to having tests of useful accuracy for worm egg count and lambing rate. The latter in particular will make it easier to make progress in dual-purpose breeds for this vital component of lamb enterprise profitability.

Alongside these production efficiency and product quality traits, DNA tests are now available for highly accurate pedigree determination in Australian breeds, and the genetic control of horn/poll.

Over the next 1-2 years, Sheep Genetics and the Sheep CRC will continue developing and trialling tests for more traits, as well as working with breeders to understand how best to use these tests in breeding and production.

Does DNA testing pay off for the ram breeder? For the supply chain?
Answering these questions depends on knowing the cost of the test, the lift in accuracy of breeding values offered, and the benefit of each trait to the commercial producer, the processor and the retailer.

Analyses of using DNA tests in terminal sire, dual-purpose and Merino studs, and calculating break-even prices for the tests.

The good news is that at the current accuracy-price combinations, DNA testing looks worthwhile for stud breeders, provided that when they sell rams their clients reward the breeder for the genetic merit of the rams; in simple terms, buyers pay more for genetically superior rams.

This is affected a great deal by the way price signals flow in the chain – where processors pay for extra yield for example, it is much easier to see a positive return for the stud breeder in testing for yield.

This in fact highlights a very important point. For the lamb industry to really get the best out of the exciting possibilities on offer, we will need to see more and clearer communication through the whole chain, ideally from the consumer all the way back to the breeder. This will ensure that we get the right balance of selection across the full range of traits affecting production efficiency, product quality and animal welfare.

What is needed to maintain these opportunities?
Earlier in this paper, I stressed that it is essential that we have a reference population to underpin, or calibrate, the DNA tests. The Information Nucleus has performed this function for Australia to date.

It is also essential that the reference population be maintained (at the right size) indefinitely, because we know that the accuracy of the DNA tests declines as we make genetic changes in our sheep population.

To date, the Information Nucleus has been a research program – measuring many more traits than will probably be needed as we move forward. We are now working on defining the right size for the Information Nucleus, in order to maintain the usefulness of the DNA tests at the lowest overall cost. The ideal size depends on determining the right number of traits, number of locations, and by what data can be collected in studs and what needs to be collected in special resource flocks.

While the exact design has not been finalised – and it will likely evolve over the coming years as the technology evolves – we can be confident of a couple of aspects:

- The reference population will involve a mixture of data from animals in well-recorded studs, and special resource flocks established to collect data that cannot readily be collected in studs (eating quality is an example).

  It is likely that breeds or breed types that want to use genomic tools will need to maintain reference populations of 1,000-2,000 animals per year **recorded for all the traits that impact on value chain profit**. If a trait is not recorded, no DNA test will work for it.

- The reference population will require funding, and almost certainly will need to be funded through a mix of industry support, including direct involvement of the processing sector, and a component of user-pays, probably in the form of a royalty on DNA tests.

What are the implications for stud breeders and for commercial lamb producers?
Taking these two questions in reverse order, it is likely that for **ram-buyers** who take account of LAMBPLAN information, the new technology will simply be a small step up from the present.

There will probably be a few more Australian Sheep Breeding Values (ASBVs) available, but we will need to work with breeders and producers to make sure that the information is presented as clearly as possible.

It will be important to really get to know the processors and retailers – to find out what traits they are looking for in lambs, and what information they will feed back to producers.
And there is a solid prospect of real lamb prices, i.e. adjusted for inflation, continuing to rise or at least be maintained as we build more and more quality into our lamb and improve production efficiency.

For **ram breeders**, it is almost certain that there will be a marked separation in roles, between:

- Collecting data, to contribute to the reference population
- Selecting the elite sires and dams at the very peak of industry genetics
- Multiplying up flock rams, probably using DNA testing as a simple screening tool, that will probably remove the need for performance recording
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Deciding which of these roles to focus on will be for the individual, but in each job, the pressure will be on to perform at the very highest level.

The other challenge and opportunity for ram breeders will be to focus more and more on the whole supply chain: ensuring that maximum genetic value is packaged not just for the commercial producer, but also for the processor, the retailer and the consumer. This will require direct communication and relationship-building.

Overall
The new DNA or genomic technologies offer exciting prospects, but there are challenges as well.

The prospects are for the delivery of higher value lambs at greater production efficiency, and hence improved margins for the whole value chain.

The challenges arise from the simple fact that genomic tools simultaneously depend on large quantities of quality data (the 1,000 to 2,000 animals fully recorded per year), married with the growing capability to accurately evaluate animals using a DNA test alone. This creates the opportunity to separate the recording and selecting, and the flock ram breeding, roles in stud breeding almost completely, and opens up the possibility of direct investment by commercial producers, processors, retailers, or combinations of them, into the recording and selection roles. In this way, it is quite conceivable that the Australian lamb industry could become much more like the pig or wine industries in how breeding and production are organised and funded.