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Genetic improvement and importance to sheep and beef farming

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ABSTRACT

The agricultural sector has undergone a large change in 15 years from 1985 to 2000. Changes in livestock numbers signpost the changes in agriculture and land use. Over 15 years of restructuring nothing has replaced agriculture's contribution to GDP. The agriculture sector change has led to a more efficient sector at all levels and of particular note is the significant increase in sheep productivity. Following from this the potential for further sheep genetic improvement is discussed using the Meat and Wool Economic Service's All Classes Sheep and Beef Farm to show farm potential.

Keywords: land; use; knowledge; sheep; lamb; productivity; GDP; genetics; carcase; fleece; improvement.

INTRODUCTION

The economic reforms introduced to the whole economy in late 1984 fell heavily on agriculture. As a result the pastoral sector underwent a major transformation at the farm, processing and market service levels. All in the sector were affected by significant change.

Livestock number trends over the past 15-years signpost the key changes that occurred. These are summarised in Table 2 below. Not so obvious is the improvement in animal performance and the continuing importance of agriculture to New Zealand.

TABLE 1: New Zealand livestock number trend

	1985-86 (m)	2000-01e (m)	
Sheep	67.85	45.82	-32%
Beef Cattle	4.61	4.55	-1%
Dairy Cattle	3.31	4.53	+37%
Deer	0.32	1.75	+447%
Goats	0.43	0.21	-52%
Stock Units	107.0	95.74	-11%

Source: Statistics New Zealand Meat a nd Wool Economic Service of New Zealand

Of all the stock number changes, the most dramatic has been the decline in sheep numbers (-32%) from 1 July 1985 to 1 July 2000. Beef cattle numbers show little change (-1%) over the period. In contrast, dairy cattle numbers have shown a significant lift of 37 per cent and their numbers are now similar to the beef cattle herd. This increase has been driven by dairy farming offering greater profitability than other land uses. While deer numbers have also shown a large percentage growth this has been from a small starting base at the beginning of the 15-year period.

Overall, converting these livestock to a common livestock unit basis shows there has been an 11 per cent decline in pastoral animals over 15 years. Virtually all of this decrease has come from reduced sheep numbers. The 11 per cent decrease in livestock units to some extent overstates the situation, as livestock today tend to be heavier and more productive per head than the livestock of 15 years ago. In this context, the "policy" stock unit has not been adjusted to reflect this change.

During this 15-year period, the Economic Service estimates that the number of commercial sheep and beef farms has decreased from 22,000 to 16,400 farms (-25%). These "commercial" farms carry around 94 per cent of the sheep flock.

This decrease has occurred through amalgamation of existing farms, sub division of farms near cities to small-holdings, plus two other major land use changes. The first of these land-use changes has been the sale of whole farms to blanket forestry. These have usually been store stock farms in hill country and this has been a factor removing poorer performing livestock from the sheep flock and beef herd. The second major land-use change has been the conversion of sheep and beef farms on prime land to dairy production.

In the past 6 years, the Economic Service has recorded 1,305 sheep and beef farm conversions to dairy farms, which have displaced 2.5 million sheep and beef stock units. Under dairy production these farms have higher value output per hectare than under meat and wool production systems, can afford higher inputs and are accordingly stocked more intensively than under sheep and beef.

Ignoring the "new" conversion dairy farms, the Economic Service estimates that 17 per cent of dairy farms have gone out of existence over the 15-year period largely through farm amalgamation of small farms. In this period the average dairy herd size has increased from 144 to 230 cows (+60%). Dairy farms numbered around 14,300 in 1999-00 and were down from 15,750 in 1985-86.

REFORMS DELIVERED

The 15 years of reforms have delivered a more efficient agricultural sector. In 1985-86, there were still residual effects of the government support that had been recently removed. However, by 1986-87 any remaining government support to agriculture was negligible. In the 13-year period between 1986-87 and 1998-99 the real Gross Domestic Production (GDP) of the whole economy increased by 21 per cent. However, agriculture's contribution to GDP, on-farm plus input supply and downstream processing, increased from 14.2 per cent to 15.4 per cent. Total GDP grew but agriculture's contribution to GDP grew faster. Reforms did not replace the importance of agriculture to the economy. Instead its contribution to GDP increased slightly. No other significant industries have appeared to displace agriculture's position in the economy.

Compared with 15 years ago, the agriculture sector now has more reliance on dairy production and the portfolio has deepened to include viticulture and deer. The volume of added-value agriculture exports has increased significantly also.

The main agriculture outputs of dairy, meat and wool remain the dominant exports. In terms of export receipts the total agriculture sector exported $10.99 billion worth of goods in 1998-99. In constant dollar terms this was 28 per cent more than in 1986-87 even though drought had depressed dairy (-5%) and meat production in 1998-99.

THE KNOWLEDGE INDUSTRY

What is clear from the 15 years of reform is that New Zealand has found nothing to replace our natural resource industries centred on pastoral farming, forestry, fishing and tourism to view our natural resources.

Our natural resources provide our comparative and competitive advantage in world markets. Knowledge applied to our natural resource industries provides the platform for product development and the base for new add-on industries to emerge. Knowledge that generates profitable development provides economic opportunity and activity. However, knowledge industries need a reason to exist, and need to cluster around centres of excellence and activity. New Zealand's key centres of activity are our natural resource-based industries and this is where we must excel as a country.

SHEEP PRODUCTIVITY

The discussion so far has tabled land use and livestock number changes. However, the decline in sheep numbers taken in isolation masks some remarkable productivity changes that have occurred within the sheep industry. Taking 1986-87 as the base when government support had almost completely dissipated, Table 2 compares 1986-87 lamb production with that achieved in 1999-00.

The sheep number change in Table 2 shows a similar percentage decrease for sheep as in Table 1. However, it should be noted that Table 2 data are for a slightly different period.

TABLE 2: New Zealand lamb productivity

	1986-87	1999-00e	
Sheep No. (m)	67.47	46.08	-32%
Ewe No. (m)	47.79	32.20	-33%
Lambing %	97.7	114.3	+16.6
Slaughter (m)	31.63	25.55	-19%
Av. Weight (kg)	13.20	16.48	+25%
Bone-in(000) tonnes	417.6	421.0	+0.8%

Source: Meat and Wool Economic Service of New Zealand MAF

1986-87 is used as the start year for the reason government support had almost completely dissipated. The 1999-00 end year refers to production for the current year at the time of writing.

Breeding ewe numbers declined by a similar percentage (-33%) to total sheep over the period. Though breeding ewe numbers were down by a third, the total lamb slaughter declined at a slower rate of 19 per cent. This lower rate of decline was achieved through a 16.6 percentage point increase in lambing percentage.

Further, lamb weights were low in 1986-87 averaging 13.20 kilograms and compare with the estimate for 1999-00 of 16.48 kilograms (+25%). The combination of increased lambing percentages and higher average weights have resulted in slightly higher lamb production (+0.8%) in 1999-00 than was achieved in 1986-87. With 33 per cent fewer breeding ewes this is a remarkable growth in sheep productivity.

Export lamb and sheep slaughter weights and bone-in production up to 1992-93 were recorded on a cold weight basis. From 1993-94 onwards these have been recorded on a hot weight basis which adds approximately 2.5 to 3.0 per cent to the cold weights. The 1986-87 total lamb production data in Table 2 was on a hot weight basis and is directly comparable with 1999-00 weight data.

This growth in productivity has come from improved management and feeding of sheep, the wide scale adoption of scanning ewes to determine those in lamb, breed changes and hogget mating.

The Economic Service Sheep and Beef Farm Survey indicates that 40 per cent of the ewe flock is scanned each year. Consistent use of this technology to identify and cull dry ewes has been a factor lifting lambing percentages.

Identifying dry ewes and their early removal from the flock has allowed valuable late winter and early spring pasture to be put to more productive use. Similarly the identification of ewes carrying multiple lambs has allowed these ewes to be given preferential feeding. Both of these strategies have resulted in performance gains.

Compared with the mid-1980s sheep are now fed at a higher level, which has allowed increased per head performance. In this context the Economic Service Sheep and Beef Farm Survey shows stocking rates per hectare are 9 per cent less than in the mid 1980s.

In addition ewe hogget mating has been an increasing practice. Lambs from ewe hoggets are estimated to account for 2.0 percentage points of the 1999-00 lambing percentage reported[1] .

There has also been a large change in the mix of lamb products exported. In 1986-87 frozen lamb carcases made up 63 per cent of lamb exports while chilled lamb made up less than 1 per cent of exports.

During the 1990s, price signals encouraged the production of lamb carcases that were heavier and leaner. These heavier carcases have allowed further added-value processing to meet customer requirements so that by the late 1990s only 11 per cent of lamb exports were in frozen carcase form. In contrast chilled lamb exports increased to reach 11 per cent of exports on a carcase weight basis.

While productivity of both the breeding ewe and lamb is up, product and market development has resulted in the receipts for the heavier and leaner lamb also increasing. In the 1999-00 season, the average lamb is estimated to return $47.50 per head at the works' gate. This is 105 per cent ahead of the 1986-87 per head price of $23.20 in inflation adjusted terms. On a simple all-in carcase plus skin and wool pull basis, the 1999-00 lamb price was $2.88 per kilogram. This price is 60 per cent ahead of the 1986-87 price of $1.81 per kilogram in constant 1999-00 dollar terms.

In aggregate, receipts for lamb delivered to the works' gate are up from $733 million in 1986-87 to $1.2 billion

[1] It is difficult to determine the number of ewe hoggets mated. The Economic Service in its Lamb Crop survey records the number of lambs tailed from ewe hoggets separately. These lambs are included in the total lamb crop data.

(+66%) in 1999-00, again in comparable inflation adjusted terms.

SHEEP GENETIC GAINS

In 1999-00, the Economic Service Sheep and Beef Farm Survey All Classes average sheep and beef farm had the characteristics shown in Table 3.

Using these farm parameters the long-term advantages from selection for basic genetic improvement have been evaluated for lambing percentage, live weight gain and fleece weight.

TABLE 3: Sheep and beef farm base data

Sheep wintered	2,800
Ewe flock	1,990
Lambing %	115.8%
No. Lambs tailed	2,305
Lambs drafted	1,450
Shorn kg sheep at open	4.81

Source: Meat and Wool Economic Service of New Zealand Sheep and Beef Farm Survey

Two scenarios have been evaluated. Firstly, the most likely rate of genetic improvement (G.Nicoll, pers. comm.) and secondly the likely best rate of genetic improvement (Geenty, 2000) for "commercial" sheep flocks.

LAMBING PERCENTAGE GAIN

The most likely genetic gain from fertility selection within a flock is a 1.1 per cent gain in lambing percentage per year. This genetic gain is cumulative, permanent and has value as shown in Table 4 below. The starting base ewe flock from Table 3 is held constant at 1,990 ewes per year. Through selection, the compound increase in lambing percentage of 1.1 per cent per year produces extra lambs, which are shown in Table 4 along with the extra dollar receipts from lamb sales. Lambs for this discussion are sold prime at the constant dollar price of $45.00 per head through time.

TABLE 4: Lambing, +1.1% per year (Ewe flock, 1,990 head)

Year	Extra Lambs	Extra$s per year
1	22	990
2	44	1,980
3	66	2,970
4	89	4,005
5	112	5,040
6	135	6,075
7	158	7,110
8	182	8,190
9	206	9,270
10	230	10,350
cumulative total		$55,980

Source: Meat and Wool Economic Service of New Zealand

Table 4 shows that genetic gains are like compound interest with extra lambs accumulating through time.

Prior to starting this genetic improvement, the base lambing percentage was 115.8 per cent for the spring of 1999. The compound 1.1 per cent gain in lambing percentage per year by year 10 would lift the lambing percentage to 127.3 per cent or +11.5 percentage points, which seems feasible. The "improved" flock with 1,990 ewes at year 10 produces 230 more lambs.

The financial gain shown in Table 4 at the constant lamb price of $45.00 per head shows an extra $10,350 in lamb receipts per year by year 10. Cumulatively the gain over 10 years was $55,980 more cash than would have been the case had no genetic progress been made.

Under conditions of "best" genetic gain, lambing percentages increase 2.0 per cent per year. In this scenario at year 10, an extra 437 lambs per year would be produced from the flock of 1,990 ewes. The lambing percentage would have increased from 115.8 per cent to 137.7 per cent, plus 21.9 percentage points. Extra lamb revenue would equal $19,665 per year.

LAMB LIVEWEIGHT GAIN

Table 5 shows the likely genetic improvement from selection within a "general" crossbred flock for lamb growth rate. Selection for this characteristic would show a gain of 0.230 kilograms per year. In terms of saleable carcase weight this would approximately halve to 0.115 kilograms.

The All Classes average farm in Table 3 produces an annual draft of 1,450 lambs. In 1999-00 these averaged a record 16.5-kilogram carcase weight largely as a result of an exceptional season. The lamb liveweight gain analysis shown in table 5 is based on a more conservative 15.5-kilogram carcase weight.

Table 5 shows the cumulative effective of 0.115 kilograms per carcase weight gain for the annual draft of 1,450 lambs. The prime lamb price of $45.00 per head with a one-kilogram wool pull is for a 15.5 kg carcase. This converts to a carcase weight average price of $2.90 per kilogram.

TABLE 5: Lamb liveweight gain, (1,450 lamb draft, + 0.115 Kg/yr)

Year	Extra Carcase kgs	Extra $s per year
1	167	484
2	335	972
3	504	1,462
4	674	1,955
5	846	2,453
6	1,019	2,955
7	1,193	3,460
8	1,369	3,970
9	1,546	4,483
10	1,724	5,000
cumulative total		$27,193

Source: Meat and Wool Economic Service of New Zealand

At the start of the genetic selection program, lamb carcase weights averaged 15.5 kilograms. By year 10, selection gains of 0.115 kilograms per year per lamb cumulatively increased the average carcase weight to 16.7 kilograms. This increase seems both reasonable and achievable.

In total, the genetic gain for the annual draft of 1,450 lambs is an extra 1.7 tonnes of lamb carcase weight at year 10. This extra carcase weight generates an extra $5,000 per year.

Selection for a terminal sheep breed focused on meat production could achieve 0.450 kilograms live-weight gain per lamb per year. In carcase weight terms this is 0.225 kilograms annual gain per carcase per year.

For the example flock, in this scenario the average carcase weight of 15.5 kilograms would increase to 17.9 kilograms at year 10. The total extra carcase weight for the draft of 1,450 lambs would equate to 3.49 tonnes and an extra $10,107 per year.

FLEECEWEIGHT GAIN

Improving fleece weight for a general crossbred flock may be an objective for some farms. Others may select for wool bulk and handle to improve the competitive advantage for their clip. The following example takes the former objective, as it is easier to demonstrate potential genetic gains.

The likely genetic gain for fleece growth rate in a crossbred flock is 0.02 kilograms (20 grams) per year. The 10-year cumulative effect of selecting for this characteristic is shown in Table 6 below. The All Classes Sheep and Beef Farm flock of 2,806 sheep on hand at 1 July 1999 produced 4.81 kilograms of shorn wool per sheep in 1999-00.

TABLE 6: Fleece weight increase (0.02 kg per sheep per year)

Year	Extra Wool kgs	Extra $s per year
1	56	137
2	112	274
3	169	414
4	226	554
5	283	693
6	340	833
7	397	973
8	455	1,115
9	513	1,257
10	571	1,400
cumulative total		$7,650

Source: Meat and Wool Economic Service of New Zealand

At year 10, the 2,806 sheep flock is producing an extra 571 kilograms of wool. Shorn wool per sheep is up from 4.81 kilograms to 5.01 kilograms (+4.2%) which seems feasible. By year 10, the annual receipts from wool in constant prices are $1,399 higher than at the start.

CUMULATIVE INCREASES

At year 10, the cumulative increases from selecting for the 3 characteristics is summarised in Table 7 using the "most likely" genetic gains previously discussed.

TABLE 7: Genetic increases, $ output

Gain per year from	Year 10 $	10 year cumulative $
Lambing %	10,350	55,980
Carcase Wt	5,000	27,193
+ extra Lamb Wt gain	780	2,932
Fleece Wt	1,400	7,650
Total	$17,710	$97,755

Source: Meat and Wool Economic Service of New Zealand

The above combined result from focusing on selection for 3 genetic improvement areas generated an extra $17,710 by year 10. This would be a l4 per cent lift in revenue from sheep for the All Classes Average Farm in 1999-00 dollar terms. The cumulative additional revenue over ten years was $97,755 in constant dollar terms.

The pragmatic farmer and farm management consultant would logically ask about the feed requirement to generate this extra production. Or does genetic improvement provide free production?

LUNCH HAS TO BE PAID FOR

While selection for genetic improvement of desired productive characteristics increases animal efficiency, there also needs to be planning so that there is adequate feed to allow animals to express their potential. After 10 years of genetic improvement the examples given generated in year 10: -

1. 230 more lambs (+10.0% lambs tailed)
2. increased lamb carcase weights (+7.7%)
3. increased shorn wool production (+4.2%)

Table 8 shows that at the start of the program the All Classes Average Farm produced an annual draft of 1,450 prime lambs. At an average 15.5 kilograms the carcase weight of lamb produced by the farm would total 22,475 kilograms.

At year 10 of the selection process an additional 5,562 kilograms of carcase lamb weight would be produced. An increase of 25 per cent.

In terms of feed provision this is a large demand.

In practice the answer may be to run fewer but more productive ewes to balance finishing lambs.

The glue to sort out the balance is effective farm management that includes feed budgeting, sufficient fencing to control stock and focused stock management policies with clear decision points when to buy and sell stock.

TABLE 8: All Classes Farm lamb carcase weight increase

	Kilograms
Base initial weight carcase weight	
1,450 lambs x 15.5 kg	22,475
Lamb % increase	
230 lambs x 15.5 kg	3,565
230 lamb Wt increase	273
Base carcase Wt increase	1,724
Total lamb carcase Wt increase	5,562
Percentage increase	+25%

Source: Meat and Wool Economic Service of New Zealand

Well thought through plans for genetic improvement for many will logically lead to the formation of strategic partnerships between farms on finishing downland country and farms on store hill country. Hill country farms are often better suited as breeding properties. In this context hill country farms would focus on flock fertility and a supply partnership with downland farms to finish stock to prime condition. These strategic partnerships would include profit (risk) sharing of the final price for the prime stock.

These partnerships would be win-win where there would be strong feed back from the finishing farm as to which lambs were most profitable to finish. The hill country farm with profit sharing would focus on flock fertility and the supply of lamb with excellent growth genetics.

CONCLUSIONS

The agricultural sector has transformed its production mix over the past 15 years. The sector is leaner and more efficient. The importance of agriculture to the economy has not diminished and it retains its international comparative and competitive advantages. The agriculture sector competes for resources with other sectors in our open economy and exports 80 to 90 per cent of production to world markets.

The future is clearly linked to knowledge growth (research) and producer development centred on our natural resource industries. The generation and adoption of profitable new systems, products and markets is essential to utilise our natural resource based agriculture effectively and wisely. We need to recognise and encourage our centres of excellence where we have international comparative and competitive advantages.

The sheep industry has made remarkable productivity gains over the past 15 years to the extent that greater volumes of lamb at higher values are produced from 33 per cent fewer breeding ewes.

The pastoral sector is dynamic and land use change is likely to be a continuing feature. In this context, a continual focus on genetic improvement is important to improve the efficiency of animals and land in production.

While genetic gains are made with animals, the management challenge centres on feed provision to allow the genetic potential of animals to be realised and profitable.

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