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Living Legend Address

The sire-breeding programmes of the Department of Lands and Survey and Landcorp Farming Limited

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Abstract

Over 44 years to 2011, the Department of Lands and Survey (Lands and Survey) and its successor Landcorp Farming Ltd (Landcorp), operated sire breeding programmes to service the large populations of females run on the many commercial farms operating under these two respective institutions. Following the establishment of the first breeding programme in 1967 (the Waihora Romney Programme), a total of 19 sheep, six beef cattle, 15 deer, and four goat programmes were established at one time or another. When Landcorp was formed in 1987, the breeding programmes were regarded as an integral part of a new coordinated production system. Breeding programmes that promised a better commercial fit for Landcorp replaced older programmes that did not. By 2011, there were five sheep, four beef cattle and five deer herds involved as either maternal- or terminal-sire breeding programmes, all of which have shown positive rates of genetic improvement and sire rankings that are at the forefront of their respective breeding industry sires. As the first animal breeding scientist appointed by the Department of Lands and Survey in 1982, it has been a privilege to have technically managed the breeding programmes, and the development of new selection criteria, database facilities and measurement techniques. This “legend” of the Lands and Survey and Landcorp breeding programmes is a documentation of an internationally unique large-animal breeding resource.

Keywords: Lands and Survey; Landcorp; breeding programmes; genetic improvement; sheep; beef cattle; deer; goats

Introduction

In 1967, the Department of Lands and Survey (Lands and Survey) first established a ram breeding programme for its Rotorua Land Development District, primarily to overcome the shortage of sires of the required genetic merit that were available from stud industry sources. The scale of the Rotorua District’s commercial ewe population provided the scope for intense screening for high-performing ewes to enter the breeding programme from which high-merit sires were distributed back to the commercial ewe flocks. This was a landmark decision for a government department to make. History has shown the importance and validity of that first decision. Other Lands and Survey Land Development Districts soon followed suit. The “legend” that follows is the documentation of that history from 1967 to 2011, including the establishment of Landcorp Farming Ltd (Landcorp), the breeding programmes that came and went, and my part in that history.

The Group Breeding Scheme concept

The concept of a group breeding scheme is to use a livestock resource (the base) to screen females to establish a nucleus from which sires are bred and selected for use over the dams in the base. Rae (1974) outlined the potential of such a system. From the mid 1960s, several groups of industry breeders with similar breeding objectives began pooling their recorded dam resources and screening the high-performing females into a nucleus so they could benefit from the use of the elite sires produced.

In 1967, the Rotorua Land Development District was the first in the Lands and Survey to follow the group breeding scheme concept, establishing a sheep breeding programme based on screening twin-rearing two-tooth ewes (Hight et al. 1975). This was followed in 1990 with the establishment of an Angus bull breeding programme based on screening cows that raised a well-grown calf (Dalton & Gibson 1975; Gibson & Dalton 1973). An entertaining history of the early stages of these two programmes has been described by Dalton & Lang (2008).

The nucleus sheep flock and beef cow herd were both run on the Waihora Farm Settlement block in the central North Island, and hence, have been commonly referred to as the Waihora Romney programme and the Waihora Angus programme. They both still exist today, respectively representing 47 and 44 years of continuous selection for improved performance. The Waihora Romney programme is now located on Landcorp’s Goudies Station east of Reporoa. The Waihora Angus programme is run on the Deep Creek block of Landcorp’s Rotomahana Station south of Reporoa.

Compared with other industry group breeding schemes operating at the time, the difference in the Lands and Survey situation was the scale of the commercial base female populations from which elite dams were screened. The screening process to form the Romney and Angus nucleus units did not involve a couple of thousand females over five or six well-developed farms. It involved populations of commercial two-tooth ewes and beef cows, each

Table 1 List of sheep and beef cattle breeding programmes instigated under the Department of Lands and Survey and Landcorp Farming Ltd.

Species	Breeding programme	Year started	Year closed
Sheep:	Waihora Romney	1967	
	Wiremu Romney	1970	1995
	Lynmore Romney	1970	1999
	Moutoa Romney	1974	1989
	Wakelins Perendale	1975	1993
	Wairakei Booroola x Romney	1981	1991
	Matea Perendale	1983	1993
	Agovine Romney	1984	1993
	Agovine Coopworth	1984	1993
	Agovine Poll Dorset	1984	1993
	Omamari Booroola x Romney	1985	1989
	Eyrewell Karakul	1989	1992
	Huanga Merino	1989	1996
	Waikite Texel	1990	
	Huirimu Lamb Supreme	1990	
	Kepler Lamb Supreme	1990	
	Otutira Oxford Down	1990	1993
Waihora Landmark	1999	2008	
Freestone Landmark	1999		
Beef cattle:	Waihora Angus	1971	
	Rangitane Angus	1972	
	Wiremu Angus	1972	
	Whareroa Simmental	1972	
	Whareroa Charolais	1972	ca 2007
	Stoney Creek Santa Gertrudis	1975	1994

numbering in the tens of thousands across a large number of stations undergoing development on the central plateau pumice country. Furthermore, the two nucleus units were proportionately larger than those in industry group schemes in order to provide sufficient numbers of above-average sires for use over the Department's commercial female populations. Many industry observers remarked at the time (and such comments continue today), on the genetic advantages of having scale in the nucleus when it came to selection. Certainly there is a scale advantage when screening from a large population to establish a nucleus flock or herd. However, from that point on, scale in the nucleus confers little if any advantage in the intensity of sire or dam selection – at least under natural mating.

Expansion of breeding programmes in Lands and Survey

Shortly after screening started for the Waihora Romney and Angus programmes, the Superintendents

of other Land Development Districts of Lands and Survey started their own breeding programmes following the principles used in establishing the two Waihora operations. The main reasons for these initiatives included a continuing shortage of sires of the required merit from industry breeders, the savings in sire costs over time, and having local control over genetic direction.

These new programmes were primarily established over the period 1970 to around 1987 (Tables 1 and 2). They involved Romney sheep on Wiremu (Taranaki), Moutoa

(Wellington) and Lynmore (Southland) stations, Perendales on Wakelins (Northland) and Matea (Taupo), Booroola x Romneys on Otangimoana then Wairakei (Taupo) and Omamari (Northland), a joint venture involving Romney, Coopworth and Poll Dorset sheep on Freestone (Te Anau), Angus cattle on Rangitane (Northland) and Wiremu (Taranaki), Simmentals on Whareroa (Wellington) and then Waikite (Rotorua), Charolais on Whareroa (Wellington) then Goudies (Rotorua), Santa Gertrudis on Stoney Creek (Northland), Wapiti on Orokonui (Otago) then Freestone (Te

Anau), and Angora goats on Waitangi transferring to Keri Downs (Northland).

In 1982, I was the first animal scientist to be appointed by Lands and Survey to technically manage, coordinate and rationalise this huge variety of programmes spread throughout the country. I assumed responsibility for the technical management and genetic direction of all breeding programmes for sheep, cattle, deer and goats which involved nine breeds operating on some 16 farms. With nobody having had this job description before, it was clearly going to be a challenge climbing a huge and rugged mountain of resistance. On the other hand, the position offered a unique opportunity to exploit the advantages that coordinated and technically sound sire breeding programmes could offer the commercial stations in Lands and Survey. After initially experiencing some punishing visits to these stations and talking with all farm managers on different occasions, the positive outcomes of improved productivity and continual genetic improvement over the last 20 years or so have been gratifying.

Table 2 List of deer and goat breeding programmes instigated under the Department of Lands and Survey and Landcorp Farming Ltd.

Species	Breeding Programme	Year started	Year closed
Deer	Kiroa Red	1989	1992
	Stuart Red	1990	
	Rangitaiki Red	2003	
	Woodstock Red	2003	2004
	Keri Downs Red	2003	2005
	Goudies Red	2003	2007
	Raurimu Red	2004	2005
	Taurewa Red	2004	2005
	Waiteti Red	2004	2005
	Otaipuhi Red	2005	2006
	Cape Foulwind Red	2005	2007
	Weka Red	2005	2007
	Butlers Red	2005	
	Orokonui Wapiti	ca 1985	
Kiroa Wapiti	2004	2013	
Goats	Waitangi/ Keri Downs Angora	1987	ca 1999
	Keri Downs Boer	1987	2005
	Eyrewell Angora	1988	1999
	Eyrewell Boer	1988	2003

The breeding programmes under Landcorp Farming Ltd

In the period from establishment of Landcorp Farming Ltd (Landcorp) in 1987 through to 1999, I assumed additional responsibilities for another 11 new breeding programmes, many of which were being evaluated as sources of additional genetic material. This period saw the total number of programmes rise to a maximum of 28 in 1990 and 1991, followed by a decline to 15 a decade later (Fig. 1).

Under Landcorp's new corporate philosophy, the breeding programmes under Landcorp were regarded more for their value in contributing to the company's national livestock productivity than for their role as localised independent sire production units. This came about through the commercial focus of Landcorp, requiring coordinated production policies among its different regions as opposed to the primarily within-region focus under Lands and Survey. The breeding programmes were rightly considered an integral part of this coordinated approach. The value of the breeding programmes was regarded as the distribution of high-merit sires over more than 400,000 breeding ewes, 38,000 breeding cows and 60,000 hinds annually producing 342,000 lambs, 19,000 prime beef cattle and 32,000 yearling deer for slaughter (figures at 30 June,

2013; M Gaukrodger, Personal communication). This integration of breeding programmes with the commercial populations in Landcorp was commonly referred to as "the entity": a concept that was foreign to some industry people who maintained that the value of the breeding programmes was the dollar value of the sires going out the gate.

Over the ensuing years, Landcorp's philosophy of continuing improvement meant that each breeding programme, new and old, was evaluated for its role in the national livestock production system – the entity. Over time, these reviews resulted in several programmes being closed down and other new ones established.

Examples of some of the new breeding programmes evaluated included (Table 1):

i. The importation of Merino sheep from Australia in partnership with the breeder (Mr J May, "Springfield", Goulburn, NSW) to form the Huangua Merino programme on Tiromoana station (Canterbury).

ii. A Texel breeding programme was established on Waikite Station (Rotorua) from purchased imported animals post quarantine. Additionally, a non-breed-specific terminal-sire breeding programme called Landcorp Lamb Supreme was established on Huirimu Station (Te Awamutu) and Kepler farm (Te Anau), based on a massive screening of 501,000 young ewes on live weight over two years (Nicoll et al. 1992).

iii. Along similar lines, a composite maternal line (the Landmark) was developed from screening high-weaning-weight ewe lambs from some 54,000 commercial terminal-sired ewe lambs.

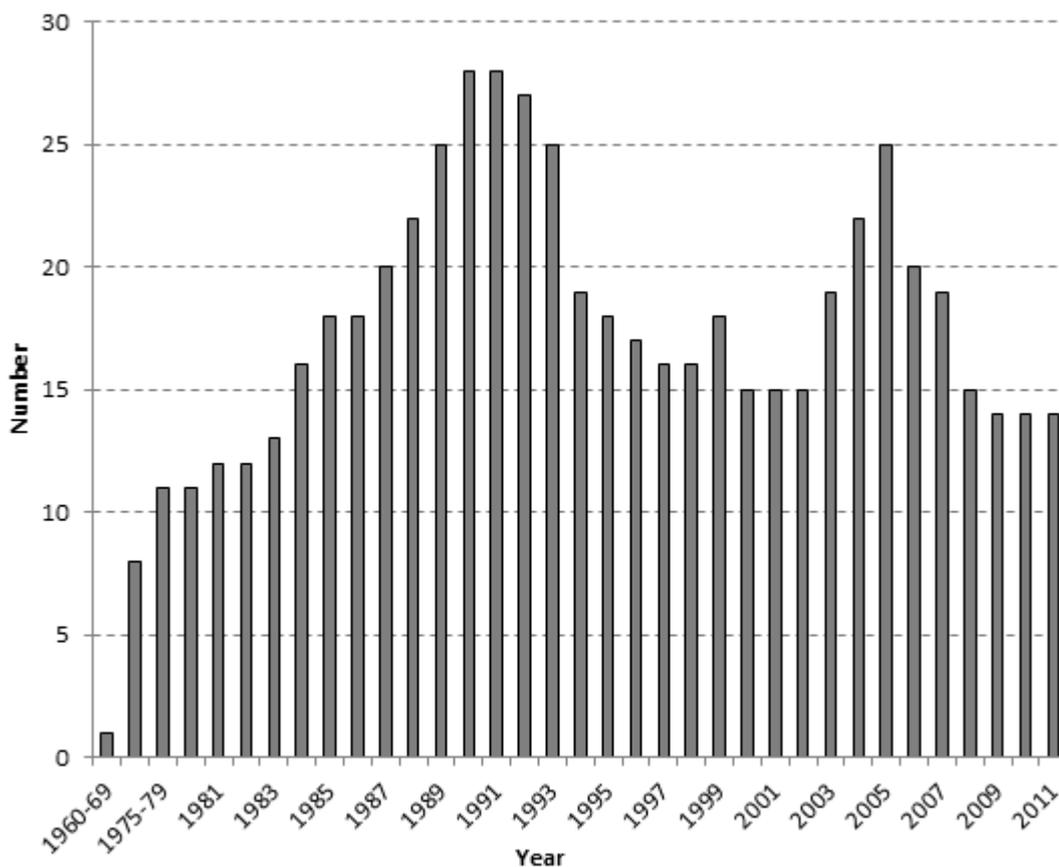
The fates of existing programmes included (Table 1):

i. Absorption of selected Moutoa Romney ewes into the Wiremu Romney flock, which in turn was subsequently absorbed into the Waihora flock, and the Lynmore Romney ewes merged into the Landmark programme on Freestone in Te Anau.

ii. Not surprisingly, given the lambing management in the 1980s and the high incidence of multiple births, poor lamb survival rates resulted in the Booroola x Romney flocks in Northland and Taupo being closed down.

iii. The Santa Gertrudis programme in Northland was closed due to the circus of pedigree registration requirements impacting on herd selection intensities and poor performance of the crossbred progeny on local Landcorp farms.

Figure 1 Total number of breeding programmes operated by the Department of Lands and Survey and Landcorp Farming Ltd from 1960 to 2011 (includes sheep, beef cattle, deer and goats).



It took approximately 10 years for the breeding programmes to settle into key breeds that had maternal or terminal roles in the Landcorp production system. The outcome was one of the largest coordinated non-dairy livestock-breeding programmes internationally. The formally defined structure and economic objective of Landcorp’s breeding programmes in association with large-scale integration with commercially producing farms, was more like the overseas pig and poultry breeding and production systems than those of sheep, beef and deer. It remains a sad fact that Landcorp’s breeding programmes were often more widely acknowledged and respected internationally than they were in New Zealand.

Rationalisation of the breeding programmes continued as focus shifted to more intense and accurate recording of animals in fewer programmes that were considered to be major contributors to the economic success of Landcorp’s commercial farming business. In the mid 2000s a novel “dispersed nucleus” structure was established in the Red deer programme (Table 2), involving small nucleus herds on Keri Downs (Northland), Rangitaiki, Woodstock, Raurimu, Taurewa, Waiteti and Otaipuhi (Rotorua-Taupo), and Cape Foulwind, Weka and Butlers farms (West Coast). However, this design was short lived due to on-farm problems with inexperienced staff not appreciating the need for quiet handling and attention to detail at all

animal recording operations. The Butler’s herd (now called Raft Creek) remained operational with the selective absorption of hinds from the Cape Foulwind and Weka herds.

Angora and Boer goats had no major productivity role in Landcorp’s commercial farming systems. Their retention up to this time had been based on industry demand for breeding sires and dams. As production of mohair and meat moved into more lifestyle/cottage-type industries, and overseas interest in these animals declined, the Angora programme was the first to be disbanded. The Boer goats were maintained a little longer to satisfy Chinese interests, but ultimately this breeding programme was also closed down and the animals sold (Table 2).

By around 2008 through to 2011, the sheep breeding programmes ended up with two maternal lines of sheep in three flocks (the Romney and the Landmark composite), and two terminal-sire lines in three flocks (the Lamb Supreme composite and the Texel). The Angus programme remained as the maternal beef cattle line with three herds, and the Simmental herd as the terminal-sire line. In the deer, the lines stabilised at three herds for the maternal Red deer and two herds in the terminal sire Wapiti.

Improved animal measurement

When the Waihora Romney and Angus programmes first began, one challenge was to support the staff on Waihora to understand the requirements of recording individual animals. It wasn't easy – instilling a culture of accuracy and patience, for example, when identifying and recording dams at lambing or calving, and recording their offspring's identification, birth rank, birth date, sex, degree of assistance, and if necessary its fate. Often all this was accomplished using pencils and waterproof pads while dodging an irate cow or putting up with an interfering and anxious ewe. It should be noted that at this time, all sheep tags were small brass tags punched in the ear; there was no such thing as highly visible plastic ear tags. Dam identification at lambing was achieved by hanging large-numbered tags around the necks of the ewes. This involved a separate "neck tagging" event prior to lambing by referencing each ewe's brass tag with the neck tag number as it was hung around the ewe's neck. The Angus programme avoided any such problems with the use of the first Ritchy plastic ear tags that had just become available – a novelty that quickly became the norm for all species as the legibility and durability of the tags improved.

More effective recording processes gradually developed in the Waihora programmes as experience developed, new products came on the market, and new things were learnt through discussions with other breeders recording the performance of their animals. At one stage, in order to improve the accuracy of recording in the yards, point-to-point radio links between tag reader and recorder was tried at lamb weaning. This effort to have clearer communication, especially under covered yards, unfortunately failed to overcome the collective reverberating din of dogs barking, shepherds yelling, and thousands of lambs and ewes bleating and baa'ing.

The primary traits recorded in these early years were number of lambs born and weaned, weaning weight, autumn weight and fleece weight in the sheep, and number of calves born and weaned, and weaning, yearling and 18-month weights in the cattle.

Some of the major recorded traits that were added to the different programmes over the years were:

- i. Tolerance to facial eczema (FE) was one of the more important traits included in selections in the Waihora Romney programme. It was introduced in 1990 to combat the negative impact of the disease on commercial flock performance in the Northland Land Development District of Lands and Survey. Now, after 24 years of continuous testing and selection, the Waihora Romney flock is the country's foremost flock in genetic merit for tolerance to FE.
- ii. The introduction of ultrasound pregnancy scanning enabled the litter size of pregnant ewes to be predicted, which in turn allowed lamb survival analyses to be better defined than before. This was particularly the case in Landcorp's breeding programmes where lamb

fates were comprehensively recorded at several time periods from pregnancy scanning on many thousands of animals (e.g., more than 30,300 lambs diagnosed *in utero* in 16,800 pregnant ewes over two years in five flocks in the study of Nicoll et al. 1999). Unfortunately, such detailed on-farm information has now been lost with the introduction of DNA parentage testing in 2001.

iii. Ultrasound scanning lambs for fat depth and eye muscle dimensions added a new component to terminal-sire breeding programmes selecting for low fat and improved weight of meat in the carcass. All lambs of both sexes underwent these measurements right from the start in Landcorp's Lamb Supreme and Texel terminal-sire programmes.

iv. The advent of computed tomography (CT) scanning added an even greater dimension to Landcorp's Lamb Supreme and Texel breeding programmes. Ultrasound scan information from all lambs in the first stage of a two-stage selection process, allowed identification of a lesser number of ram lamb candidates to undergo the more expensive CT scanning in the second stage to produce information for final sire selection. Use of CT scanning was considered profitable in large scale breeding operations, particularly when the programme was integrated with commercial production of slaughter lambs as in Landcorp (Jopson et al. 1997). Certainly, there was a 68% advantage in the rate of genetic improvement in a Lean Growth Index from using ultrasound and CT scanning in the breeding programmes compared with using ultrasound scanning alone (Nicoll et al. 2002). A more recent comparison has shown that under the same two-stage process, the rate of genetic improvement in today's SIL-ACE Terminal Sire Index (TS) was double that expected under ultrasound scanning alone (GB Nicoll, Unpublished data).

To my knowledge, Landcorp is internationally the largest individual user of CT scanning for selection purposes in sire breeding programmes (approximately 250 ram lambs and 60 young stags annually). Furthermore, Landcorp was the first in the world to collaboratively develop the protocols to apply CT scanning in its deer breeding operations (Nicoll & Jopson, 2006).

v. Along with other industry breeders, Landcorp has continued an active participation in the development of genomic tools, particularly in sheep. Such investigations require large numbers of accurate and reliable phenotypes from which to establish SNP-based criteria for subsequent use in selection. The breeding programmes have yet to develop appropriate procedures to apply the results of these developments.

Recording systems and genetic evaluation

To improve data accuracy and speed of operation, Landcorp was among the first of the performance recording breeders to develop and apply the use of computers for on-farm animal recording. The first step

was to evaluate the process in the Waihora Romney operation by recording animal data on a computer in the yards using a heavy wooden-cased Apple II - with two 5¼ inch floppy drives! Around 1989, the second step was the development of what was probably the first relational database for sheep improvement in the country by my colleague Maureen Alderton. By this stage we were using laptop computers and 3½ inch discs which were pre-loaded with the appropriate animals to record. On completion of the recording operation by farm staff, the discs were returned by post for import into the database. All of Landcorp’s sheep, deer and goat programmes were using this system. In 1995, the third step was the development of a more sophisticated database and recording system by Peter Gallagher, the manager of Landcorp’s IT group, again with the intensive involvement of Maureen. This system electronically delivered both raw and processed data to and from the Landcorp breeding operations. The final step involved this in-house database being retired in 2010 and the transfer of Landcorp’s sheep, deer and goat data to the now technically more efficient Sheep Improvement Ltd (SIL) and DEERSelect systems.

In the very early days of the Waihora Romney and Angus programmes, evaluation of animals for selection was based on individual trait deviations from their contemporaries. This was pretty smartly replaced by use of index selection, based on the definition of an economically-based breeding objective for commercial farm production. A selection index is an equation that predicts an animal’s aggregate genetic merit across the different traits by economically weighting the breeding value of each trait according to its contribution to the defined breeding objective (usually profitability per dam or per ha). The Waihora Romney programme was among the first performance-based ram breeding operations to apply index selection, which served to form the basis of the index(es) used in the National Flock Recording Scheme (NFRS). The Waihora Angus programme, to my knowledge, was the first commercial bull breeding operation internationally to formally define an economically-based breeding objective and use index selection. Much of the background material in relation to this has been covered by Enns & Nicoll (1997a, 2008), CA Morris, RL Baker, DL Johnson 1978 (Unpublished manuscript), Newman et al. (1992) and Nicoll et al.

(1979).

The Lands and Survey breeding programmes that were established throughout the country initially used the industry-based NFRS (then Sheeplan) and Beefplan performance recording systems. The two Waihora programmes remained independent of these systems due to the database designs, traits recorded and the genetic evaluations being more quickly developed and in advance of the comparable industry systems of the day. Many industry breeders and their clients were critical of that position. However, in the early 1990s, the data from the Angus programme (and all other Landcorp beef cattle programmes) were transferred to the Breedplan system and have continued with that genetic evaluation system ever since then.

In 1995, a similar genetic evaluation system was developed for Landcorp’s other breeding programmes by Dr Mark Enns, a contracted post-doctoral student from the University of Colorado. This new genetic evaluation system resulted in Landcorp becoming the first breeding operation in New Zealand to select animals using BLUP-derived trait BVs and to provide evidence of genetic improvement over time in sheep, deer and goat programmes. This was a watershed moment. For up to 30 years we had been selecting animals on objectively measured traits and contemporaneous least-squares analyses, but could not provide substantiation of genetic improvement over time. There was information available comparing the performance of progeny sired by Waihora Romney and Angus sires with those sired by industry-bred sires in the mid 1980s (see next section), but it was effectively a static outcome applicable to the time of the trials. However, this new BLUP-based evidence of successful genetic improvement across years in the breeding programmes brought feelings of both relief and satisfaction that we had been selecting animals appropriately. Landcorp no longer had to defend its breeding programmes to breeders sceptical of “computer-bred animals” and rams and bulls with “figures” that didn’t match the way real sires should look. Now we had indisputable evidence of genetic improvement which confirmed for us that we had been right in using the technical principles of selection, and from that we gained a new-found confidence in our processes, selection decisions and results. Some examples of successful selection in the breeding

Table 3 Comparative rankings of Landcorp- and Industry-bred sires for a range of SIL-ACE Indexes.¹

	SIL-ACE Index			
	Dual Purpose ²	Dual Purpose+FE ²	Terminal Sire ³	Terminal Sire Meat ³
Number of flocks	116	17	72	72
Number of sires	2615	355	1177	1177
Landcorp sires in top 25	6 (24%)	20 (80%)	6 (24%)	13 (52%)
Landcorp sires in top 50	13 (26%)	35 (70%)	15 (30%)	24 (48%)

¹SIL-ACE run Feb 2014 (Accessed 26/3/14); ²Waihora Romney; ³Lamb Supreme and Texel.

programmes are shown in Table 3. It compares the numbers of Landcorp-bred sires used in the Romney, Lamb Supreme and Texel breeding programmes with industry-bred sires evaluated on a range of SIL-derived Advanced Central Evaluation (SIL-ACE) Indexes (SIL-ACE run of February 2014).

Of the sires ranked in the top 25 of 2,615 sires analysed for the SIL-ACE Dual Purpose Index, six (24%) were Landcorp-bred Waihora Romney sires, and 13 (26%) of the sires ranked in the top 50. Incorporating the breeding value for FE in the SIL-ACE Dual Purpose Index, fewer flocks (17) and sires (355) were involved in the analysis. Waihora Romney sires comprised 20 of the top 25 (80%) and 35 in the top 50 (70%), reflecting the selection intensity available from FE tolerance testing large numbers of young rams (averaging 138 per year), over a long period of time (23 years to autumn 2013).

Similar numbers of Landcorp-bred Lamb Supreme and Texel rams also ranked in the top 20 and 50 sires for the Terminal Sire Index (six and 15, respectively) and Terminal Sire Meat Index (13 and 24, respectively). The dominance in these rankings reflects the long-term use of CT scanning for selecting sires for improved carcass meat production and low fat (18 years as at March 2014).

Lands and Survey and Landcorp trials

The land and animal resources enabled Lands and Survey/Landcorp to conduct comparative trials and evaluations for a variety of reasons. Five notable collaborative projects of this nature are shown in Table 4.

When Lands and Survey set up the Romney and Angus breeding programmes, industry breeders actively objected, citing the loss of business and the conflict of a public service department entering into the sire market. They also believed that the progeny by sires derived from commercial animals would not confer productive benefits compared with those sired by industry-bred stud sires. Lands and Survey established the Romney and Angus trials on Tihoi Station (Taupo) to compare the progeny sired by average merit Waihora-bred sires with those of industry-bred stud sires independently purchased by another Lands and Survey District. Both these groups of sires were mated to commercial Lands and Survey females, with all progeny recorded for growth and

reproduction traits.

The sheep trial ran for 15 years (1972-1985 lambings). More complete records from 1979-1985 were used to compare the performance and financial returns from two flocks that had been continuously mated to either Lands and Survey or industry-purchased rams (Nicoll 1989). By 1985, the composition of the ewe flocks was regarded as Waihora-bred and Industry-bred. The Waihora-bred flock out-performed the Industry-bred flock in reproductive rate, litter size, weaning and carcass weights, earlier drafts to slaughter, ewe weight (particularly as hoggets and two-tooths) and financial returns per ewe from lambs and wool.

The Angus trial ran for 10 years (1976-1986 calvings), and was designed in a 2 x 2 mating design to produce second-generation progeny that were sired by either Waihora- or Industry-bred bulls and were out of dams that in turn were sired by either Waihora- or Industry-bred bulls. Weights at weaning, calf weaning weight per 100 kg cow weight, and yearling and 18-month weights were compared in the second-generation animals. For all traits except 18-month weight, animals with any Waihora-sourced pedigree, whether through a sire or a maternal grandsire, had higher levels of performance than individuals that had both a maternal grandsire and a sire from industry sources (Enns & Nicoll 1997b).

Two Lands and Survey trials were much less intensive, involving comparatively small numbers of goats captured independently from Arapawa and Auckland Islands. The objective of both trials was to evaluate the commercial potential of animals that had not undergone any artificial selection for over 100 years. The Arapawa Island goats were run on a Ngawhatu Station (Nelson) and the Auckland Island goats on Snowden Station (Te Anau). The Arapawa trial unfortunately lasted only four years due to the constant and successful attention of feral bucks from the neighbouring gorse covered hills, despite “goat-proof” fences having been erected. With no other “goat-proof” locations available in the region, the project was closed down. The Auckland Island goats experienced survivability issues arising from climatic and probably nutritional adaptation, in addition to susceptibility to a range of diseases. Fortunately, sufficient performance information was available to indicate that there would be limited commercial value in maintaining these animals as a distinct line and they

were absorbed into Snowden’s commercial goat flock.

The Carwell Gene Project involved Landcorp and AgResearch generating lambs initially sired by two putative carrier Poll Dorset rams from the “Carwell” stud in Australia. The locus of the Carwell gene was identified, a marker test developed, the

Table 4 List of experimental projects instigated by the Department of Lands and Survey and Landcorp Farming Ltd.

Project	Year started	Year closed
Tihoi Romney Comparison	1972	1985
Tihoi Angus Comparison	1976	1987
Ngawhatu Arapawa Island Goats	1978	1982
Snowden Auckland Island Goats	1987	1990
Dun Craigen Carwell	1996	2000

gene's effects evaluated, and its mode of inheritance determined (e.g., Nicoll et al. 1998; Jopson et al. 2001). Further independent refinements of the marker test by AgResearch resulted in it being marketed as the "LoinMAXTM" test.

Some personal reflections

It is fair to say that when I was appointed by Lands and Survey to manage and coordinate all the breeding programmes, I found the prospect exciting, and in my ignorance did not consider for a minute what challenges would face me. One challenge to overcome in the coordinating role was the resistance from senior office staff and some of the older farm managers over a young academic taking over "their" breeding programmes. Without knowing that management courses would call it "managing upwards", I spent my time working directly with the more positive field officers and farm managers of the different breeding programmes around the country. Exploiting their interest, we just got on with the job of operating the programmes in the field – a feature that gradually spread over time. In terms of coordinating the programmes, the process simply flowed from the sheep and beef operations using the national recording systems available at the time.

Some of the highlights over nearly 40 years working with Lands and Survey and Landcorp have included:

- i. The satisfaction when we first had evidence of positive genetic improvement in a wide range of traits and indexes in all breeding programmes operating at the time. It is rewarding to know that this positive progress continues with the breeding programmes of today.
- ii. Developing database systems to ensure data integrity for effective genetic evaluation. The outcomes have included improved recording and operational efficiency.
- iii. The development of the Landcorp Lamb Supreme and the Landmark terminal and maternal composites, respectively has been another highlight. The opportunity to exploit the huge animal resource in Landcorp to establish these programmes makes them internationally unique: a powerful illustration of the benefits of scale and its impact on selection intensity.
- iv. Investigation of new measurement techniques to better align with selection criteria and improve genetic evaluation accuracy. The establishment of the *INNERVISIONTM* CT facility in association with Bernard Card and AgResearch personnel, has been a particularly memorable highlight. The Carwell gene project was one example of the benefit resulting from the deliberate use of CT measurements. Accurate carcass measurement to determine the effect and mode of inheritance of the gene still allowed the measured animals to be retained for breeding.
- v. The opportunity to travel internationally to attend animal breeding conferences and to present papers on

Landcorp's breeding programmes and unique livestock resources, has enabled me to gain an understanding of breeding and farming systems in a variety of environments, and to establish some long-lasting professional friendships.

vi. No career is experienced in a bubble. Over almost 40 years, it is humbling to look back and consider the huge number of people that have been associated with the many different breeding programmes. Three men in particular have been closely involved in the programmes as senior managers and mentors. Eric Gibson, for his foresight in accepting scientific evidence to establish the Waihora sheep and beef breeding programmes, Tom Mackenzie for his decision to proceed with those programmes and for his support in providing animal and land resources for scientific enquiry, and Bernard Card for his continued support of science and of the role of the breeding programmes within a corporate structure. The association I've had with the many farm managers, shepherds, farm field officers/business managers, and regional managers has also been very gratifying. It is a credit to them all that their commitment to the programmes was typical of the rural ethic – understand what needs to be done then get on with it. The same is true for the many scientific, technical and database staff who worked behind the scenes of the breeding programmes. I also want to sincerely thank the many industry scientific researchers, teachers and technicians throughout the country who have willingly provided advice and support over the years.

Every one of these people contributed something of value that is reflected in the breeding programmes, and every one of these people must share in the successes that the programmes have achieved to date.

Finally, I've often stated with sincerity that running the breeding programmes was to me, "The best animal breeding job in the world". Who else has had the privilege of having the support and opportunity to develop and manage a coordinated suite of sire breeding programmes integrated with real populations of commercially-producing sheep, beef cattle and deer?

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