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be motivated by its application to non-production traits such as fertility, survival, health and product quality. There will need to be greater vertical integration and greater use of AI in these industries to allow a financial return to entities that invest in GWS. These facets may cause a barrier to the use of GWS until genotyping costs drop sufficiently to catalyse the changes needed.

Uptake of DNA testing by the livestock industries of New Zealand

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ABSTRACT

This paper describes, from the perspective of the main animal genotyping service laboratory, the uptake of DNA tests by the New Zealand livestock industries. We describe a rapid increase in the use of DNA testing over the last 3-4 years in New Zealand. In particular pedigree establishment and verification has shown significant uptake by deer, cattle and sheep breeders. The highest penetration of DNA testing has been in the deer industry where we estimate 30-40% of the recorded breeding population uses DNA testing to establish and verify pedigrees. The increases have mainly been due to an increase in the number of samples per client rather than an increase in the number of clients using the service.

Keywords: DNA; pedigrees; parentage testing; gene tests.

INTRODUCTION

The last fifteen years have seen the development of microsatellite based systems to identify pedigrees in a wide range of animal species including livestock and companion animals (Dodds *et al.*, 2005). More recently a large number of QTL, and in some cases the causative gene alteration, have been discovered for an array of productive traits in livestock (Andersson & Georges, 2004). The motivation for such work is to assist farmers and breeding companies to select for improved livestock and maximise genetic gain. This paper examines, from the perspective of one major DNA genotyping service company, *Genomnz*™, how widespread and rapidly DNA testing in sheep, cattle and deer has been taken up by the livestock breeding industry in New Zealand.

MATERIALS AND METHODS

The commercial DNA tests offered by *Genomnz*™ are listed in Table 1. Although our data covers most non-dairy livestock DNA testing in New Zealand we are only a minor provider of DNA testing to the dairy industry where GeneMark™ is the major provider. Two other service laboratories have been active during this time. Commercial DNA tests are provided by Lincoln University for footrot resistance and lamb survival, and between 1999 and 2003 a DNA testing service was provided by Signagen™ which has since ceased trading.

Table 1: Combined list of DNA tests offered by the *Genomnz*™ service laboratory.

Species	Test	Total number of samples tested up to Jan 2007	Year test introduced
Sheep	Parentage identification	277,707	2000
	Inverdale gene test	10,642	1997
	Booroola gene test	8,747	1996
Cattle	Parentage verification and identification	15,597	1996
	Myostatin gene test	332	2001
	Calpain-1 gene test	290	2004
	BLAD gene test	232	2005
	CVM gene test	276	2005
Deer	Parentage identification	59,329	1996
	Wapiti hybrid test	~5000	1996
Salmon	Parentage verification	4,287	2003

Not included in this table is the contract R&D testing undertaken by *Genomnz*™, in particular genome scans that are done under contract to research organisations, many of which have confidentiality provisions. The scope of this report is therefore limited to the uptake of DNA testing by commercial breeding enterprises. To our knowledge only a few single gene tests have been supplied by overseas laboratories, and all DNA parentage identification undertaken by commercial breeders in NZ has been provided by New Zealand laboratories. The thoroughbred and standardbred horse racing industries have for many years required auditing of their pedigrees. In NZ this is undertaken at Massey University for thoroughbreds and in Australia for standardbreds. The samples from all animals sent to the laboratory are stored. Most samples are either blood spots on Whatman FTA paper or hair follicles stored in envelopes. In both cases when stored in a cool dry environment these samples are likely to last for decades. This large collection of DNA samples, from many of NZ's leading livestock breeders, is likely to prove useful in tracking the genetic progress of our national herds and flock.

RESULTS

The growth of parentage testing in all three ruminant species is shown in Figures 1- 3.

In deer, cattle and sheep major growth has taken place in the last 3-4 years. Prior to 2001 relatively slow growth occurred in deer and cattle. With sheep DNA testing, which did not become available until 2000, uptake by the sheep community has shown rapid growth. Gene tests have not experienced the same rapid growth of the parentage tests (Figure 4).

This is probably due to the specialised nature of the tests and because, once a gene variant has either been fixed or eliminated in a population, testing requirements are reduced. The cause of the growth is shown in Figures 5 and 6 where the mean number of DNA samples per client has been determined for deer and cattle. In both cases the increase is due to an increase in the number of samples existing clients send to the laboratory rather than any major increase in the number of clients using the service.

DISCUSSION

It is clear from this paper that the use of DNA testing especially for parentage has become a widely used technology by the animal breeding industries for deer, sheep and cattle in New Zealand. Its adoption has primarily been by larger scale breeders who are best able to capture the benefits of reduced labour inputs and hence justify its cost. The highly skilled labour to observe and record the birth of pastoral livestock is not required if DNA parentage is used. An additional benefit is that single sire mating is not required. This means mating groups can be larger and more efficient use of grazing can be made.

At present DNA tests for a few genes of major effect are also available for sheep and cattle. Those DNA tests for deleterious genes such as BLAD (Batt *et al.*, 1994) in cattle and spider lamb syndrome in sheep (Drogemuller *et al.*, 2005) have been widely used to screen affected populations but as carriers are removed use of the tests diminishes. Those DNA tests for traits having a beneficial effect such as DGAT1 in dairy cattle (Spelman *et al.*, 2002) and Inverdale in sheep (Galloway *et al.*, 2000) have been widely adopted by the industry and DNA testing has been used to introgress the beneficial gene variants into new populations. Once again, however, as the trait becomes fixed in the population, use of the test will diminish.

The sequencing of the cattle genome has recently been completed and an international consortium to sequence the sheep genome is in place, the goal being to complete the sheep genome within 4 years. These initiatives have or will give us over a million DNA markers. This means that for these two species DNA markers can be used directly to estimate the breeding worth of an individual. This process, called Genome wide selection (GWS), has just begun to be used in the dairy industry (Schaeffer, 2006). It will increase the rate of genetic improvement and is the logical successor to single DNA tests as it means that all the genomic contributions to a particular trait can be recognised and used to assess the breeding worth of an individual.

Unlike manufactured products where the design blueprint and assembly schedule are separate from the product itself, biological products carry the blueprint with them in the form of their DNA. We can only change many features of the biological product at breeding time. Previously this has been done using a combination of pedigree information and measuring the performance of the animal (product). Increasingly the future will see direct examination of the product blueprint (DNA) replacing trait measurement in animals. Those breeders currently collecting samples for DNA parentage will find that the samples have increasing value, over the next decade, for direct measurement of the animals DNA blueprint.

Figure 1: Annual number of Cattle parentage tests.

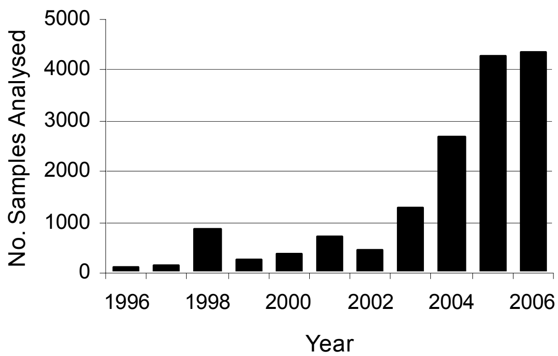


Figure 2: Annual number of Deer parentage tests.

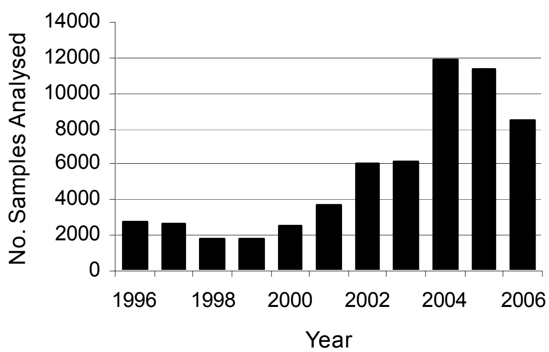


Figure 3: Annual number of Sheep parentage tests.

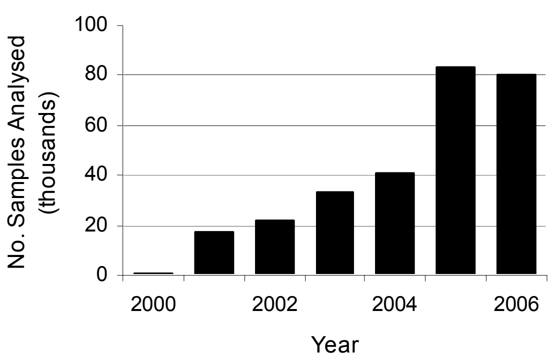


Figure 4: Annual number of gene tests in all species.

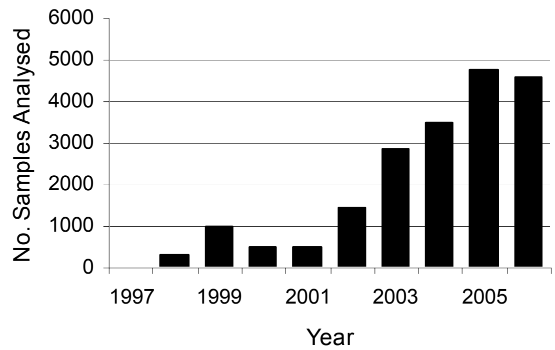


Figure 5: Mean number of Deer parentage tests per client.

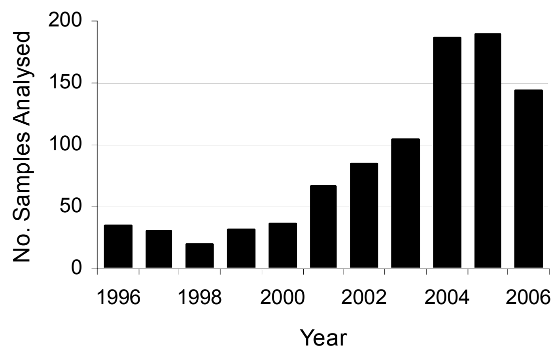
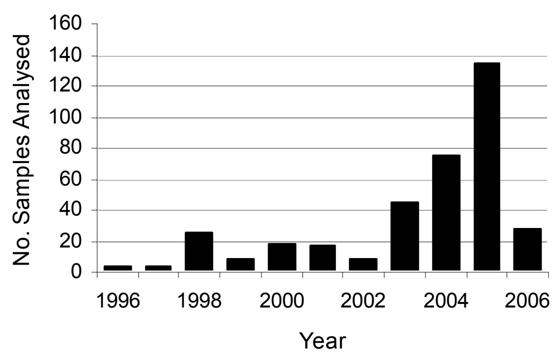


Figure 6: Mean number of Cattle parentage tests per client.



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