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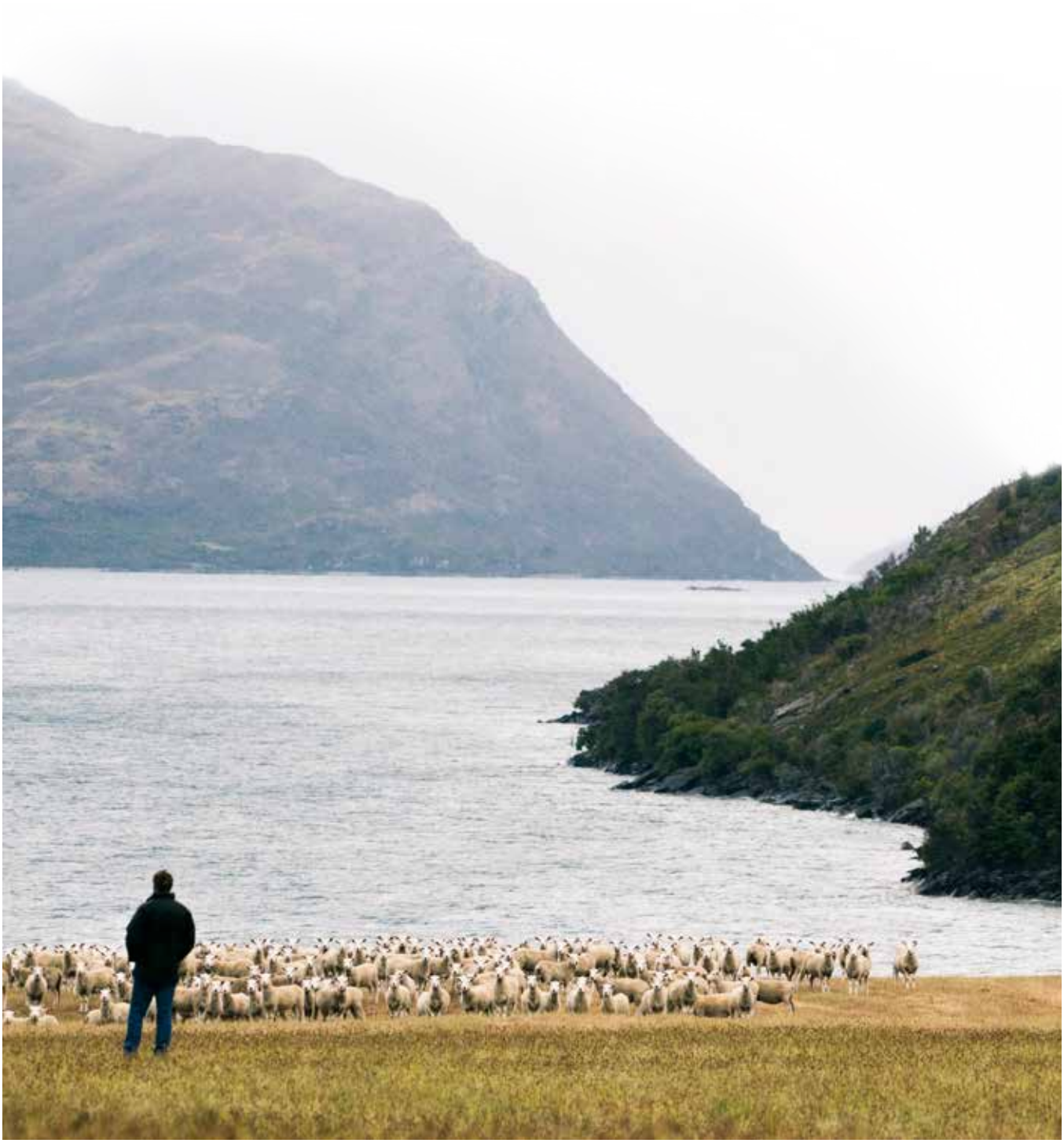

FUTURE OF NZ DAIRY INDUSTRY UNDERSTANDING YOUR DATA **ONCE-A-DAY AND TWICE-A-DAY MILKING**
LONGEVITY AND WASTAGE IN COMMERCIAL EWE FLOCKS **FARM ANIMAL WELFARE**

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Contents

STEPHEN MACAULAY CEO

Future role and capabilities of rural professionals in a world of big data

The impact of new and emerging technologies likely to influence New Zealand's primary industry is getting a lot of coverage within the media and at various conferences at the moment. There is a constant stream of commentators providing their views on the impact of disruptive technologies on the production, processing and marketing of our primary products – ranging from a business as usual approach with nothing really changing other than gradual incrementalism, through to elevated hysteria of apocalyptic proportions whereby everything from farm to consumption is up for systemic and irrevocable change.

Regardless of where you may sit along the spectrum, there is no doubt we are on the cusp of significant technological change within the agricultural and horticultural sectors, with an expanding range of technology-based tools targeted at improving on-farm productivity and sustainability through enhanced decision-making capabilities.

As part of my Winston Churchill Memorial Fellowship I have been considering the impact of new and emerging technologies occurring on-farm and across the value system, as well as the future role of rural professionals in the provision of professional advice and services to their farming clients.

So what might the future look like where farmers have access to more information and data than their rural professionals?

Farmers already have access to a wide range of on-farm information and data through a number of technology platforms including; cloud-based accounting packages, farm management and production software, data sensory technology and climatic information data. We can also expect that the amount of data available to farmers, rural professionals and consumers will continue to grow with the explosion of social networking sites, search and retrieval engines, data networks, media sharing sites, stock trading sites, news sources and so on.

We are entering an era of big data – data sets that are characterised by huge volumes of both structured and unstructured data, received from multiple sources, at ultra-high velocity and variety on a day-to-day basis. The role of the future rural professional in this big data world could be even more important as they work with their clients in assessing the quality and relevancy of data to use from the enormous amount of information available from a wide variety of sources.

Big data provides opportunities for rural professionals to analyse and mine data sources to explore patterns and relationships hidden in large volumes of raw data, and in doing so providing valuable insights and analysis that could ultimately lead to better farm management decisions.

This will require rural professionals to develop their data mining capability and become familiar and proficient with technology and machine learning platforms required to mine big data. Rural professionals will need to be competent in interpreting data and understand how this integrates within the farm system to be able to challenge information and assumptions made or being considered by their farming clients. Importantly, they will need to understand the impact of biological variability on precision measurement and decision consequences of using precision measurement on biological production systems.

This may well give rise to a new group of rural professionals, including data analysts, information technology consultants and data modellers, which is consistent with findings of a recent IBM report *The Quant Crunch – How the Demand for Data Science Skills is Disrupting the Job Market*. The report identifies that machine learning, big data and data science skills is a projected growth area and there was a strong need for new training programmes in this field.

A limiting factor of the wider roll-out of big data in the primary industry is the sheer velocity of information generated, and the computing power required to quickly process high volumes and variety of data, particularly in areas with limited broadband access. But given how quickly technology is developing, this may have a short lag time.

Ultimately, the value and effectiveness of much big data depends on the human operators tasked with the role of understanding it and formulating the proper queries in extracting relevant information available from big data sources – the nexus between biological variability and precision measurement.

Rural professionals will have an important role in providing intuition, curiosity and depth of industry knowledge in the world of big data, without which we run the risk of myopic on-farm solutions and accepting that 'correlation is enough'. In this new world it will be important for rural professionals to develop an expanded understanding of big data and machine learning to guide and motivate their clients in the use of information generated to improve on-farm decision-making processes.

JOHN LUXTON

FARMING FOR TOMORROW – THE FUTURE OF THE NEW ZEALAND DAIRY INDUSTRY

The New Zealand dairy sector has developed a 'free range farming system'. Along with a kind climate and a specialised milk processing sector, this gives it a significant commercial advantage compared to other major dairy countries, despite the distance from the market place and the domestic protection accorded other competitors.

Change and uncertainty

These are times of change for farming, and with change comes uncertainty, whether it be in international politics or uncertainty around sustainability and what it means for the industry. Added to this mix is the increasing role of social media and the activism of specific-issue non-governmental organisations. However, change also produces opportunity.

These changes have been underway for some time and coincide with rising urbanisation and, in many cases, an increasing polarisation of views in society. Social media is changing perceptions, sometimes at the expense of reality, plus it is changing the speed of information flow. Mega data will also mean many changes over the next few years. This reflects improving information and, in some areas, better science and also fake science. As always, different parties often highlight information which helps their arguments.

One could discuss artificial milk and meat as a doom scenario for our farm systems, but I am more optimistic about the future of farming in New Zealand.

Farming important to economy

Farming is still a very important part of the New Zealand economy. In merchandise exports, the primary sector still contributes around two-thirds of the value, and of that dairy has accounted for up to half or generally around one-third of merchandise exports by value. Fonterra alone is responsible for around a quarter of New Zealand's exports.

Our exports are important; they also highlight the areas of our economy which are truly competitive internationally and none more so than dairy exports. With 93-95% of New Zealand milk production being exported, the dairy sector has relied for the last century on being able to land a vast array of products into almost every country in the world despite significant tariff barriers and subsidies to its international competitors. This country's dairy sector has doubled in size over the last two decades.

Compared to other dairy exporting countries, New Zealand is unique with its almost total reliance on the world market. Australia's dairy sector has the next largest dependence on exports at 40%, meaning there is less volatility over time from the international commodity market. The EU and US sell around 15% of total milk production internationally.

The New Zealand dairy sector's reliance on the international market also means more significant market fluctuations, particularly as international supply and demand are fairly evenly matched. However, such price fluctuations also drive on-farm innovation. For any business to succeed, over time revenue must exceed expenditure. Of our land-based industries, dairy has consistently given a better return to landowners than most other farming alternatives, hence the very significant growth in dairy exports from around $2 billion in 1990 to $16.6 billion in 2014. To this could be added another $3 billion worth of beef exports from the dairy sector.

New Zealand has benefited from the growth in dairy exports. The stronger New Zealand dollar has allowed consumers to buy lower-cost items in the market place. It has also pushed the dairy sector to continue to improve its productivity. One could discuss artificial milk and meat as a doom scenario for our farm systems, but I am more optimistic about the future of farming in New Zealand.

Farming versus the environment

With the increasing intensity and herd size of farms in the dairy sector there has been some noticeable impact on the environment, which makes it a political issue for some in our society. Such an impact has been observed in other dairy-intensive countries such as Ireland, the Netherlands and Denmark, other countries in the EU and in the US.

The increasing prosperity of our society has also seen changing public attitudes, and with that our legislation and regulations. One of the basic challenges for farming and dairying is to keep ahead of society's changing attitudes.

Most notable are the nitrate and phosphate directives now in place across EU countries. New Zealand is now moving through a similar process of reducing nutrient loads into our groundwater, rivers and lakes. The National Policy Statement for Freshwater Management drives this process and, in the case of the Waikato River Catchment, it is the Vision and Strategy in the Waikato Tainui Raupatu Claims (Waikato River) Settlement Act 2010.

The New Zealand dairy industry has been proactive, with leadership from Fonterra signing up to the Dairying and Clean Streams Accord in 2003 and then the wider industry setting national good management practice benchmarks in the Sustainable Dairying: Water Accord in 2013. These agreements are already showing measurable benefits in reducing nutrient run-off into waterways and in decreasing sediment and E-coli loadings.

DairyNZ has also provided significant leadership through its team of water quality scientists and its development and extension team. When such challenges as nutrient run-off or leaching arise, then this also focuses attention on resolving them.

Science has alerted us to the challenge and is also likely to provide some solutions over time. Nitrogen leaching is also a challenge in heavily cropped areas and with crops such as rice or potatoes. Interestingly, recent research in Sri Lanka has shown that a compound found in bones, hydroxyapatite, can be bound to urea and significantly reduce nitrate leaching (*Economist*, 18 February 2017).

So the dairy sector's response has not been a knee jerk one; it has shown leadership in this area ahead of regulators and some of our environmental lobby groups. The scale of environmental work on New Zealand dairy farms should not be underestimated. Effluent treatment

Fenced and planted streams in Waihi

Gray and Marilyn Baldwin's new wetland in Putaruru under construction

systems, low application rate effluent recycling, waterway and drain fencing, wetland restoration, and significant riparian and retired land planting all demonstrate how the dairy sector is meeting these challenges positively. The mix of market and environmental pressures is also creating innovative responses from individual farmers, with a re-focus on lower-cost and lower-intensity dairy farming, which remain some of our most profitable farms. Very much a 'free range' farming system.

Investment in wintering barns in some areas can lower nutrient loads, but can also add to the capital costs of the farm, and overall return on capital may diminish. There will be trade-offs in the future.

The Dutch dairy industry now has a cap on nutrient levels, application rates and timing, and on cow numbers, as have several other jurisdictions. Land use change is being restricted, as is water use in many regions. But farmers respond to challenges (whether they be climatic, market-related or regulatory), and dairying with its dynamism is already changing.

Just as the environment is one such challenge, so too are animal welfare issues. The increasing prosperity of our society has also seen changing public attitudes, and with that our legislation and regulations. One of the basic challenges for farming and dairying is to keep ahead of society's changing attitudes. Today there is more transparency across the food-producing sector and to sell on the international market our systems must be the world's best.

With animal welfare concerns, for example, some farms are looking to reduce or minimise the selling of bobby calves. This is another of those challenges which will likely follow the elimination of battery cages for hens or sow crates for pigs.

Farms for the future

It is difficult to predict where dairy will develop on-farm other than a greater focus on systems to ensure regulatory compliance and to reduce the demand for labour. Because of the sector's growth and innovation, New Zealand

The New Zealand dairy model has evolved into a more corporate-family model, which should assist our competitiveness over time. I believe there will still be a place for the family farm, but there will continue to be fewer of them. This creates some political risk, as fewer voters will be directly dependent on dairying.

dairying has led the world in pastoral low-cost systems of milk production, focusing on harvesting a maximum amount of pasture closely aligned to the annual growth curve. This system has ensured a low production cost and has also minimised greenhouse gas emissions compared to other countries which have major dairy industries that rely largely on harvested feed year-round. Most of our dairying will remain seasonal.

However, in focusing on market niches there will be a demand for more winter-sourced milk. Fresh milk exports into Asia will grow as will food service demands from the market place. Processors will need to pay incentives (and already do) to procure such milk during May, June and July.

The distance from our markets has also led to a processing skill base which is able to convert short-life perishable fresh milk into its longer-life products. We can convert most of our seasonal production curve into a year-round generally flat-to-rising demand in world markets.

Most major traditional dairy markets still restrict trade access to protect their rural sectors and because others, such as ourselves, can operate at a lower production and processing cost.

Traditional milk-consuming countries such as India, Japan, Britain, Europe, Russia, Canada and the US all consume significant volumes of generally higher-priced dairy products, but still severely limit access to their own markets. Dairy, along with rice and sugar, is probably the most protected area of traditional food production around the world and has always been something of a stumbling block in free trade deals. This really signals this country's long-term price advantage.

So if the US Government wants to increase that type of protection to protect their 50,000 dairy farmers, then we may see similar barriers erected in other countries to which US farmers export. This may price them out of markets to New Zealand's advantage. The US dairy sector is very dependent on low-paid Mexican migrant workers with a current minimum wage of US$7.25. If workers are paid a higher minimum wage, or even the New Zealand minimum wage, then production costs would also increase. Similarly, if migrant workers are repatriated to Mexico then production costs would also rise. There is an ageing population of farmers, largely on small farms in much of Europe and Japan, and I believe these markets will gradually open up to New Zealand dairying.

The New Zealand dairy model has evolved into a more corporate-family model, which should assist our competitiveness over time. I believe there will still be a place for the family farm, but there will continue to be fewer of them. This creates some political risk, as fewer voters will be directly dependent on dairying.

Dairy sector debt on over-valued farms could present a challenge to some farmers. However, the fact that many international pension funds now have a stake in the New Zealand dairy sector suggests that many international investment managers have recognised the long-term competitive nature of dairying in this country.

Value add and the market for dairy

The ability of dairying to provide such a versatile foodstuff rich in protein to a protein hungry world will see the industry continue to prosper in this country. Because of

Future growth will be tempered by challenges. However, slower growth in volume will see our processors able to focus even more on adding value to our dairy exports.

the dairy sector's contribution to this country's economic wellbeing, particularly to the regions, and its impact over time on the value of the New Zealand dollar, it will continue to see a balance between its leadership around the issues of concern to all New Zealanders and the legislative restrictions it will face.

As mentioned, over the last two decades considerable growth has occurred in the sector. Future growth will be tempered by challenges. However, slower growth in volume will see our processors able to focus even more on adding value to our dairy exports. Most of our dairy processors have had a dominant focus in recent years on increasing processing capacity to handle the growth in volume. While whole-milk powder is a value add from skim milk powder and butter or anhydrous milk-fat, there are so many possible products available from milk and its micro-nutrients that over time many more of these will be able to find specific markets. However, all New Zealand milk processors are continually looking for a point of difference, which is another way of saying they look to add value.

Milk is a rather unique base substrate from which to manufacture products. It is produced daily in nature to provide nutrition to young animals. Most other foodstuffs are produced as reproductive material (e.g. seeds) or as a result of movement (e.g. meat or fish muscle). As a consequence, milk contains most (if not all) of the essentials for mammalian growth and sustenance.

The growing middle classes of the world are very focused on high-quality food. New Zealand, despite some critics, is one of the world leaders in food quality and also in the quality of our environment. Rapid global urbanisation and growth has created a dependence on world markets to meet this increasing demand. Considerable growth is occurring in the food service sector for a variety of dairy products, particularly those based on milk fat. Demand from bakeries, restaurants, institutions and hotels is driving this, partially through changing diets and also because of increasing international tourism.

Already there is sophistication to our dairy products marketed internationally, which will only continue to grow, including nutraceutical and pharmaceutical products from or with components from milk. New Zealand dairy scientists, marketers and processors continue to discover new dairy products and niches in the food chain for products made from milk and from isolates from milk fat and proteins. Some of these products sell at hundreds of dollars per kilogram. Growing some of these valuable markets without turning them into another commodity is an ongoing market challenge. Likewise, there is a consumer story to tell the way Icebreaker does with its references to high country sheep runs, even though most of their product is processed in China.

The New Zealand milk processing and marketing sector is continually working internationally to seek new opportunities. Despite what some critics might say, Fonterra is a leader in this space and could be considered New Zealand's only true multinational of size, with a market presence in over 120 countries and a global supply chain sending products to almost every country in the world. Most of our dairy processors will have products in 50 or more countries.

Fonterra has identified some significant food trends which are to our advantage. Our milk is produced naturally from pasture. It is a natural authentic whole food and it is good for you. Milk contains high-quality protein and some healthy fats produced in a sustainable way. Consumers want less sugar and to know the source of their food. There is a trend towards healthier snacking and gourmet convenience with the occasional indulgence. Eating is more social, interactive and authentic, and with new products such as 'My Food Bag' also creating different food choices.

Summary

There may be a slow down in globalisation if the US goes down a more nationalistic path, but this has happened before. Countering this is an overall increase in urbanisation and rising prosperity in many countries, which will continue to grow demand for quality food to meet consumer preferences. Around the world local restaurants, snack manufacturers, bakeries and fast food outlets are always looking to make something that appeals more than their competitor's product or meal.

A large proportion of these new products that global and local food manufacturers produce will contain some of our dairy ingredients. We are very much a part of many global supply chains. It may be the top-end cappuccino requiring milk to froth, the Sao Paulo pizza with New Zealand-sourced mozzarella, crème fraiche in a Japanese restaurant, the special protein in a European hospital drip, or the lactose from Kapuni binding pharmaceutical drugs in pills around the world – all contain New Zealand pasture-sourced milk components.

So while negative headlines might cause some pessimism, our dairy sector has a bright future. It needs to continue to attract top people and to tell its story better to New Zealanders.

The Hon. John Luxton is currently based in Wellington where he is involved in governance roles. He has also been dairying in the Waikato for 40 years. Email: john@luxton.co.nz. J

KEVIN WILSON

UNDERSTANDING YOUR DATA – CLARITY OR CLUTTER AND CONFUSION?

The article sets out to raise the awareness of common errors in the analysis and presentation of numeric data. It explains the underlying principles of statistics so the limitations of any analysis can be better understood and the data presented accordingly.

Errors and consequences

Much of the numeric analysis provided to the public and clients is poorly presented, with the analyst exhibiting a poor understanding of fundamental statistical theory and good presentation techniques.

Errors include:

- Spurious accuracy
- The use of averages
- Not allowing for the inherent errors in samples for financial surveys
- Failure to identify the magnitude of errors in the underlying estimates or physical measures.

Consequences include:

- Reduced effectiveness of the analysis
- Bad or wrong decisions
- Ultimately, potential damage to the reputation of the presenter.

The above comments apply to large numbers of rural professionals.

Spurious accuracy

The first clue to poor understanding of statistical theory is spurious accuracy, which is prevalent in much of the numeric analysis presented by a large number of commentators. So what is spurious accuracy? It is defined by data being presented showing a greater level of accuracy than the underlying measurement can support. A classic example is reporting that the dry matter (DM) produced was 14,569 kg/ha and the 80.6 ha farm grew a total of 1,174,261 kg. Never mind that the margin of error in the measurement of DM/ha may have been +30%. The total feed grown might be better presented as 1,170 tonnes or even 1,150 tonnes.

Understand the base data

The first task of any numeric analysis is to test the consistency of the data. Is the average price for lambs sold by each farm in ***Table 1*** consistently calculated for the series? Questions could include:

- Is any retention by cooperatives included or excluded in all sales of prime lambs to such outlets?
- Are all store lamb sales at the gross price or net of commissions, yard fees and freight?
- Is the difference in price received by individual farms due to the proportion of lambs sold as stores rather than prime?
- Would the data be better split between farms that sell the majority of lambs prime and those that mainly sell stores?

Similar questions can be asked of all data. The calculated effective area of a farm is another statistic that needs to be understood. Has the effective area been surveyed or is it an estimate? Are race ways and the areas occupied by buildings in or out? One view might be that they should be included as it is not possible to run a farm without them. All the questions above help avoid spurious accuracy in the presentation of results.

Clutter

A lot of data is presented in fine detail with multiple headings. That tendency is not helped by spreadsheets that calculate to several decimal places. How much easier it is to remember that the average lambs sold in Series

FIVE KEY QUESTIONS IN ANALYSING DATA:

If I am looking at someone else's data:

1. How statistically robust is the underlying base data, e.g. what was the sample size?
2. Is the base data consistent within each data field, e.g. GST inclusive or exclusive?
3. Has the correct statistic been used to describe the data, e.g. is using an average or a median?
4. Do the conclusions about the data contain spurious accuracy, e.g. does it overstate the accuracy?
5. Is the presentation of the data more cluttered or complex than it needs to be?

Table 1: Number of lambs sold and average price

FARM	SERIES ONE	FARM	SERIES TWO ORDERED	SERIES THREE[1] ORDERED	AVERAGE PRICE[1]
1	579	1	579	580	121
2	1,798	5	872	870	76
3	1,269	4	1,125	1,130	94
4	1,125	3	1,269	1,270	97
5	872	6	1,348	1,350	97
6	1,348	2	1,798	1,800	103
7	1,972	7	1,972	1,970	89
8	2,241	8	2,241	2,240	81
9	3,984	10	2,987	2,990	78
10	2,987	9	3,984	3,985	71
Total	**18,175**		**18,175**	**18,175**	
Average	1,818		1,818	1,818	91[2]
Average	1,820[1]		1,820[1]	1,820[1]	86[3]
Median	1,573		1,573	1,573	91.70
Median[1]	1,570		1,570	1,570	92

Note 1: Rounded
Note 2: Average of averages (rounded)
*Note 3: Weighted average, i.e. the sum of each count of lambs sold * price for that count divided by the total number of lambs sold (rounded)*

One of ***Table 1*** is 1,820 or even 1,800 rather than 1,818? Look how much easier the table is to read when the data is presented in ascending (or descending) order and all the data is rounded to the nearest 5 or 10 with the appropriate footnote under the table.

The assumption in Series Two is the data on lamb prices is the key piece of information and not the farm. Try presenting a summary of the key data in a report and perhaps supply the detail as appendices. Hopefully no-one would present the average number of lambs sold in ***Table 1*** to the first decimal place (spurious accuracy). Learn how to use the 'round' function in your spreadsheet.

Averages or means

The average or mean is commonly misused. The average of a series is a very useful measure if the data has a small or even spread in magnitude between the smallest and largest number in the series and has no outliers. Outliers can have a distorting effect on the average.

Outliers

Are there any outliers in the data? An outlier is a number, or a very small proportion of a larger series, that is greatly different in magnitude to the majority of the numbers. There are several statistical rules to determine whether or not numbers are outliers. Comparison of the suspect numbers with the average or median can be useful. Common sense and knowledge of the data can guide the decision.

There are three ways to deal with outliers: acknowledge they exist and leave in the analysis; discard the numbers altogether if they are clearly erroneous; or, if there are several, stratify the data into bands. ***Table 1*** might usefully be split into less than 1,000, 1,000 to less than 2,000, and 2,000 and over.

Weighted averages

What is the average price of the lambs sold in ***Table 1*** – $91 or $86? An average of averages is considered bad practice for disparate data as it takes no account of the relative weighting of each number in the series, i.e. a series with a large range in magnitude between the smallest and largest numbers. The larger number of lambs sold at a low price carries significant weighting in the data series presented in ***Table 1***. The weighted average is the correct measure for the average price of lambs sold in this instance. The median price may be a better indicator of the price received for lambs sold in the sample or survey.

Average of what?

The analyst needs to be very clear about how the average is to be used. How do you calculate the average of an expenditure item in a survey if one or more participants have no expenditure on that item? Is the average taken over all participants or only those with costs associated with the category of interest?

Note the influence of a blank cell or a zero on the calculation of an average or median by formula in spreadsheets. A zero is counted as an observation in a series of numbers. The spreadsheet calculated the

Table 2: Expenditure on grazing

FARM	DOLLARS
1	0
2	3,520
3	4,590
4	6,890
5	7,870
6	10,990
7	14,360
Total	**48,220**
Average[1]	
All farms (total divided by 7)	6,890
Only farms with grazing (total divided by 6)	8,040
Median[1]	
All farms	6,890
Only farms with grazing	7,380

Note 1: Rounded

Table 3: Averages of survey data

CATEGORY OF EXPENSES	TOTAL SPEND	NUMBER OF FARMS	AVERAGE/FARM	
	ALL FARMS		ALL FARMS	THOSE WHO SPEND
Wages	89,650	6	12,810	14,940
Feed	48,220	5	6,890	9,640
Fert	120,430	7	17,200	17,200
Animal health	165,430	7	23,630	23,630
Weed & pest	45,360	7	6,480	6,480
Shed exp	25,690	6	3,670	4,280
Contract	62,370	7	8,910	8,910
Grand total spent	557,150			
Total average spend	**79,590[1]**		**79,590[2]**	**85,080[3]**

Note 1: Gross total spend divided by 7
Notes 2 & 3: Sum of each column

average of the series in ***Table 2*** with a zero is $6,890, i.e. the all farm average. The average of the column with a blank instead of the zero is $8,040, i.e. only those who spend. A zero is not interpreted by the spreadsheet formula as a 'no spend'.

The average of all farms in a sample or survey for every category of expenditure analysed has to be used if the sum of the averages of every category is to equal the average of the total spent in all categories in the analysis.

Median

The median is the mid-point of the data when sorted in ascending or descending order. The magnitude of the difference between the average and the median indicates how evenly the data is distributed either side of the average. The median is equal or very close in value to the average in a normal or even distribution. It is also common to have distributions skewed to the right or left of the mean. A right-skewed distribution is illustrated by the numbers of lambs sold shown in ***Table 1***. In a right-skewed distribution there is a greater range of values above the average than below and the median may be much lower than the average. Left-skewed data is the converse of the previous sentence.

The median is a better indicator than the average of the series if the data is significantly skewed. Again, there are statistical methods to determine the degree of skew but let common sense prevail. Make a judgement call and note the detail as a footnote to the table or article. The average in ***Table 1*** is influenced by the magnitude of the largest two numbers of lambs sold in the series which is skewed to the right. The median of the series is a better indicator of the number of lambs sold for the 10 farms if all the data is retained.

Inherent errors in samples or surveys

Financial surveys by organisations or consolidation of financial data from accounting practices provide a wealth of information about the businesses in the survey or practice, but they have inherent errors and again spurious accuracy often prevails. Extrapolating the data to represent the population in the same business in a region (or even nationally) is common, but the inherent errors expand and are never acknowledged.

The bigger the variability in a key statistic for the sample, e.g. farm size, then the bigger the sample needs to be to give confidence that the answers from the survey represent the population within an acceptable margin of error. Increasing the required confidence level of the results further increases the size of the sample. Sample sizes can be reduced by stratifying the key statistic into bands. Once again, extensive statistical theory deals with confidence intervals and margins of error in samples. And, once again, the implication for rural professionals is to be aware of the issue and treat the presentation and use of results from samples as only indicative of the sample or wider population and not as precise and gospel numeric answers.

One error is in the selection of the sample. Is it representative of the group that information is required from, i.e. not skewed by outliers, management ability or even willingness to participate? Other examples of sample error include all participants being above average by some criteria, heavily indebted or having little debt.

There will also be errors within the numbers collected. The finer the analysis, the more likely there will be inconsistencies in the calculation. Did Farmer A put some expenditure into shed expenses that Farmer B

The bigger the variability in a key statistic for the sample, e.g. farm size, then the bigger the sample needs to be to give confidence that the answers from the survey represent the population within an acceptable margin of error.

considers to be animal health? The necessity to change the composition of the sample between years for whatever reason induces another error when comparing the same data series between years. Comparing like with between years can be very difficult.

Once again, there are statistical formulae for determining sample size. Rural professionals completing surveys or analysis need only be aware of the inherent errors of samples and consolidated data and avoid spurious accuracy. More examples include writing that the average economic farm surplus for the farming year ending 2015/16 was $58,634 for a sample of 30. The answer should be expressed as $58,600 as a minimum, or even $58,000.

Margin of error in on-farm analysis

All measurements and estimates each have a known, or usually unknown, margin of error which is almost always ignored in most analysis and spurious accuracy prevails. The margins of error mean that the true value from the base data probably lies within a range. Obviously, the greater the margin of error in the base data, the greater the range will be that the true value or calculation(s) lie between. The following table provides a fictitious example of an analysis of weight gains on a feed crop and assumed margins of error for all the base data. The analysis was to determine the dollar margin/ha and cents/kg/DM grown. The range in the answers lies within a range of +20% of the base data.

Reporting the dollar margin/ha of the example to the nearest whole number and to the first decimal place of cents/kg from the base data is spurious accuracy. Placing a lot of weight on the returns from the fodder crop analysed over another policy that returned only 4 cents/kg/DM, with its associated margin of errors, is obviously fraught with risk.

Forecast error

A forecast by its very nature has inherent errors. Forecasts for agricultural enterprises are not exempt. The inherent errors are associated with risks including markets, weather, specific risks for that business and political risks, both national and international. The knowledge and expertise, or lack of, held by the person preparing the forecast are part of the forecast error. Presenting the cash surplus to the nearest dollar in an enterprise turning over hundreds of thousands of dollars is another example of spurious accuracy. Including a percentage contingency on the cost side of the forecast and sensitivity analysis are useful techniques to examine the 'what if' in the forecast, again presented as rounded numbers.

Summary

Numeric analysis is the bread and butter of many rural professionals. It provides masses of information for decisions by clients. A high-level knowledge of statistical theory is not necessary. But rural professionals need to be aware of any underlying limitations of the data, and margins of error, and present the data without spurious accuracy and with the necessary caveat(s). Uncluttered and rounded presentation adds clarity and reputation.

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Table 4: Return from a feed crop

DATA	BASE DATA PER HA	MARGIN OF ERROR (+ %)	LOWER BOUND	UPPER BOUND
DM grown (kg)	13,569	30	9,500	17,640
Area of paddock (ha)	20.2	1	20	20.4
Live wt in (kg)	1214	5	1,155	1,275
Live wt out (kg)	1,959	5	1,860	2,060
Live wt gain (kg)	745	5	710	780
Carcase yield (%)	49	1	49	49
Meat to sell	365	2	350	385
Meat schedule	4.5	0	4.5	4.5
Revenue ($)	1,643		1,560	1,725
Estimated costs ($)	831	5	790	875
Margin/ha ($)	812		770	850
Margin/kg/DM/ha (cents)	6.1		8	5

PAUL EDWARDS

WHAT TO EXPECT FROM ONCE-A-DAY (OAD) MILKING

A significant interest has grown in full season OAD milking in recent seasons. Milking OAD has many potential advantages, but until recently there has been little information available from commercial farms to give confidence to farmers and advisors evaluating whether to adopt it. Adopting OAD milking is more than simply a change of milking frequency and requires an evaluation of the whole farm system.

Labour efficiency

Labour is one of the largest components of dairy farm working expenses and attracting quality staff can be a challenge in a competitive marketplace. With milking occupying around half of farm working time, there is clearly potential to reduce costs and improve the work environment by reducing the time spent milking cows.

Milking interval has a substantial impact on milking efficiency and how labour can be organised on-farm, including start-finish times and total hours worked by staff. For example, under a conventional twice-a-day (TAD) system many farmers are choosing to use a 16-8 hour instead of a 12-12 hour milking interval so that staff can finish work earlier. However, an even larger impact can come from reducing the number of milkings (e.g. milking three times in two days or OAD milking).

The late Professor Colin Holmes predicted that full season OAD milking would be the next evolution for the New Zealand dairy industry. Throughout history dairy farmers have strived to operate low-cost systems, including adopting routines and technology to improve milking efficiency. This included the adoption of milking machines encouraged by expansion in herd sizes post-World War I, and the evolution in milking routines where the use of machine stripping post-milking declined following World War II. Later, the need for pre-milking stimulation was eliminated through selective breeding.

Dairies have also evolved, from walk-through dairies where cows were milked individually, to batch milking in herringbone sheds, and later on rotary platforms. It was the example of breeding cows that did not require pre-milking stimulation, and other research, that led Holmes to believe that, in time, the industry could breed cows suited to OAD milking.

This article will focus on the strategic use of OAD milking (i.e. full season), rather than the tactical use (e.g. in response to dry summer conditions or low body condition score or BCS). The purpose of the article is to increase understanding of what can be expected from full season OAD to help farmers and advisors decide if it makes sense for a particular farm.

Table 1: Use of milking regimes in 2015/16

MILKING REGIME	(DIGAD DATA)
TAD	52%
OAD	9%
Mix*	3%
Switch TAD/OAD	19%
Switch other#	16%
*Some cows were milked TAD and OAD at all herd tests	
#Milking regime changed during the season, e.g. TAD and then some cows TAD and some cows OAD	

Milking interval has a substantial impact on milking efficiency and how labour can be organised on-farm, including start-finish times and total hours worked by staff.

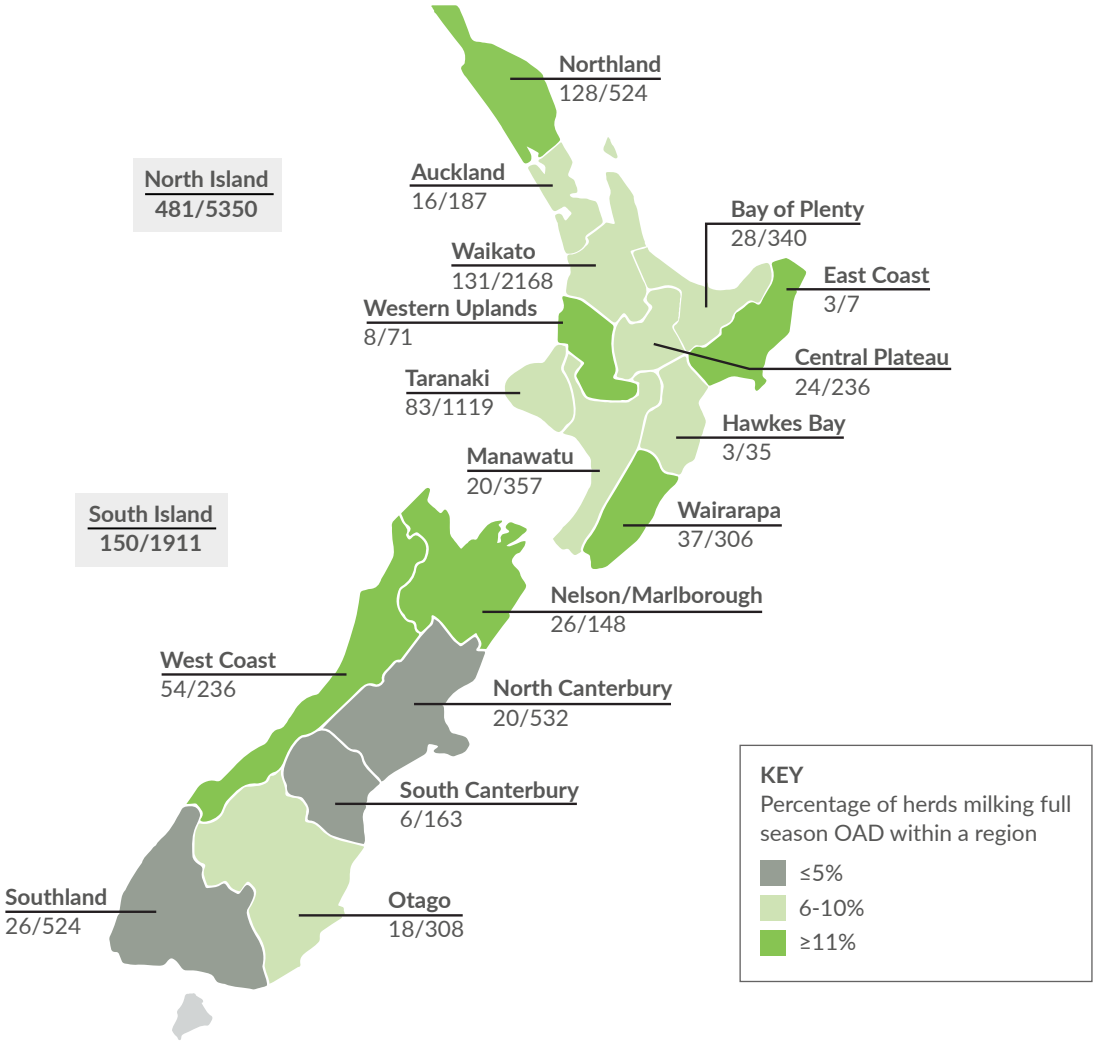


Figure 1. Regional distribution of OAD herds in 2015/16 (DIGAD data)
*OAD herds/Herds tested**

Current use of milking intervals

Only a handful of multi-year farm systems experiments using full season OAD milking have been conducted so far in New Zealand. So for this article data from the Dairy Industry Good Animal Database and the levy milk production database have been used to make a comparison between herds milking OAD and a contemporary group of herds milking TAD. These were located within 25 km of the OAD herds and had similar herd sizes and calving dates.

In the 2015/16 season only half of herd-tested farms were milking using conventional TAD milking: 9% used full season OAD for the whole herd (up from 5% in the 2014/15 season); and 3% used full season OAD for a portion of the herd (***Table 1***). The remaining 35% used OAD milking tactically for the whole herd (switch TAD/OAD) or part of the herd (switch other).

There was significant regional variation in the use of whole herd, full season, OAD milking (***Figure 1***). Regions with the greatest use of OAD were Northland (24% of herds), the West Coast (23%) and Nelson-Marlborough (18%). This may indicate that OAD is better suited to these more extensive farming regions. North and South Canterbury and Southland had the lowest use of OAD (≤5%). However, OAD is not solely a North Island phenomenon, with 9% of herds milking OAD in the North Island and 8% in the South Island.

Farm performance changes

The most common question when discussing OAD is how is it going to affect milk production? ***Figure 2a*** shows the total farm milk solids (MS) production for the current group of OAD herds (year 0 being the year they started full season OAD) and their paired TAD herds. Production as kg MS/cow and kg MS/ha shows similar trends. In this dataset OAD farmers had not increased stocking rate, although it was slightly lower than their TAD pairs.
Key points to take from ***Figure 2a*** include:

- Prior to adopting OAD these herds were less productive (~11%) than their TAD pairs. This may be due to OAD farmers choosing to operate a lower-intensity farm system with less imported feed, using OAD tactically, or the farm having physical limitations, such as poorer soils, steeper terrain, or a greater distance between paddocks due to farm layout.
- The OAD herds show a similar rate of increasing MS production each year to TAD herds, except in the year of adopting OAD.

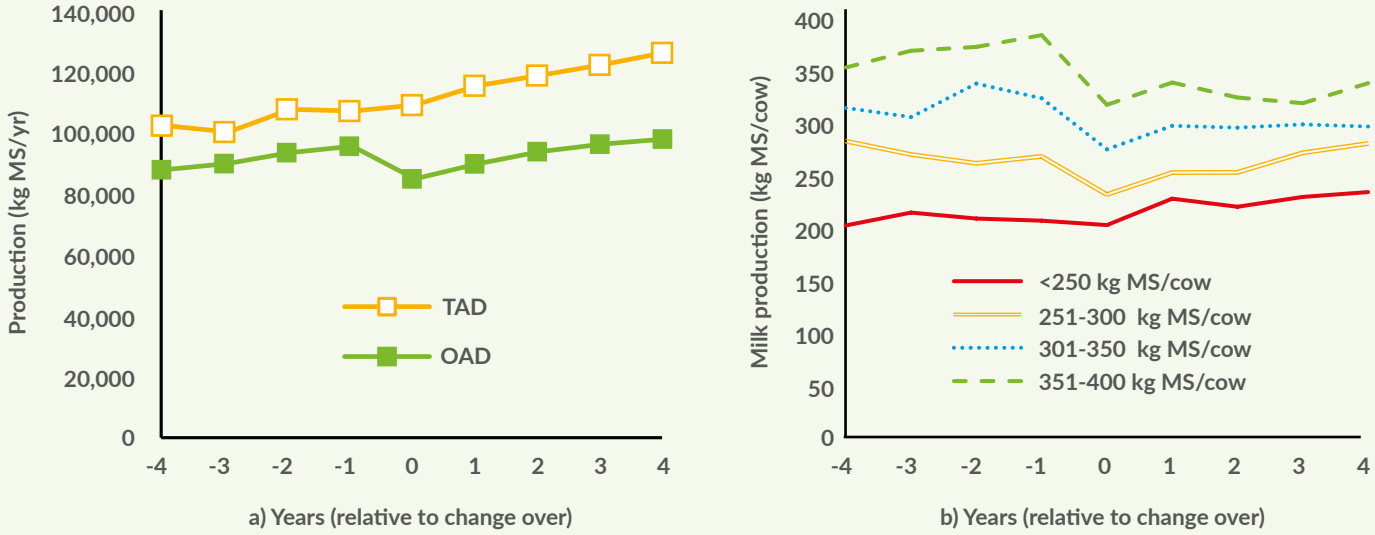


Figure 2: a) Total farm MS production comparing OAD and paired TAD herds; and b) MS production per cow before and after adopting OAD grouped by pre-OAD production (kg MS/cow)

- MS production decreased by about 11% in the first year of milking OAD, but returned to the pre-OAD level by the fourth season (year 3 on graph). However, the continued increase in productivity of the TAD herds meant the OAD herds remained 11% behind. This implies that, to retain an equivalent level of profitability as TAD, costs must be permanently reduced on adoption of OAD (more discussion on this in the next section). It also highlights the importance of having a contemporary TAD group for comparison.

The national data suggest that, on average, adopting OAD reduces MS production by 11%. However, averages hide many things. ***Figure 2b*** explains some of this variation. It indicates that herds that had a low level of productivity (<250 kg MS/cow) prior to adopting OAD were less affected (-2%) and in later years actually increased production. Conversely, those herds that had a higher level of productivity prior to OAD (351-400 kg MS/cow) experienced a larger production loss (-16%). On average, the highest-producing herds prior to OAD remained the highest-producing (of OAD herds) after changing to OAD.

This result may help explain the regional variations. For example, in 2015/16, the regions with the lowest use of OAD (North and South Canterbury) had the highest level of production at 416 and 409 kg MS/cow (DairyNZ, 2016). Conversely, Northland and the West Coast, with the highest use of OAD, averaged 322 and 336 kg MS/cow, respectively, which were the lowest in the country apart from the Western Uplands and the East Coast, both of which also had significant use of OAD. Given these figures are averages, a large number of herds are likely to be in the lower production categories of ***Figure 2b***, hence they had little to lose by adopting OAD.

Economics of adopting OAD

Figure 2a suggests that if a production loss is experienced in year 0, costs must be permanently reduced to retain

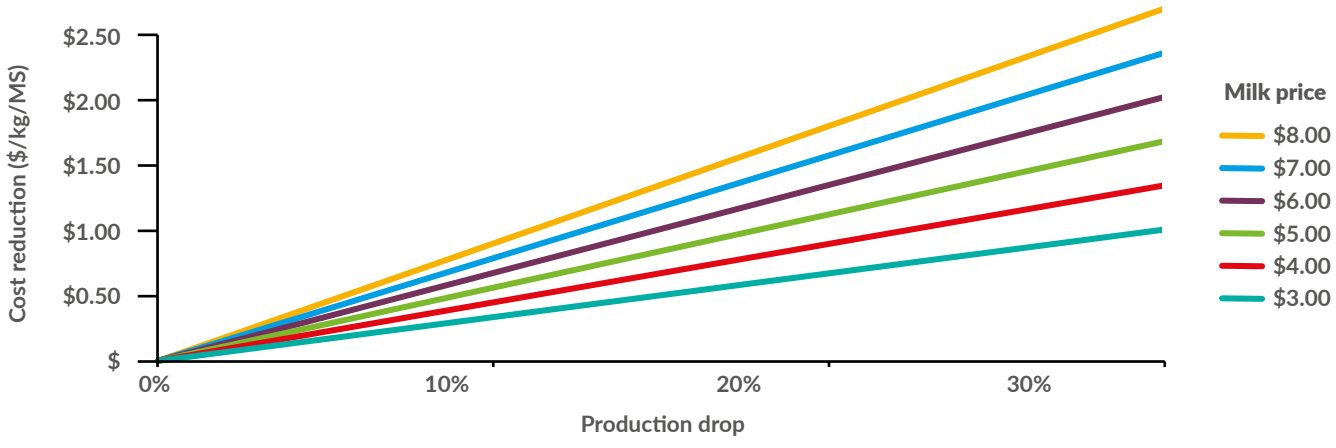


Figure 3: Cost reduction (CRED) required to maintain profit parity between OAD and TAD with different production losses under a range of milk prices ($/kg MS)

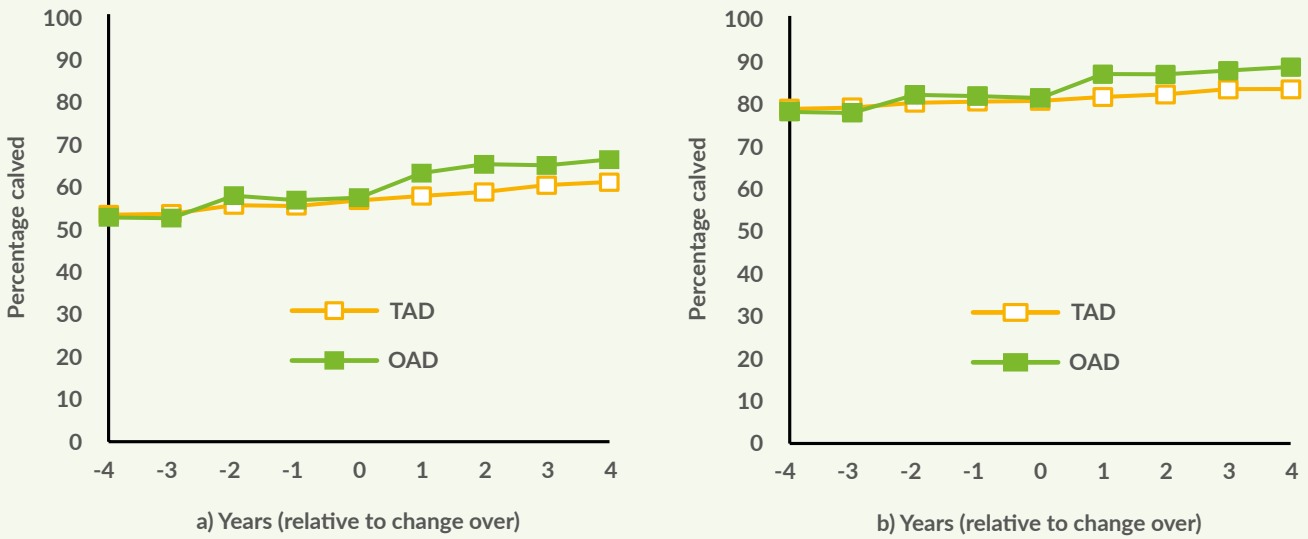


Figure 4: Comparison of the percentage of cows calved in (a) three weeks and (b) six weeks after planned start of calving between OAD and TAD herds

The key message is that the greater the production loss and/or the higher the milk price, the greater the cost reduction required. This makes OAD easier to justify in a low milk price environment and if production losses can be minimised.

an equivalent level of profit as TAD, irrespective of a farm's initial cost structure. The cost reduction required is directly proportional to the change in production and can be calculated using the formula $C_{RED} = \Delta MS\% \times MP$, where:

- C_{RED} is the reduction in cost required ($/kg MS)
- ΔMS% is the percentage change in MS production
- MP is the milk price ($/kg MS).

Farms with low initial costs may find this cost reduction more difficult to achieve as it will be a greater proportion of their costs. Farms with large fixed costs (e.g. irrigation) may also find this more challenging. ***Figure 3*** shows the level of cost reduction required for a range of production losses and milk prices.

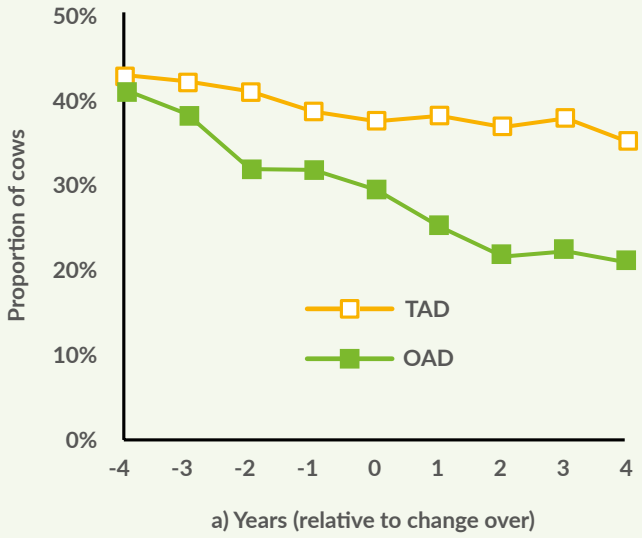
The key message is that the greater the production loss and/or the higher the milk price, the greater the cost reduction required. This makes OAD easier to justify in a low milk price environment and if production losses can be minimised. Using the average of the group (11% production drop) and a long-term milk price of $5, then this means a cost reduction of $0.55/kg MS. Achieving this will be highly farm-specific. However, if this cost reduction is not achieved it does not mean the farm is unprofitable, just that potentially some profit is being sacrificed. Alternatively, if a greater cost reduction can be made this implies OAD is a more appropriate system for that farm.

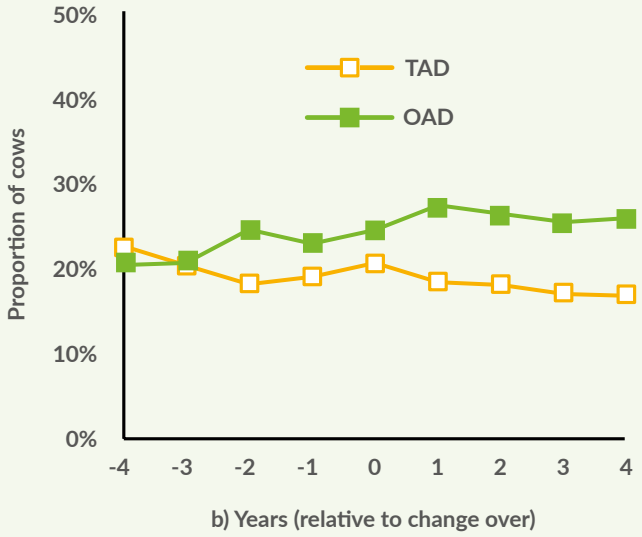
Labour, if employed, is an obvious area where cost might be reduced on adoption of OAD. By definition, OAD has 50% of the milkings compared with TAD. Farm labour represents 20% of operating expenditure for owner-operators, with milking accounting for over half of that time, hence there may be an opportunity to reduce operating expenses by up to 10% (or provide an opportunity for other enterprises in the case of unpaid management). However, these are averages, the number of staff is a discrete variable, and the remaining milkings will be longer so it is unlikely the full amount will be captured. A proper evaluation will be farm-specific.

On farms with employed staff another scenario is the potential to access new pools of labour. Under OAD milking can be carried out at any time of day, thus providing opportunities for people wanting to work part-time, such as parents who can only work during school hours. This could help in situations where some part-time labour is required because a whole (full-time) labour unit cannot be removed.

Other opportunities to reduce costs include lower direct dairy parlour costs, such as electricity and dairy shed consumables, although these costs only represent about 4% of farm working expenses. Vehicle and repairs and maintenance expenses may also be reduced (e.g. there is less wear on races due to the cows walking to and from the dairy less often). Improved body condition, particularly in late lactation, can also offer some significant savings in winter feed costs. Ideally, future research would quantify these potential savings.

Milking OAD can provide improved reproductive performance, potentially reducing costs. For example, the percentage of cows calved within six weeks of the planned start of calving was approximately 5% higher for the OAD herds (80% vs 85%; ***Figure 4***). Improved reproductive performance under OAD was also reported





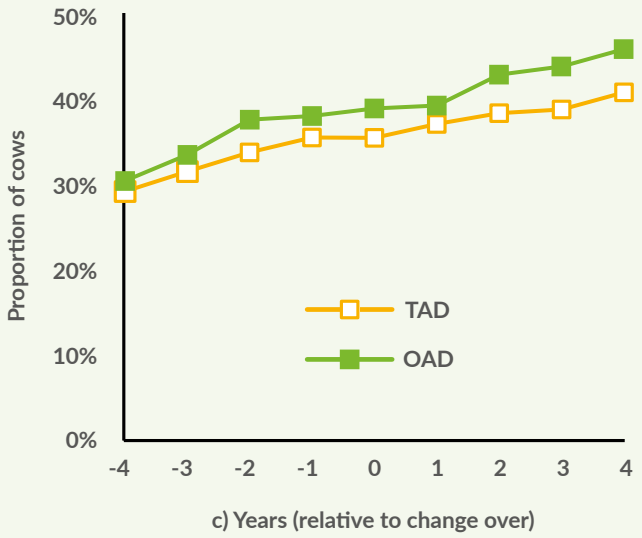


Figure 5: Breed differences between OAD and TAD herd: a) Holstein-Friesian; b) Jersey; and c) Jersey-Friesian cross

Some cows are more suited to OAD than others, so ideally less suitable cows could be identified (e.g. via a ranking index) and removed prior to adopting OAD, reducing both the production drop and the cost reduction required to maintain profit parity.

in a farm systems experiment run between 2000 and 2004 in Taranaki by Clark et al. and published in 2006 in the *Journal of Dairy Science*. The OAD treatment had an 8% greater three-week pregnancy rate, requiring five days less from calving to conception and 11% fewer CIDR inserts. However, a tighter calving spread results in greater spring feed demand, and thus many OAD farmers choose to delay the planned start of calving to maintain the same median calving date.

When working out the estimated cost reduction required it is important to note that C_{RED} in the formula refers to all costs, not just farm working expenses, which is where most of the savings are made by changing to OAD. Working expenses make up a smaller proportion of total costs for farms with high debt levels, meaning it may be harder for them to achieve the target cost reduction, unless it means they can sell a house from reduced staff numbers to reduce debt or milking OAD prevents an increase in debt (e.g. needing a new farm dairy). Note that this formula assumes that there are no other (non-production) changes to farm revenue. Any increase in income (e.g. from stock sales) will help to mitigate changes in milk production.

Overall, it is possible that many OAD farms will remain equally (or more) profitable as their TAD cohort, especially where the milk production drop is minimised. Alternatively, some farmers may choose to sacrifice some profit in exchange for lifestyle or improved working conditions.

OAD herd dynamics

The final important aspect of changing to OAD is cow selection. Some cows are more suited to OAD than others, so ideally less suitable cows could be identified (e.g. via a ranking index) and removed prior to adopting OAD, reducing both the production drop and the cost reduction required to maintain profit parity. This is an area requiring more research. One of the results of the Taranaki experiment was that Jersey cows were less affected by OAD than Holstein-Friesian cows.

This appears to be supported by commercial herds that have adopted OAD. ***Figure 5*** shows that the current group of OAD herds started reducing the number of Holstein-

Friesian cows in their herd from two years prior to adopting OAD. These were replaced by Jersey and Jersey-Friesian cross animals. However, it is not known how these herds would have performed if they had retained their Holstein-Friesian animals. Similar trends can be observed when comparing semen use, with OAD herds using more Jersey and cross-breed semen.

Looking at herd age structure, there is little difference between the current group of OAD adopters and their TAD pairs. This includes a similar replacement rate of 20% between the groups. This is an unexpected result, given the improved reproductive performance, and therefore fewer involuntary culls due to being empty. However, this was balanced by an increased number of animals being removed from OAD herds due to low production and udder health. The overall removal and replacement rate was therefore similar between the OAD and TAD groups.

An increased focus on udder health could be expected under OAD due to carrying a larger volume of milk to the next milking. Similarly, a greater rate of removal due to low production is logical for those animals not suited to OAD. It will be interesting to see if, over a longer time-scale, the number of animals removed for low production and udder-related reasons decreases. This would potentially allow OAD herds to have a lower replacement rate, providing another cost saving.

Summary

Overall, the prospect for OAD is bright. The key things to consider when assessing if changing to OAD makes sense for a farm are what the change in production might be and where cost savings can be made. Previous production is a good indicator of potential future production loss or lower rate of production gain (as shown in ***Figure 2b***). When evaluating costs, the effect of OAD on labour requirements may be the largest opportunity. Making contact with local OAD farmers to draw on their experience is also highly recommended. Future research will hopefully determine exactly what makes a good OAD cow to minimise production losses and provide detailed analysis of cost savings to facilitate more accurate budgeting.

More information, including contacts for regional OAD groups, can be found at: www.dairynz.co.nz/full-season-OAD. A further useful reference is: www.dairynz.co.nz/media/5416078/nz-dairy-statistics-2015-16.pdf.

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BRENT BOYCE

MILKING FREQUENCY – COMBINING THREE MILKINGS IN TWO DAYS (3IN2), ONCE-A-DAY (OAD) AND TWICE-A-DAY (TAD) MILKING

This article looks at the practical applications of changing the frequency of daily milking regimes throughout a seasonal lactation.

In recent years there has been a steady increase in dairy farmers altering the frequency of milking. This has usually meant a shift from the tradition of either TAD or OAD all season, as well as incorporating three milkings in two days (3in2). Consequently, the herd can be on either TAD, 3in2 or OAD at various times throughout the season.

Why have farmers altered milking frequency?

The increase in the use of 3in2 and OAD, in conjunction with TAD, during lactation has occurred for a myriad of reasons:

- Potential cost savings
- Mitigation of climatic conditions
- Improved farm logistics
- Reduction in laminitis
- Better cow condition
- Health and mating benefits
- Improved staff conditions
- Maintaining or even increasing milk solid production.

Sudden climatic changes may require a spot decision to move to 3in2 or OAD to alleviate the effects of these challenges when they occur. The herd can simply be returned to TAD (in early lactation before Christmas) if conditions improve, or remain on 3in2 or OAD if after Christmas.

Incorporating OAD into early lactation

In early spring, farmers can use OAD in the first two to six weeks of lactation, to reduce the workload and stress on staff and cows in the early calving period. Modelling undertaken by DairyNZ estimates that if a whole herd is milked OAD for two to three weeks from the planned start of calving, milk production loss for the whole season would only be 1-2%. This compares to the trial work that showed a 7% loss for the whole season if every individual cow was milked OAD for their first three weeks of its lactation. They found that milking the cows OAD over this period improves cow energy status and body condition score, but only after five to six weeks from the cow first being milking OAD.

Milking OAD at the start of calving is relatively straightforward. All cows and colostrums are milked OAD from the planned start of calving for approximately three weeks, e.g. from 1 August. To minimise potential production losses to 1-2% they would then go to TAD milking by 21 August.

As difficult feed or environmental issues dictate, the cows as a herd could be milked for a further three weeks and then go to TAD by 12 September. The extra three weeks on OAD (total six weeks) will mean that the whole season production losses may be in the 3-5% range, as noted by DairyNZ. Some farmers milk theirs herds on OAD during this period between 10am and 1pm so that feeding and shifting of stock and calf checks can be undertaken in daylight hours.

Incorporating OAD over mating

OAD over mating can involve making decisions on a part or the whole of the herd, depending on the challenges involved:

- Light condition or young cows
- Below target cycling activity
- Tight feed situation
- Extremes of weather
- Lame cows.

If the above issues are present, cows can be milked OAD over the mating period. Production losses will depend on length of time on OAD and the level of feeding. If some cows, especially heifers, are particularly light they can be drafted off and put on OAD in a separate herd in the weeks leading up to mating. These cows can stay on OAD over artificial insemination (AI) and return to the same milking regime as the rest of the herd at the end of AI.

On a number of properties farmers are placing all non-cycling cows on OAD at the start of mating, sometimes termed low intervention mating. This is regardless of whether the cows appear to be in good condition or not and even if the feed situation is ideal. These cows have a reason for not cycling such as an infection, laminitis, age, mastitis, social pressure etc.

The practice for these farmers is that the cows are run in a separate herd on OAD over the AI period – they can be added to make an enlarged care mob. They are usually returned to the main herd (and its milking regime) at the end of AI. Some farmers will run bulls with this mob, others have a bull and AI, while others solely use AI. Anecdotally, these farmers report that this system works for them. The cows return well to milk with the main mob, and mating results are often better than the main herd.

3in2 is not generally recommended over the mating period as the cows will continue to produce at high levels.

In recent years there has been a steady increase in dairy farmers altering the frequency of milking.

The goal is to take the pressure off the cows and improve mating. 3in2 will also conflict with timing for the AI technician. From observations over 17 years, the end of the five to six weeks of AI appears to be the earliest time in the lactation when cow milk production is not compromised when changing from TAD to 3in2.

Incorporating OAD at Christmas

OAD or 3in2 can be used post-Christmas or post-AI for the following reasons:

- The desire to avoid the hot afternoon milkings
- Possible feed challenges
- Cow condition issues
- Milk decline in production from peak
- To slow the grazing rotation
- Grazing of summer crops.

There are also staff and family holiday benefits with the reduction in milkings. DairyNZ's work on milking OAD post-Christmas has shown that milk production will drop approximately 10% when placed on OAD at this time, which equates to a 4% loss in production for the whole season. They also found that while cows will produce 10% less milk solids (MS) daily, their feed intakes only drop 3%. The extra energy was partitioned to weight gain – the cows are ¼ condition score (CS) is better at dry off than their TAD peers.

A critical point for some farmers going on OAD is that cow condition can be maintained at lower feed intakes, but expect production levels to fall significantly if underfed. Conversely, as mentioned above, condition score can be increased with only a 10% loss in daily milk solids production if cows are fed at rates closer to TAD levels.

The daily milking can be done at a time during the day that suits. There are savings in labour and shed costs, and greater opportunities for farm maintenance or recreation. The latter two points are big drivers for many farming businesses.

From observation, expect the somatic cell count (SCC) to increase 25,000 to 100,000 above existing levels when switching to OAD mid-season. A farm example of the practical application of changing to OAD from TAD leading up to Christmas time would be as follows:

Milking scenario to Christmas (on TAD):

- 150 ha farm with 50 x 3 ha paddocks milked OAD for two to three weeks at the start and then TAD right through to Christmas

The daily milking can be done at a time during the day that suits. There are savings in labour and shed costs, and greater opportunities for farm maintenance or recreation. The latter two points are big drivers for many farming businesses.

- 450 cows are milked through to Christmas (one paddock per milking) two paddocks (6 ha) per day
- The cows have a 20-25 day rotation, with perhaps five paddocks out for summer crops and some surplus taken for supplement.

Change to OAD scenario after Christmas:

- The rotation is slowed down to a 30-day round on the 45 available paddocks, grazing one-and-a-half paddocks per day (4.5 ha of pasture per day)
- The summer crop is introduced at this time.

For grazing management the cows go to the half paddock of pasture directly from milking. After dairy clean up and breakfast/lunch and enough grazing time, the herd would then be fed their 5 kg dry matter (DM) of summer crop for the given period. In the late afternoon they would then be moved to their whole 3 ha paddock. If there are no summer crops, or with reliable rainfall or irrigation, the summer rotation on OAD could be kept at 25 days depending on the expectation of grazing at third leaf emergence.

Incorporating 3in2 at Christmas

The effect of going to 3in2 (from TAD) at Christmas is also commented on by DairyNZ. The impact of milking interval and milk yield indicates that there are no production losses when the interval between milking is no more than 18 hours. Farmers generally report little or no production loss when cows are switched from TAD to 3in2 at Christmas.

Research by G.A. Eldridge and J. Clark from 1977 published in the *Journal of Dairy Research* found that cows milked 3in2 after 20 weeks of lactation on TAD had far less production loss than if 3in2 was started earlier in the lactation. This supports the author's observations that well-fed cows transitioning to 3in2 from TAD at Christmas will maintain their production levels. Farmers also report that cow condition improved (¼ CS) if the cows have the second half of their lactation on 3in2 instead of TAD. This may be a function of energy saved by reducing walking by 25% and cows apportioning this to weight gain.

To change to 3in2, some farmers prefer a production target figure to decide when to start. An example would be the herd averaging 1.7 MS/cow in late December, declining from a 2.0 peak in mid-October. From numerous observations there appears to be no magic figure. If the cows are fed the same as TAD, their rate of decline will stay the same with the transition. A practical guide is if most of the cows are not leaking milk in the yard at the start of the morning milking, then extending the milking frequency out to 18 hours will not be detrimental.

Change to 3in2 scenario after Christmas (using the TAD to OAD example above):

- The rotation is slowed down to a 30-day round on the 45 available paddocks, grazing one-and-a-half paddocks/day (4.5 ha of pasture per day). This is one paddock per milking – no break fences
- The summer crop is introduced, which is typically fed before the night milking and before the noon milking. Some farmers use smart switch releases on their gates for the crops
- Three examples of typical 3in2 milking times for December to early March would be:
  Day 1: 5am and 7pm; or 5am and 6pm; or 4.30am and 6.30pm
  Day 2: 12 noon; or 11am; or 10.30am.

These examples give a 14-17-17 hour split, a 13-18-17 split, or a 14-16-18 split. These milking times and hours can be varied between December and March to suit the farm. From author and farmer observations, splits longer than 18 hours or shorter than 13 hours will reduce production during this period.

It is not necessary to alter the allocated areas grazed between the milking times when on 3in2 from Christmas to March. There is a greater variance between the milking times on TAD. Pasture allocation can be done on a 48-hour basis if needed, especially if on 3in2 in April-May when the hours between milking may range considerably (see ***Table 1***). The cows will adapt their grazing and sleeping habits to fit.

From March onwards, keep the morning milking on Day 1 at the same time. Bring the evening milking forward with the shorter daylight hours (see the middle of ***Table 1***). This ensures that the first cows milked can be sighted going to their paddock from the milking. On Day 2, bring forward the mid-day milking if the time between milkings becomes too long from the night milking (>20 hours).

Farmer observations and the records of the author indicate that by the eighth month of lactation little production is lost by lengthening the milking times, which can get down to 10-20-18-hour splits during this later period of lactation. The author was unable to find any applicable research to support these observations.

Working hours when on 3in2

- Day 1 – staff involved in the evening milking should finish their working day by 1pm at the latest. Staff not involved in the evening milking would have lunch etc, as usual, and should finish at 5pm
- Day 2 – everyone gets a sleep in, with office hours of 8am to 5pm.

Everyone wants the sleep in on Day 2, but not everyone wants to do the night milkings in the weekend. Good rostering will help alleviate some of this. Communicate with staff, e.g. in January the night milkings will be on odd days, in February even days etc. ***Table 1*** shows a typical milking regime on 3in2.

Changing from 3in2 to OAD in late autumn

By the end of the eighth month of lactation (in this example March), cow production will have declined from the peak in October. It is necessary to slow the grazing rotation further and to ensure cow condition targets are met at dry off. If these objectives appear difficult to attain on 3in2, there is the option of going onto OAD in mid-April.

Using the example 150 ha farm above, the cows are restricted to 3 ha per day. This is one paddock per milking and a 45-day round (and no break fences). Culling cows and adding autumn supplements such as maize, silage or fodder beet are introduced to maintain this round.

Total hours of milking from different milking frequencies

Changing the frequency of milking throughout the season will reduce time spent in the shed for you, your staff and your cows. Examples of the time savings of the different milking regimes are shown in ***Table 2*** using an example lactation of 304 days from 1 August to 31 May.

Table 1: 3in2 milking splits – December to March

Day 1 =>	5am	3 ha	14 hours	Feed Summer Crop	7pm	
17 hours	*Late season night milkings = 6-6.30pm March; 5-5.30pm April; 4-4.30pm May*					17 hours
Day 2 =>	3 ha	noon	Feed Summer Crop	3 ha		

On Day 1:	Have breakfast like normal then work till 1pm. Finish around 1pm for lunch and siesta. Have a long break before the night milking.
On Day 2:	Work 8am to 5pm

Table 2: Milking frequency – milkings per lactation

		MILKINGS PER PERIOD			
Months	**Days/Period**	**TAD all season**	**OAD TAD 3in2 OAD**	**TAD then OAD**	**OAD all season**
August	21	42	OAD 21	42	21
August	10	20	TAD 20	20	10
September	30	60	60	60	30
October	31	62	62	62	31
November	30	60	60	60	30
December	26	52	52	52	26
December	5	10	3in2 7.5	OAD 5	5
January	31	62	46.5	31	31
February	28	56	42	28	28
March	31	62	46.5	31	31
April	13	26	19.5	13	13
April	17	34	OAD 17	17	17
May	31	62	31	31	31
TOTAL MILKINGS	**304**	**608**	**485**	**452**	**304**
Hours per milking*		3	3	3.2	3.5
Milkings saved vs TAD			*123.0*	*156.0*	*304.0*
Total Hours Milking		1824.0	1455.0	1446.4	1064.0
Hours saved vs TAD		–	*369.0*	*377.6*	*760.0*
Total Days Milking		76.0	60.6	60.3	44.3
Days saved vs TAD		–	*15.4*	*15.7*	*31.7*

**includes getting cows and washup*

Milking frequency efficiency

In ***Table 2***, there is a range of 304 to 604 milkings across the different regimes, with big savings in total milkings and hours worked when compared to TAD. The author has recorded extensive lactation data in the Tasman, Marlborough and Buller regions since 2002. From this data and farmer observations there are efficiency gains of milk solids harvested per each milking:

- Farms are producing 350 to 400 MS/cow from 304 milkings on farms milked OAD all season. This is approximately 1.15 to 1.30 MS harvested/milking
- Farms milking TAD/OAD are producing 400 to 450 MS/cow, equating to 0.88 to 1.00 MS harvested/milking
- OAD/TAD/3in2/OAD production levels are 440 to 495 MS/cow, equating to 0.93 to 1.02 MS harvested/milking.

These farms are not high input, but they are generally well-run farms, typically Systems 2-4. The production from OAD/TAD/3in2/OAD is similar to TAD. In comparison, the milk solids harvested per milking from TAD is 0.72 to 0.81 MS.

These OAD/TAD/3in2/OAD farms are producing at similar or better levels than what they did when solely on TAD. These production results are also being mirrored by less well-resourced farms. On OAD/TAD/3in2/OAD they are able to match or better their previous productivity levels, with approximately 100 to 125 less milkings per year.

Financial outcomes

Significant benchmarking datasets are not yet available to fully compare the financial benefits of split milking frequency versus traditional TAD or OAD regimes. However, marginal analysis will show increased profitability if productivity is maintained and costs (electricity, shed costs etc) are reduced.

There are less tangible benefits, such as reduced laminitis, improved condition score and reproductive results, and the human cost through fewer milkings. These enhance profitability and business sustainability. The incorporation of more datasets on milking frequency into the DairyNZ Dairybase will provide definitive answers on profitability.

Summary

Farmers will continue to evolve their systems to better suit staff, the environment and the logistics they work under. 3in2, OAD and TAD all have their roles to play. There is still much to understand about how milking frequency can be adjusted and how the ever-evolving modern cow can be bred to achieve more milk from less milkings. Further research, combined with physical and financial analysis, is required to provide definitive answers to its evolution under differing management systems.

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Woogenellup sub-clover. Note that it is less hairy and has no red band on its flower compared with Mt Barker sub-cover which is common on a lot of hill country

DAVID AND JOANNA GRIGG, DICK LUCAS AND DERRICK MOOT

SUB-CLOVER FITS THE BILL FOR DRY HILLS

A system to enhance annual clover on dry hill country has brought production and financial benefits to a Marlborough sheep and cattle farm.

New level of stock performance

A species that has been in New Zealand for years has been harnessed to give a new level of stock performance. Subterranean clover (sub-clover), an annual clover that was first introduced to this country in the 1920s, has become the key focus at Tempello, the sheep and beef property of David and Joanna Grigg in Marlborough. By understanding how to establish sub-clover and manage it, and let it produce bulk feed over late winter and into spring, stock performance and profitability have increased dramatically.

Much of New Zealand's summer-dry eastern hill country has existing populations of annual clovers. Using that clover resource successfully requires knowledge of the annual clover life-cycle, fencing (permanent or temporary) to get high grazing pressure to reduce grass competition, and the discipline to hold off grazing key blocks in autumn and late spring. These skills are not new to many farmers.

The article describes the farm, the development done on the Tempello front country 'hub', and the changes in grazing management to promote sub-clover. It finishes with the financial benefits and skills needed to roll out the system.

Tempello layout

Tempello is around 2,500 ha effective area of hill country running from the Wairau Plains south-west of Blenheim through to the Awatere Valley. Altitude ranges from 100 m asl to 909 m and the hill country soils are Hurunui Steepland. It has a dry sub-humid climate, with 500 mm annual rainfall at the northern end to 900 mm at the south-west end. In the 1970s, Woogenellup sub-clover seeds were oversown by plane at the low rate of 3 kg/ha. Existing grass species include browntop, danthonia, Wana cocksfoot, barley grass, silver tussock and perennial ryegrass in higher fertility areas.

There are six distinct farm areas within the 4,780 ha grazing area of the farm:

- 36 ha gentle hill
- 560 ha medium and steep hill on sub-divided north-facing country below the airstrip (called Tempello front country)
- 1,120 ha higher summer country between the airstrip and the top of the range
- 418 ha Taylor Pass eastern and drier side in five large blocks

- 450 ha Islands Awatere wetter steep area in nine blocks
- 2,195 ha Ned country, which includes 380 ha effective grazing for Merinos and the rest in native kanuka, manuka and beech forest.

At Tempello, Corriedale and Merino ewe flocks and 1,450 Merino wethers are run. As of June 2017, there were 2,090 breeding ewes and 550 capital hoggets (ewe and wether) and 1,000 trading lambs/hoggets. The 560 ha area of Tempello front country is the key area for tupping, wintering and lambing and is where enhancing sub-clover content has been the primary objective.

Tempello also runs 335 breeding cows and usually finishes all 300 steer and cull heifer progeny to 290 kg CW by 20-22 months. Around 270 calves are weaned each year and the in-calf rate is typically 98%. The Tempello front country winters the trading cattle, calves and carries 200 cows all year round. The cattle:sheep ratio is 50:50, with trading cattle the first stock class to be sold in dry seasons.

Old system pre-2001

Prior to sub-division the 2,700 ewes – mixed age (MA)/two-tooth – ran on large blocks. These ewes with 100 cows with calves grazed a block for up to two months in spring/summer, trying to get pasture control. Total stocking rate wintered, including the 200 weaned calves, was 8.2 SU/ha. Feed quality was often uneven across the block, with some areas of long taggy grass (estimated at nine MJME/kg DM) and some grazed-out short green areas (12 MJME).

Lambing percentage was around 120%. During the 1996/97 drought some blocks could not be grazed (the dams dried up). The favourable southerly areas of a block were often over-grazed, while north-facing areas with clumpy dead material remained ungrazed. Following sub-clover germination in autumn, plants could not always be protected from close grazing during the vulnerable stages of the clover's life-cycle.

Ewes often weaned lighter than their tupping weight, so supplements (grain, silage, baleage) were typically used to put weight on ewes leading up to and during tupping. In 1996/97, around $100,000 was spent on supplementary feed to get ewes up to mating weight and cows in calf.

Development and changes in management

Three key changes have bought about an increase in legume yield:

- Installing a trough water scheme
- Fencing sub-division from 30-120 ha blocks down to 9-18 ha blocks
- Recognising the potential of sub-clover as a feed source and altering grazing management to suit it. Key to the success of the system is hard grazing of competing grass in selected blocks by cows during summer and ewes during winter.

Development process

From 2001 to 2008, the Tempello front country (560 ha) area was fenced up. This initial development required 30 km of five-wire fencing with electrics on the top wire.

Farm boundary and the Tempello front country where sub-clover enhancement has focused (in yellow)

David and Joanna Grigg joined Sheep For Profit in 2001 and used the information on ewe body condition and weight to devise a management system to regularly meet ewe weight targets using sub-clover as a cornerstone.

The warratah and post fence cost $6/m or $300/ha (total cost $180,000). This reduced block size from 30-120 ha blocks down to between 9-18 ha blocks. Block numbers increased from six to 30. Temporary electric fencing gear was purchased to allow strip grazing by ewes over winter on steep hills (around $2/m).

Between 2001 and 2003, a trough water reticulation scheme from the Fairhall River was installed costing $220,000 or $360/ha. Previously water was via dams which dried up during droughts. Water is now pumped via a 60 mm alkathane pipe to 60 round concrete troughs. The scheme costs around $20/day over summer to service 600 ha and the house water. These investments in infrastructure (total of around $670/ha) and lifting soil fertility were the building blocks to increasing clover content.

Since 2011, the fertiliser inputs on the 560 ha Tempello front country have changed from 31.5 kg P/ha to 8.2 kg P/ha plus added sulphur and boron. Fertiliser is usually applied to half of this area each year (200-300 ha depending on budget). The blocks earmarked to go through the sub-clover enhancement process get this rate, plus one tonne lime/ha the autumn prior. The pH levels in this area are around 5.4 to 5.8, the Olsen P between 7.0 and 18, and sulphur between 7.0 to 20.

Drought and good advice spur to change

While the 1997 drought was a spur to change, good farm management advice helped shape the new system.

One of the authors, Dick Lucas of Lincoln University, and Peter Anderson, a veterinarian consultant, encouraged the Griggs to see the potential of sub-clover for later winter/spring production. They worked with them to develop a new grazing management system. David and Joanna Grigg joined Sheep For Profit in 2001 and used the information on ewe body condition and weight to devise a management system to regularly meet ewe weight targets using sub-clover as a cornerstone. They also developed and tested the system when they were involved with the Meat & Wool NZ Monitor Farm Programme (2002-2005), which provided good monitoring support.

The new system is characterised by rotational grazing of ewes, break-feeding on saved pasture in mid-winter and periods of spelling pasture. Ewe numbers were dropped by 600 (from 2,700 to 2,100) and 100 beef cows were added (from 100 to 200 head) giving more mouths for pasture control. By 2003, the average capital stocking rate was between 7.5 and 8.5 SU/ha and the Tempello front country was also wintering 300 R2 cattle for 16 weeks, to be finished prime by September/October. This adds another 2.9 SU over this time, bringing it to 10.5 to 11.5 SU/ha on average.

Pasture renewal using natural re-seeding

Fencing, stock water and fertiliser were just the first steps to improved pasture quality. The next step was building the seedbank of the clover in the soil, and then letting this clover seed germinate, establish and flourish to produce a legume dominant sward. To do this, in spring David Grigg chooses a block to put through the 'enhancement process'. It may have few clover plants and/or large distances between areas of sub-clover. Usually most blocks get a turn to be renewed every 10 to 15 years. This is the only form of pasture renewal on the Tempello front country.

In January/February the block is grazed by cows/calves to 800 kg DM/ha and the thatch and dead grass strands are removed. Rain is expected in late February/early March, although April is not too late. Typically, 20 mm is enough to germinate the seed that has softened over the long hot summer.

The rain brings clover germination so sheep are then excluded from the block to let the sub-clover establish. When the clover is at the five trifoliate leaf stage it can then be grazed. The block is strip grazed by 900 twinning ewes from June 20 to mid-August (35 SU/ha). This removes the grass competition and it gives the ewes pre-lamb the high-energy diet that they need. The clover base survives this grazing down to 600 kg DM/ha.

The sheep have a front break fence, not a following fence. Twinning ewes are allocated 2 kg DM/head/day. The two-wire electric fence is on very steep country so it has the added advantage of keeping ewes fit. Cows follow to clean up any stalky remains.

From mid-August onwards the block is left to recover. The sub-clover soon grows a huge sward of leaf by early October (3,500 kg DM/ha). At Tempello they resist the temptation to graze it, but let it flower and set seed. Up to a tonne of seed will be set. The long runners can invade areas with no clover and colonise new ground. The block can be grazed December onwards when most seed burrs are safely buried by the plant.

Rainfall in January can cause some seeds to germinate. When no rain follows up these seedlings can die. This 'false strike' is disheartening, but this is typically only 20% of the seed bank, leaving plenty more seed in the ground. Some early strikes can survive, but the best scenario for success is a dry January and February followed by 20 mm of rain in early March, giving a clover strike and grass

Bared out block in a growthy summer at Tempello. Controlling grass is key to a successful sub-clover establishment in autumn and bulk legume late winter/early spring

Ongoing pasture maintenance costs are minimal. There is no need to oversow, drill or cultivate the lower hill country as the annual sub-clover germinates each autumn and sets seed in spring.

recovery for 20 March tupping. The legume fixes nitrogen at the rate of 25-30 kg N/T legume grown. If clover contributes two tonnes of legume dry matter in spring this is 60 units of N/ha fixed for free.

Management of balance of front country

This section describes the grazing management for the sub-clover blocks not earmarked for pasture renewal, i.e. for production.

- Winter: The area is spelled for seven to 10 weeks to grow feed for lambing on 20 August.
- Spring: Ewes are set-stocked for lambing at a rate of 7 SU/ha for singles and 3 SU/ha for twinning ewes. Target covers are 1,400 kg DM/ha for twins and 1,200 kg DM/ha for singles. Cattle are mixed in with ewes, depending on feed covers. Ewes are weaned when lambs are between 10 and 12 weeks of age. Lambs are sold prime and replacements return to this area. Ewes return here or go onto the top Tempello country.
- Summer: Cows clean up the lambing blocks (20 cows/ha). They are used to bare down grass, so that following the February/March rains the sub-clover has space to germinate, grow and compete with grass.
- Autumn: Ewes are typically tupped on the short green pick of grass and young sub-clover (1,000 kg DM/ha). They have a quick rotation (three or four days). At Tempello they find that fresh, short and green is far better at flushing than long and taggy poorer quality pasture.

Production lift

The changes have brought a significant lift in per hectare and individual ewe performance in terms of lamb weight/ewe weaned. This has been despite a shift back to Corriedale genetics for wool income, which has impacted on lamb growth rates.

The Corriedale lamb weaning weight average has increased from 27 kg to 35 kg and the lambing percentage

Table 1: Corriedale-based ewe performance over the 560 ha Tempello front country area (note weaning age does vary)

	2001 CORRIE/POLL DORSET	2003 CORRIE/POLL DORSET	2007 CORRIE/POLL DORSET	2016 90% CORRIE FLOCK*
Ewe tup weight	63	65	71	70
MA scanning %	145%	148%	165%	178%
Two-tooth and MA lambing %	128%	128%	138%	135%
Lamb growth rate pre-wean (g/day)	250	374	345	295
Average lamb weaning weight	27	30.9	33	35
Lamb weight/ewe weaned kg	34.5	39.5	45.5	47.25
% prime at weaning (over 32 kg)	50%	75%	85%	90%
SU wintered/ha	7.2 – 8.2	7.5 – 8.5		10.5 – 11.5

** Two-week delay to weaning so weaned heavier, also two-tooth lambing was less because of a storm during lambing*

from 128% to 138%. The stocking rate over 16 weeks of winter has increased by 40%, with home-bred beef cattle being taken through to be sold prime as R2, rather than as yearlings.

Ongoing pasture maintenance costs are minimal. There is no need to oversow, drill or cultivate the lower hill country as the annual sub-clover germinates each autumn and sets seed in spring. No bag nitrogen fertiliser is applied to hill country as they rely on N-fixation by legumes.

No supplements have been fed to ewes, despite some difficult spring and autumns. To allow the above system, all hoggets are grazed off-farm on vineyards over winter (100 days). Trading cattle are summered on another part of the farm in the Awatere.

Ewes are weaned early, with prime lambs at foot, at their target mating weight. This means they only have to be maintained through summer.

In 2001, each ewe was weaning only 29 kg of lamb weight per ewe mated (or 34.5 kg/ewe weaned). By the mid-2000s ewes were producing 45.5 kg of lamb liveweight per ewe weaned. Pre-weaning growth rates had lifted from 250 g/head/day to 350 g/head/day (mob average). The most recent change to a higher Corriedale genetic influence has seen a reduction in average lamb growth rate, but gross wool returns lifted by around $30,000. The Poll Dorset/Corriedale ewe at 30 micron grossed $10/head and the Corriedale at 27 micron $25/head.

There are still Corriedale lambs that grow at 350 g/head/day, but it is currently not the mob average. Lambing percentage has lifted from 128% in 2002 to an average of 138% by 2006 onwards. This is because of the flow-on effect of ewes having good nutrition and weaning at a higher body condition score (BCS). Lambs consistently wean at 34 kg+. In the first year of the new system, this gave a $32 to $49 advantage per head as many more lambs were prime at weaning. In years where store lamb prices are low this is a considerable advantage.

Over 2,200 lambs, the difference in the mid-2000s was an extra $70,000 to $100,000 in the bank. Over the 560 ha of the Corriedale/Poll Dorset operation the return in the first year following development was $125/ha to $191/ha extra. It cost $660/ha. The tonnes of meat coming off the 560 ha hub of the farm increased from 60 to 76 tonnes over the first three years, despite ewe numbers dropping by 600.

Feeding costs are minimal as the only supplements are fed to bulls and rams. All other stock get pasture, which is a huge saving. Feed utilisation has improved. By way of example, 10 km of fencing in 2003 allowed an extra 65 days of grazing for 1,000 ewes because of better utilisation. This was worth $13,000 (at $0.20 of feed/ewe/day if supplementary feeding).

Financial benefits

Returns have allowed the purchase of a 36-foot sailing boat and management changes means more free time over summer to use it, which was one of David and Joanna's personal goals. Profitability increases were initially quite big as lamb weights improved dramatically. For example, with a modest lamb schedule price of $4.40/kg CW and $1.80/kg, store LW income is $40,000 more if lambs are 7 kg heavier at weaning (25 kg versus 32 kg).

Profitability gains are now smaller incremental steps each year. Fluctuations occur, mainly driven by market prices and/or a dry spring. Cattle prices and high in-calf rates have been the biggest contributor to increases in profitability most recently.

In 2013/14, gross margins were $48.80/sheep SU and $52.88/cattle SU. The mean price/lamb was $95/head compared to $84 for the Beef + Lamb New Zealand Economic Service Class Two SI Hill average, and this includes stores. Economic farm surplus was $17.20/SU, while the Class Two mean was $7.36/SU. In 2014/15 (a dry spring), economic farm surplus was $30/SU, producing a farm surplus of $279,000. Standard farm expenses were 54%. The most recent gross margin (2017) was $108/SU for the Corriedale flock before interest, but net of direct costs, and $90/cattle SU.

By improving the front country, it now has the ability to finish beef cattle over winter into early spring. Sub-division and oversowing improved species on the wetter Awatere side of the farm has meant it is now suitable for summering rising R2 month cattle, which then return to the front country to be finished. The legume content improvements to both these distinct areas of the farm has allowed Tempello to go from producing store cattle to producing prime cattle.

Skills needed

The Tempello system is not complicated, uses existing technology and ideas, and would suit many warmer east coast dryland farms where white clover does not survive and annual clovers can grow over winter. The knowledge required was understanding the sub-clover's life-cycle, skills to organise fencing sub-division, fertiliser and water reticulation, an ability to gauge pasture height and legume content, plus an ability to plan a stock rotation that will increase/decrease grazing pressure in a timely fashion and meet animal requirements in a dryland environment.

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CHOICE OF SUB-CLOVER CULTIVAR
Dick Lucas, Lincoln University

There are up to 10 sub-clover cultivars currently available from New Zealand seed companies, and they have a wide range of characteristics so it is important to choose suitable cultivars for different environments. Flowering time, hard-seededness, tolerance of close grazing, seed burr burial ability, and pest and disease tolerance are considerations when purchasing seed. A mixture of two complementary sub-clover cultivars is recommended to compensate for variations in climate and soil depth.

At Tempello, sub-clover was introduced in the 1950s. Mt Barker and the very late flowering Tallarook were the only sub-clover cultivars available at that time. The mid-late flowering, soft-seeded Mt Barker was best adapted to the low rainfall climate and it is still present on most sites at Tempello. However, Woogenellup is currently the dominant sub-clover cultivar on the 560 ha Tempello front country. It was introduced in the 1970s with the assistance of a Land Development Loan.

The excellent adaptation of Woogenellup to the Tempello environment was illustrated by the fact that it was sufficiently widespread to be able to respond to management designed to exploit the potential productivity of the resident sub-clover. If it had been poorly distributed, additional seed would have been required to exploit the considerable costs of fertiliser, sub-division fencing and water supply.

At least 30 new sub-clover cultivars have been released in Australia since the 1960s when Woogenellup was first marketed. Not all of the new cultivars have been introduced to New Zealand. In general, the most successful have been late-flowering and soft-seeded. Ongoing research at Lincoln University suggests that mid-flowering and soft-seeded cultivars, such as Woogenellup and Narrikup, will be best adapted to areas where white clover does not survive. In areas with higher rainfall and/or deeper soils late-flowering cultivars, such as Denmark, are able to exploit the later onset of summer drought. Cultivars bred for Australian conditions usually have high levels of hard-seededness to help avoid false strikes in summer. Further work locally is required to demonstrate the usefulness of hard-seededness in New Zealand.

Sub-clover is the best adapted clover for summer dry permanent pastures in New Zealand. Of the 8.9 million ha of sheep, beef and deer farms in this country, sub-clover is probably suited to at least half of that area.

There is a continuum from very dry areas, such as at Tempello where the perennial white clover does not survive and sub-clover is dominant, through to summer moist areas where white clover is the best adapted legume in permanent pastures. Annual sub-clover is adapted to sites where there is an average of at least a month of summer drought each year. The simplest way to assess the need for sub-clover in an individual paddock is to observe the duration of the negligible growth period during dry seasons.

This 'length of dry season' concept may seem rather unsophisticated, but it is the best integrator of several influential components, such as seasonal rainfall and evapotranspiration, soil water-holding capacity, slope and aspect. Total annual rainfall is a poor indicator of the need for sub-clover in areas with over 600 mm rain/p.a. For example, there is very little land in the North Island which receives less than 800 mm rain/p.a., but there are large areas where the sub-clover is present. Subtle adjustment of grazing management would encourage large increases in production of resident sub-clover. In higher rainfall country, north and west-facing paddocks could be designated for sub-clover management and shady faces for white clover.

KATE GRIFFITHS, ANNE RIDLER AND PAUL KENYON

LONGEVITY AND WASTAGE IN NEW ZEALAND COMMERCIAL EWE FLOCKS – A SIGNIFICANT COST

Reduced ewe longevity and increased ewe wastage pose a significant cost to the New Zealand sheep industry. The following article outlines a long-term research project undertaken by researchers at Massey University investigating this issue. It involves commercial flocks and is nearing completion.

Exploring the potential cost of wastage

Reduced longevity and increased wastage of commercial ewes poses a potentially significant cost to both individual farmers and to the New Zealand sheep industry. Interestingly, there is currently little accurate data related to longevity and wastage rates in commercial flocks, and the scant data that is available is at the flock level rather than the individual level.

Productive longevity is the ability of a ewe to survive and be productive until she is culled for age (farm policy dependent). Ewe wastage is a combination of both on-farm mortality and premature culling. Premature culling is where a ewe is culled prior to the potential end of her productive lifespan, either to slaughter, direct sale or via slaughter on-farm. To maintain flock numbers, replacement rates for commercial flocks are typically in the range of 25% to 35%. This represents an inherent degree of cost, including fewer sale lambs, increased management and feed costs, and potentially reduced selection pressure, while some farms may opt to purchase additional replacements which can have biosecurity risks associated. In addition, the reproductive performance of ewes increases as they age, so having a higher proportion of younger ewes reduces the overall productivity of a commercial flock.

Historical and recent survey results indicate that on-farm ewe mortality lies in the range of 2.8% to above 20% per annum, with significant variation between farms. A recent (2016) longitudinal study by Anderson and Heuer reported an on-farm mortality rate in

Historical and recent survey results indicate that on-farm ewe mortality lies in the range of 2.8% to above 20% per annum, with significant variation between farms.

New Zealand commercial ewes ranging from 2.8% to 15.7%. Similar mortality rates (6% to 22%) have been reported in Australian ewe flocks in a 2014 study by Kelly, Kahn and Walkden-Brown. This on-farm mortality has a direct cost in that the cull value of the ewe is not obtained, and may have an additional cost if the ewe dies during the pregnancy or lambing period as there is the loss of potential lamb(s).

It is also important to consider the welfare implications of having increased on-farm mortality rates, and the perception that this creates of the New Zealand sheep industry. There are approximately 20 million breeding ewes in this country. If we assume an annual average on-farm mortality of 8% (1.6 million ewe deaths/year) and aim to reduce on-farm mortality to 6% (1.2 million ewe deaths/year), this will result in 400,000 less ewe deaths annually. Assuming ewes are valued at $100/ewe this equates to an extra 40 million/year, and has not accounted for both replacement savings, which includes feed savings, and increased revenue from increased lamb sales.

In New Zealand, ewes are typically kept and managed as flock animals rather than individuals. This presents a particular challenge when investigating longevity and wastage traits as ewe numbers are typically based on flock totals at key times of the year (pregnancy scanning and shearing being examples) and, in some instances, an annual stock reconciliation. The exception to this may be stud/recorded ewe flocks, which tend to have good individual monitoring, as this is essential to their breeding success. The recent introduction of electronic identification (EID) tags for sheep has provided farmers with a relatively straightforward means of tracking individual ewes within a flock, if they choose to utilise it. New Zealand survey results from 2014 reported that up to 24% of respondent farmers were utilising EID technology in their flocks, a four-fold increase from reported 2012 survey results.

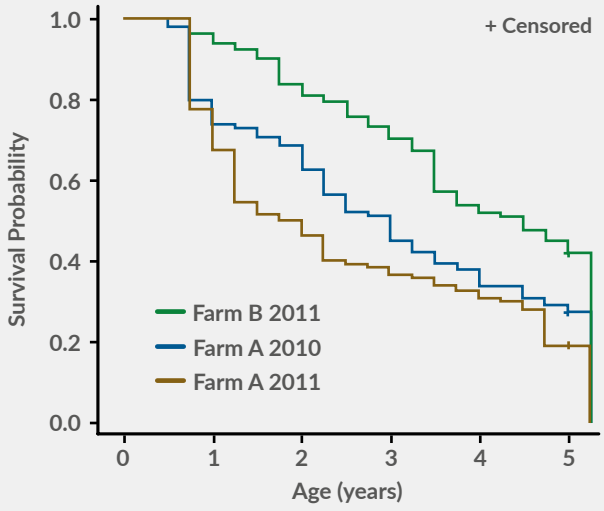
Current investigation

In the present study just over 13,000 ewe hoggets were enrolled, all of whom were individually identified at the time of enrolment using EID tags. Enrolled hoggets were 2010 and 2011-born (Farm A), 2011-born (Farm B) and 2014-born (Farm C). Farm A is located in the Waikato, while Farms B and C are located in the Wairarapa. A proportion of the enrolled hoggets, approximately 85%, were presented for breeding at seven to eight months of age, while the remainder were not bred until they were two-tooths. Of those that were presented for breeding, approximately 70% of the hoggets were up to the recommended target mating weight of 40 kg, while the remainder were lighter than 40 kg.

Specific lifetime data has then been collected for each enrolled ewe. Liveweights and body condition scores (BCS's) have been collected at four key management times each year (pre-breeding, pregnancy scanning, set-stocking and weaning). Reproductive parameters are recorded via pregnancy scanning results, and also palpation of the ewes' udders at docking to classify each ewe as wet (actively lactating) or wet-dry (not actively lactating). In addition, the date and reason for culling is recorded and tags are collected from any ewes that die on-farm. On one farm (Farm A) a small number of poor BCS ewes are euthanised each year at pregnancy scanning, and on-farm necropsy is conducted to establish the likely cause of the poor condition.

Preliminary results

Basic survival analysis has been conducted for three cohorts of ewes (Farm A 2010 and 2011-born and Farm B 2011-born), analysing data up until six-tooth age. As demonstrated in ***Figure 1***, survival rates vary between



A survival probability of 1.0 means 100% of the ewes in the cohort are still alive and within the study flock. A survival probability of 0.6 means 60% of the ewes in the cohort are still alive and within the flock, while 40% have died, been culled or have gone missing on-farm. A higher survival curve, as seen in Farm B 2011, indicates greater retention of study ewes in the flock, and reduced wastage. The survival probabilities vary between cohorts (farms), vary between years, and also vary within each year.

Figure 1: Survival plot

Annual rates for on-farm mortality/missing on-farm vary between cohorts and years, but currently range from 8% to 16%.

farms and between years. Farm B 2011-born has the highest rate of survival, while Farm A 2011-born has the lowest. Note that Farm C is excluded from this preliminary survival analysis as data is currently complete only up until two-tooth age.

Of ewes that were no longer present in the flock by six-tooth age, more had died or gone missing than had been culled. However, this may change as the ewes age and are culled more aggressively for traits such as body condition, teeth, feet and udder characteristics. Annual rates for on-farm mortality/missing on-farm vary between cohorts and years, but currently range from 8% to 16%. Most ewes that die/go missing appear to do so over the lambing period. In addition, poor BCS at set-stocking (<2.5/5) appears to be a risk factor for reduced longevity.

The primary reasons for culling thus far are failure to rear a lamb (wet-dry), failure to conceive (dry) and poor condition/ill-thrift. Approximately 500 poor BCS ewes have been euthanised for on-farm necropsy, for which a number of causes of weight loss have been identified including Johne's disease, teeth problems, liver damage/facial eczema and pneumonia. No diagnosis has been possible for approximately half of these euthanised ewes and it is suspected that poor nutrition and/or internal parasitism may have been the primary reason for their weight loss. As such, the recommendation to draft out thin ewes, drench them if required, and feed them preferentially has been reinforced.

A subset of the enrolled hoggets were included in two further studies, one examining the relationship between hogget liveweight and BCS and reproductive rate, with the other the effect of liveweight and BCS on the ability of hoggets to successfully rear their lamb(s).

The aim of the first study was to establish the relationship between hogget liveweight and BCS immediately pre-breeding with fertility and fecundity. Improvements in both fertility (percentage of hoggets pregnant) and fecundity (percentage of multiple-bearing hoggets) were reported, with increases in pre-breeding liveweight up to 47.5 kg. However, there appeared to be

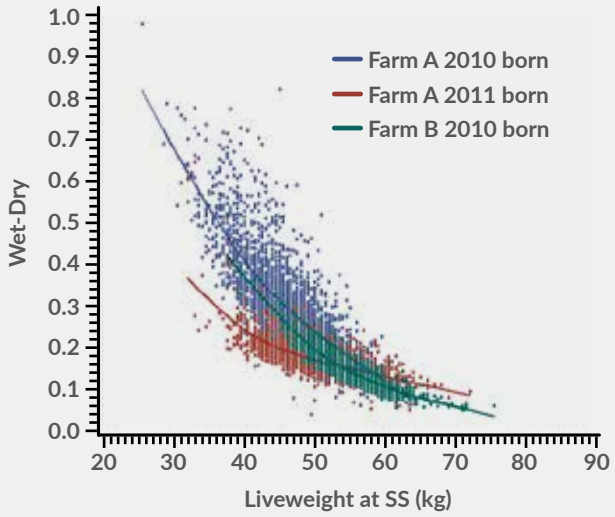


Figure 2: Hogget set-stock weight vs. risk of wet-dry

no further benefit to having hoggets heavier than 47.5 kg pre-breeding. Improvements in fertility and fecundity were also seen in hoggets with BCS equal to or greater than 3.0 or 3.5, respectively.

The aim of the second study was to investigate the effect of hogget liveweight and BCS at different times of the year on the risk of being identified as wet-dry at docking. It takes considerable resources and management to successfully breed and manage hoggets through to late pregnancy, so if she then fails to rear her offspring this is an important economic loss for a farmer. The study found a significant relationship between hogget liveweight at set-stocking and the risk of being wet-dry, with heavier hoggets at less risk of being wet-dry ***(Figure 2)***. There was also a significant effect of liveweight changes between pregnancy diagnosis (PD) and set-stocking, such that the more liveweight hoggets gained between PD and set-stocking the less likely they were to be wet-dry.

These findings reinforce the recommendation that hoggets need to continue growing throughout the pregnancy period (aiming for 100-130 g/day), as the hogget needs to grow herself in addition to maintaining the growing foetus. In this study, for every 1 kg heavier at set-stocking the hogget was approximately 10% less likely to be wet-dry. Farmers should aim to weigh hoggets routinely, both prior to breeding and throughout the pregnancy period. Those that are not meeting target growth rates/target weights should be promptly identified and preferentially fed.

As this is a longevity trial, the dataset will not be complete until all enrolled ewes are culled or have died. A comprehensive analysis of the longevity trial results can be expected in 2019.

The longevity study has identified failure to rear a lamb (wet-dry ewes) as one of the predominant reasons for premature culling from commercial flocks.

The longevity study has identified failure to rear a lamb (wet-dry ewes) as one of the predominant reasons for premature culling from commercial flocks. Poor or reduced milk production and impaired lactation performance may be contributing to these ewes being subsequently identified as wet-dry, but this is not accurately known. Recent survey results indicate greater than 85% of farmers were examining ewes' udders, presumably as a means of identifying which ewes to cull based on apparent 'poor' udder characteristics. However, there is currently no standardised scoring method available for farmers to use that relates udder characteristics to the ewe's ability to successfully rear a lamb(s).

There is also a current lack of recent research in this area that relates ewe udder traits to either lamb survival or lamb growth to weaning. Therefore, ewes may be culled unnecessarily or conversely ewes that are not suitable for lamb-rearing may be retained in the flock. We also do not know if udder characteristics change over the course of a production cycle (one year), and as such do not currently know the most appropriate time at which ewes' udders should be examined.

A further study was therefore started in 2016 utilising 1,200 ewes from a commercial flock. It aims to identify udder traits that are related to the ability of a ewe to successfully rear a lamb(s) and udder traits that farmers can use to correctly identify which ewes to cull. This will enable more targeted ewe culling and have the flow-on effect of a reduction in unnecessary lamb wastage. This project will be undertaken over multiple years. Preliminary results suggest that there are changes in udder characteristics over the course of the year, for instance, abnormalities present at docking may no longer be identified in the autumn of the following year. Subsequent data collection on the same ewes will enable these trends to be investigated further.

Acknowledgements

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STEVE MORRIS

WHERE HAVE ALL THE LAMBS GONE?

The number of lambs produced for finishing is falling, but the number of hill country farmers trying to finish lambs is increasing. The pipeline for the supply of lambs is therefore disappearing and this article explores how land use changes have contributed to this.

Sheep exports

Recent articles and news items in the popular press and on TV have highlighted a supposed decline in the sheep industry. The recent closure of the Silver Fern Farms Fairton sheep meat processing plant added to this conjecture. Despite the company saying the right things about its support to those affected and realigning its plant strategy, it was a timely reminder of a contracting industry – at least in terms of numbers.

The New Zealand sheep and beef sector has always been a principal driver of the economy, representing 3.5% of GDP and $7.5 billion in export receipts. It also forms the basis of the visual and social landscape of New Zealand which helps underpin our tourism industry. New Zealand sheep and beef farms cover 9.3 million ha, a third of the land mass.

New Zealand is the largest exporter of lamb in the world, accounting for just under 50% of the global trade in lamb. Lamb export revenues for the year ended 30 September 2016 were estimated at $2.57 billion, with mutton exports generating another $419 million in export receipts. The major market for our lamb is the European Union, which takes around 41% of our lamb and 18% of mutton exports. North Asia (principally China) accounts for 35% of lamb exports and 62% of mutton exports.

Sheep numbers

There are few specialist sheep farms in New Zealand, with most farms having a mix of sheep and beef cattle (some farmers have substituted dairy cattle grazing in place of beef cattle) on the same farm. This increases management flexibility through the ability to preferentially feed some livestock while maintaining high levels of grazing pressure with other livestock classes. It is relatively easy for farmers to alter their mix of sheep and cattle to suit economic conditions and preferences. The main driving force behind this substitution is often the relative profitability between cattle and sheep.

Early records indicate there were 223,000 sheep in New Zealand in 1851 and numbers increased to 23 million between 1851 and the 1920s based largely on the natural, unimproved fertility of the country's soils. As soil fertility started to decline, the growth in sheep numbers slowed, but the application of science to agriculture helped counter this trend from the 1920s to 1950. Sheep numbers in 1950 were 33 million. With the introduction of aerial topdressing in 1949, relatively cheap superphosphate, and high prices for meat and wool, it generated a rapid rise through the 1950s and 1960s to 60 million sheep in 1970. Government subsidies helped maintain that growth through the 1970s and numbers peaked at just over 70 million in 1982.

The removal of subsidies and the restructuring of the agricultural industry led to a steep decline in sheep numbers in the last two decades of the 20th century. Sheep numbers have continued to fall – they were around 40 million in 2002 and by 2016 were estimated at 27.6 million. The last time there were this many sheep in New Zealand was in 1933, and in fact we are approaching the number of sheep present 100 years ago (i.e. 25 million in 1917).

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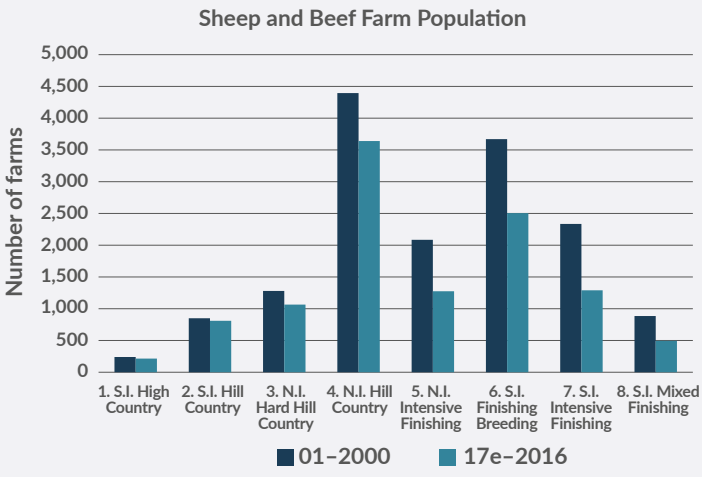
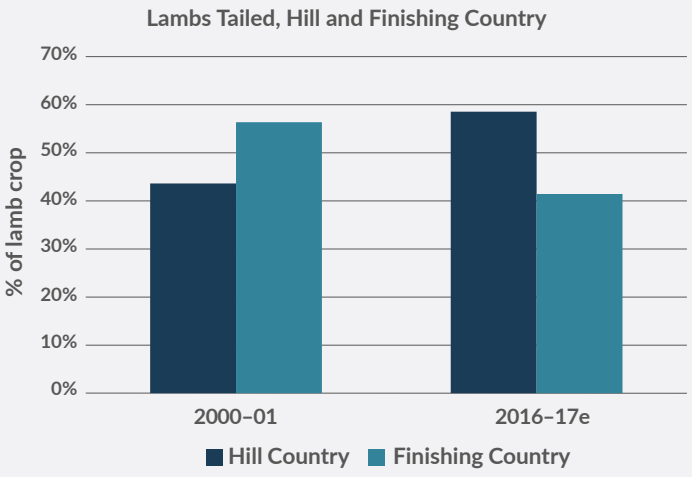


Source: Beef + Lamb New Zealand Economic Service

Figure 1: Numbers of sheep and beef farms in the different farm classes in 2000/2001 and 2016/2017



Source: Beef + Lamb New Zealand Economic Service

Figure 2: Changes in numbers of lambs tailed in hill country and finishing country in 2000/2001 and 2016/2017

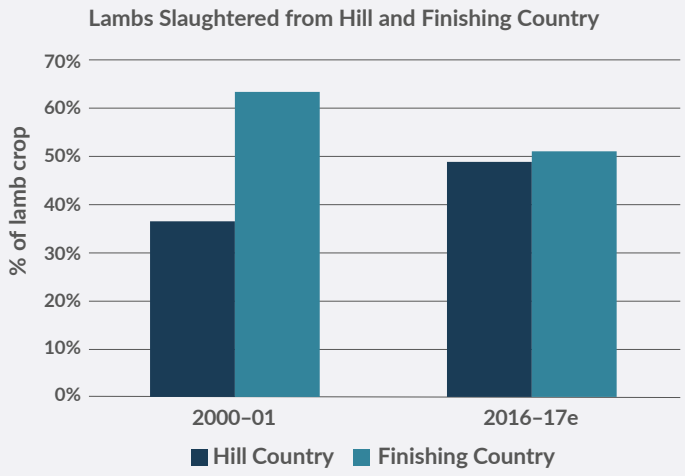


Figure 3: Numbers of lambs slaughtered directly from hill country and finishing country in 2000/2001 and 2016/2017

Source: Beef + Lamb New Zealand Economic Service

Figure 4: The export lamb monthly slaughter pattern for selected years

Source: Beef + Lamb New Zealand Economic Service

Changes in land use

Associated with the decline in sheep numbers has been a change in land use. Since 1990, the land area farmed and classified as sheep, beef, deer and goat pastoral land farms has declined 34% (equivalent to 4.2 million ha) to an estimated 8 million ha at 2016/2017. Some of this decrease has been associated with conversion to dairy land (around 1 million ha), but overall there has been a decline in pastoral land use (both dairy, sheep and beef) of 24% (or 3.2 million ha) since 1990. This land use change would be spread amongst forestry, marginal land closed for conservation, land reverting to scrub and bush, and urban encroachment (especially from small-holder lifestyle blocks, viticulture and horticulture).

The change in land use can also be measured by the number of farms running sheep and cattle from 2000/2001 to 2016/2017. There was a universal decrease in the number of farms across all eight of the Beef + Lamb New Zealand Economic Service farm classes (see ***Figure 1***). This is perhaps more pronounced in the intensive farm classes 5, 6, 7 and 8, where there has been a 38% decrease in the number of farms, most likely due to the conversion of land from beef and sheep to dairy. There was a 15% decrease in the number of farms in the more extensive sheep and beef farm classes (classes 1 to 4). This definitely indicates a land use change in the last 16 years with less farms running sheep (and beef cattle), and it is more pronounced on the most intensive farm classes than in the extensive hill country farmed areas.

Lambs born, tailed and finished

Associated with this change in land use has been a change in the proportion of lambs born and tailed on hill country farms defined as the extensive farm classes (classes 1 to 4) versus the more intensive farm classes (classes 5 to 8). In 2000, 44% of lambs were tailed in hill country and this proportion increased to 59% in 2016 (see ***Figure 2***). Note the 31% decline in total number of lambs tailed from 2000/2001 to 2016/2017 from 33.5 million to 23.2 million.

There has also been a shift in the farm of origin of lambs slaughtered. In 2000/2001, it was estimated that only 37 % of the lambs slaughtered came directly from hill country farms, whereas in 2016/2017 an estimated 49% went straight to slaughter from hill country farms. Lambs slaughtered from finishing farms has dropped from 63% to 51%, so now there is approximately a 50:50 ratio of slaughter of lambs directly from hill and finishing farms. These numbers indicate that there are fewer lambs available for lamb finishers to purchase from hill country farms as these farms are attempting to finish more lambs for slaughter.

It is very difficult to determine if there has been a change in the monthly slaughter pattern associated with the shift to more lambs moving directly to slaughter from hill country farms. When looking at ***Figure 4***, it does seem to indicate a drift to a later kill date, which probably backs up the assumption that more hill country farms are attempting to finish lambs. However, it is confounded by different seasonal weather patterns in the different years determining when lambs have reached their desired slaughter target liveweights. What is clear is that only 20-25% of lambs are slaughtered before Christmas and the mid-point in the annual lamb kill is still some time in early March.

The sheep industry has been able to maintain production levels, despite the decrease in sheep numbers, via an impressive increase in sheep performance. Since the 1990s, there has been a 23% increase in lambing percentages and a 28% increase in lamb carcass weights, which probably equates to at least 50 g a day improvement in lamb growth rate. Together the increase

The sheep industry has been able to maintain production levels, despite the decrease in sheep numbers, via an impressive increase in sheep performance. Since the 1990s, there has been a 23% increase in lambing percentages and a 28% increase in lamb carcass weights.

in lambing percentage and carcass weight has resulted in an increase in efficiency measured as lambs sold per kg of ewe and hogget bred.

Other estimates suggest there has been little change in stocking rate in the last 20 years, but a change in livestock performance resulting in a lift in sheep meat production of 72% in hard hill country since 1989/1990.

What of the future?

The tight global lamb supply situation has enabled prices to surge this late autumn and early winter. Predictions by most commentators are that the supply side will remain tight for the rest of 2017. High pregnancy diagnosis results may cause a slight surge in supply over the summer of 2017/2018. The UK/Europe has been a key market and product prices often rise with the tight supply period for meeting chilled product shipping deadlines for Christmas and Easter. It is worth noting that lamb consumption in the UK has been declining, down 35% from 1995 levels, and there is an emerging strong preference for local supplies and an ever-increasing competition from alternative proteins.

All this suggests that diversification from the UK and European market is long overdue. Exporters have moved the focus to other markets, notably China. Demand from the Middle East continues to lift and offers some potential. The other factor in demand is the growth in demand for traditional ethnic cuisines (who traditionally like and use lamb and mutton) due to growing Indian, African and Hispanic populations in all countries. So new markets will emerge and our exporters need to be in a position to take advantage of these.

It is quite clear that there has a decline in sheep numbers and that land use changes have contributed to this decline. The decline in numbers has been offset to some extent by improved production via increased lambing percentage and carcass weights. The number of hill country farmers trying to finish lambs is also increasing, therefore the pipeline of supply of store lambs to intensive finishing farms is declining.

Acknowledgements

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MIKE TATE

THE OMEGA LAMB PROJECT

The Omega Lamb Project, a Primary Growth Partnership (PGP) programme involving leading food company Alliance, Headwaters and the Ministry for Primary Industries (MPI), has developed Te Mana Lamb, a new kind of premium lamb. The demand for Te Mana Lamb following its commercial launch in premium restaurants in Hong Kong and New Zealand means new farmers are being sought for the project.

Escaping the commodity trap

New Zealand has struggled for some time to escape the commodity trap. Exporters have been despatching undifferentiated commodities like lamb to customers in the four corners of the world for more than a century. However, there has been significant progress in the red meat sector to break away from this 'race to the bottom', with a number of initiatives and programmes underway.

One programme, which was formed in 2015 and where there is evidence of innovation and a move towards change from farmers and partners, is the Omega Lamb Project. This is a PGP programme involving leading food company Alliance, a group of innovative farmers known as Headwaters, and MPI. The project has developed Te Mana Lamb, which is a good illustration of what can be achieved. It is creating new value for lamb and sparking a renaissance in the global appetite for New Zealand's premium meats.

Staff at the Omega Lamb project have worked hard to develop the precise combination of genetics, management and feeding to alter the fat profile of the lamb.

Genesis of the project

The genesis of the Omega Lamb Project began with a programme to produce sheep with the fat levels needed to better breed and thrive in the South Island's high-altitude pastures and conditions. It was while breeding sheep to be healthier and better adapted to this harsher high-country environment that it was realised that the fats in lamb (not lean muscle) that were the key, both for the animal and the consumer.

This led to 10 years of scientific search, discovery and natural breeding of sheep with a different type of fat, an intramuscular fat, higher in omega-3 with marbling on a micro-scale – something never before seen in lamb. Those involved in the project took this new breed and researched rearing locations and conditions, farming practices and finishing grazing to produce an entirely new lamb eating experience. All this was achieved using natural breeding, and outdoor pasture-based farming, but underpinned by modern individual animal recording and product analysis.

Staff at the Omega Lamb project have worked hard to develop the precise combination of genetics, management and feeding to alter the fat profile of the lamb. It has involved a focus on a very different way of doing things, through a partnership between breeders, finishers, marketers and distributors, with the aim of adding value to the total system – not just to any individual part.

Exceptional meat qualities

The goal has been to produce the world's tastiest and healthiest lamb. The outcome is an animal with exceptional meat qualities, well suited to our high-country conditions, with a unique genetic profile and nutrition that enhances omega-3 levels.

The animals are a selection of New Zealand white-faced breeds bred specifically by Headwaters for the Omega Lamb Project. Hundreds of genetic lines are screened for taste and fat characteristics. Because the breed was developed by the project the parentage of these lambs can be traced right back to the first sires. Animals are selected only at the very top end of natural variation in omega-3 and polyunsaturated content for lamb, and they are then farmed in systems that further enhance omega-3 levels. The process is now complete to make official 'Source of Omega-3' on a pack claim for some cuts.

The project has been built on an all-natural farming system, integrating unique genetics with specially developed agronomy. Lambs are bred in the high country and exclusively grass fed. Post-weaning, they are moved to lowland farms to be finished on specially developed chicory herb-based pastures.

The lambs have greater stores of muscle glycogen, low pH and exceptional and consistent taste, tenderness, succulence and colour with rich marbling, including the omega-3 fats. The meat also doesn't behave like regular lamb when cooking. Because it is full of 'good fat', it has essentially less moisture. That means it doesn't suffer shrinkage, retains its shape, flavour and texture and is more versatile.

Marketing

Te Mana Lamb was launched in New Zealand and Hong Kong this year, with plans for a wider roll out underway. It is not a supermarket lamb. It is a premium product aimed at the fine dining market, and the reaction from that market has been exceptional.

In January, the Omega Lamb Project brought leading New Zealand chefs and food writers from across the country together to try the lamb and visit some of the farms involved in the project. Their response was that this is a lamb like no other – delicately-flavoured, clean and succulent, and without the strong odour associated with traditional lamb.

That has also been the wider feedback as Te Mana Lamb has been rolled out to fine dining restaurants here and in Hong Kong. Chefs are saying it is proving popular with diners who do not usually like lamb and provides scope to use it in new ways. In Hong Kong it has even being served thinly sliced on sushi.

World's best lamb

It is driving a whole new approach to lamb, and the reaffirmation of New Zealand as the home of the world's best lamb. It is also an opportunity to increase the total value of lamb in this country.

Te Mana Lamb is a luxury ingredient and priced at that level. In the marketplace, it has been compared to Wagyu beef, truffles and caviar for products which diners can justify paying a premium for. Since July, it has also been supplied through chef Nadia Lim's 'My Food Bag' home delivery gourmet bag service.

The results are very encouraging, but these are still early days and this is still a pilot project. One thing that is clear is that the demand for new authentic, quality products at the top end the market is large and real.

Adding value and team effort

Every farmer wants to maximise the opportunities available to them. However, the Omega Lamb Project takes the approach that to truly add value to a farm you have to look at the entire value chain. The programme works as a partnership, with the onus on creating greater overall value into the system, which everyone in the chain can ultimately share in. Pulling together that whole value chain has been a large undertaking. To achieve that requires intensive input from team members, from geneticists to farm consultants. Gilbert Enoka, who also provides mental skills coaching to the All Blacks, has been brought in to work with the project's breeders and finishers about how to behave as a high-functioning team.

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The PGP's aspirational goal is for a 30% increase in farm gate returns for the lambs over time.

EID tagging and scaling up

When you are changing practice on a farm there is inevitably a bedding-in period. For our programme, this has included getting to grips with the technology. All the lambs need to be electronic-identification (EID) tagged. That has probably been the biggest challenge for many of our pilot farmers, but in the third year of our programme it is steadily becoming more common practice. With support from the project team, these farmers are working through this very well. All have passed the audit developed for the Omega Lamb Project and are looking at continuing with the programme for the 2018 season.

The challenge now is to scale up the system, to grow Te Mana Lamb from a pilot programme to a commercial model while retaining the essential disciplines. The system needs to be more streamlined and efficient and remove costs without compromising on quality.

Farmers and farm consultants

We also need to bring on board more breeders and finishers. They need to be willing to use the technology and to adapt to a common system and keep evolving it to get better and better results. Only by following a system with genetics, and prescribed finishing, recording of key events, and responsiveness to quality feedback, can chefs be provided with the quality they are looking for, every time.

A farm consultant who works in conjunction with the project liaises with breeders and finishers very regularly, usually on a weekly basis. Planning starts about 18 months out, with breeders planning the mating programme and which animals they will put the Omega ram with, and how they will structure their farm plan so they move animals with the right specifics at the right time.

With finishers, the farm consultant will look at how the programme can fit onto the farm. This is looking at the climatic conditions, whether it is complementary to the rest of their business, and what they can do to meet the required timeframes. The aim is to build a strategy that does not compromise the profitability of any of the farmers, while enabling lambs to be supplied when the chicory can handle it.

Other support

During the December to May finishing period much time is spent with breeders to help them make the call on when to move stock, and with finishers to determine how many lambs they can accommodate and what their projected growth rates will be.

Support is also provided around agronomics. Chicory forage is quite expensive to get established and the aim is to get two to three years out of it, ensuring a sustainable diet so the lambs can grow at the optimal weight. This support for the pilot farmers is gradually reducing over time, as they have become accustomed to the processes and are very good at handling these aspects themselves.

For suppliers, key factors include the capacity to have store lambs for supply to finishing programmes in late December to early January. For finishers, they include input costs, the ease of procuring animals, the performance and longevity of chicory, the additional uses of the chicory in the spring, and the lambs' arrival and exit value. Typically, our finishers have an accomplished lamb finishing/cropping operation with a track record of innovation and high production.

Rewards for farmers

As for these rewards, there is still quite a lot of cost in the system, but it is essential to spend to build the market so these kinds of costs will reduce over time. Once this has been achieved, the returns to farmers will grow. The PGP's aspirational goal is for a 30% increase in farm gate returns for the lambs over time.

In the early phase, market returns are covering extra costs so farmer returns are equivalent to other lamb options. The larger issue for the farmers involved is that existing lamb options are not always returning as much as other stock classes or business alternatives, so lamb is being reduced or used opportunistically to 'fill gaps' in the farm business. The attraction of Te Mana Lamb is not the immediate returns, but that it provides a pathway for lamb to be once more the primary profit centre and focus for hill farm and intensive finishing operations.

Delivering examples of successful, added-value ventures such as Te Mana Lamb is good for the whole industry. The farmers involved have embraced change and the results they are seeing are promising. They have identified that the programme has something for them that fits with their existing business, offering significant potential, not just for them but for the New Zealand sheep industry.

Mike Tate is General Manager of the Omega Lamb Project, and developer of Te Mana Lamb, based in North Canterbury. Email: mike@omegalamb.co.nz.

KEVIN STAFFORD

FARM ANIMAL WELFARE UPDATE

Animal welfare is an agribusiness priority. The 2015 amendment to the Animal Welfare Act allows for 'regulations' which are essentially fineable offences. The regulations for bobby calves are in force, a speedy response by the Ministry for Primary Industries (MPI) to national disquiet following exposés of brutal treatment of calves. Many more regulations will follow as MPI works to protect the reputation of our livestock industries.

A high priority issue

In the recent KPMG *Agribusiness Agenda 2017*, the top 10 priorities for agribusiness leaders included world-class biosecurity, food safety and high-quality trade deals (***Table 1***). The number 11 priority was 'Penalties for those that don't protect animals'. That this rather punitive perspective is a high priority for these leaders suggests that they are worried about the public concern for how we manage farm animals. That it is punitive rather than educational or regulatory suggests that something has changed and, moreover, that animal welfare is now an important factor in ensuring that our primary industries prosper. It targets those farmers who don't meet some undefined level of animal welfare for punishment.

Table 1: KPMG Agribusiness Agenda 2017 top 10 priorities

1	World class biosecurity
2	Create NZ provenance brands
3	Food safety
4	High spec rural broadband
5	Innovate with customers
6	High-quality trade agreements
7	Deliver R&D incentives
8	Increase rural/urban understanding
9	Develop future leaders
10	Deliver market signals to producers

Source: KPMG (2017)

There are many aspects to farm animal welfare in a modern democracy. First, there is the legislation, its structure and enforcement. Then there is farmer attitudes and behaviour, their awareness of the legislation per se, and their ability and willingness to comply. Non-governmental organisations (NGOs) have a role in informing the public about issues they see as important. Science has a role in informing the legislation and public discussion about animal welfare. Most important are the public, who as consumers and voters are the final arbiters in what is acceptable.

Animal Welfare Act and codes of welfare

The Animal Welfare Act was passed in 1999 and amended in 2015. It is an important piece of legislation with some very praiseworthy characteristics. It is readable and easily understood. It places the responsibility for managing livestock with the owner or manager. Animals have to be managed so that their physical, health and behavioural needs are met in accordance with good practice and scientific knowledge. These needs may not be met under normal farming practice (e.g. laying hens in battery cages cannot roost which is defined as a behavioural need), but the Act allows for this.

Table 2: Codes of welfare

Rodeos	2003
Zoos	2005
Circuses	2005
Painful husbandry procedures	2005
Companion cats	2007
Deer	2007
Dairy cattle	2010
Commercial slaughter	2010
Dogs	2010
Sheep and beef cattle	2010
Pigs	2010
Transport within New Zealand	2011
Goats	2012
Meat chickens	2012
Layer hens	2012
Horses and donkeys	2016

The Act covers all animals and is supported in detail by 16 codes of welfare which deal with specific animals or practices (***Table 2***). These codes identify minimum

Bobby calf

standards of welfare and should be read by animal owners and managers. As an example, dairy farmers should read the code of welfare for dairy cattle as it specifies how they are allowed to manage their animals. These codes are long and tend to be dull reading, so that in the case of the dairy cattle code DairyNZ took some specific elements of it and put those into posters which could be hung in farm offices.

In 2015, the Animal Welfare Act was amended 'to recognise that animals are sentient'. What this will mean in the courts is yet to be determined. The amendment also allows for specific 'regulations' which are based on the minimum standards found in the codes and breach of these will result in a penalty. A document, *Proposed Animal Welfare Regulations*, listing possible regulations was released for public comment by MPI in 2016. A breach of a minimum standard in a code of welfare is not an offence in itself.

Bobby calves

The MPI regulations about bobby calf welfare, *Caring for Bobby Calves*, came into force in August 2016. These regulations:

- Require that young calves must be at least four full days of age and physically fit before they are transported off farm for sale or slaughter as a result of sale
- Set a maximum of 12 hours' journey time for young calves
- Prohibit the transport of young calves by sea across Cook Strait
- Prohibit the killing of any calves by use of blunt force to the head, except in an emergency situation.

The regulations are essentially fineable offences and another group of regulations will come into force in the near future (see ***Table 3***). The enforcement of the Animal Welfare Act through the courts is expensive and time-consuming. A breach of the regulations will result in a fine, a much cheaper way of enforcing specific aspects of the Act.

New Zealand's ranking

The animal welfare system in New Zealand has been ranked 'first equal' with Austria, Switzerland and the UK by World Animal Protection. This ranks the system, which is interesting given the limited number of MPI welfare inspectors and the government dependence on the

Animals have to be managed so that their physical, health and behavioural needs are met in accordance with good practice and scientific knowledge.

SPCA for investigating many welfare cases. However, New Zealand has banned gestation stalls for sows in 2015 and battery cages for laying hens will be prohibited after 2022. The addition of the word 'sentient' to the Animal Welfare Act and the development of fineable offences will keep the New Zealand system at the leading edge of international legislation.

Farmers' views

Livestock and poultry farmers are responsible for the welfare of their animals. There is probably quite a lot of agreement amongst farmers as to what the major welfare issues are. When dairy farmers were surveyed by Tucker, C.B. et al. in the *Proceedings of New Zealand Society of Animal Production* in 2005 they listed lameness, nutrition/growth, disease/health, weather and calving problems in that order as being the important welfare problems on dairy farms.

The significance of these problems will vary from farm to farm and year to year. Lameness affects between 8% and 20% of dairy cows annually, as I noted in 2013 in *Animal Welfare in New Zealand* published by the New Zealand Society of Animal Production. A case of lameness lasts for an average of 27 (±17) days and it was estimated that each case costs on average $221. Lameness is a therefore a significant welfare and economic issue, and given that the causes of lameness in dairy cows are understood one might expect its national incidence to decrease over the years. This does not seem to have happened, although it will have decreased on some farms.

Sheep farmers are likely to cite flystrike, facial eczema, bearings and lambing problems, poor nutrition, lamb mortality and foot rot as major issues and will try to minimise these as they are also economically significant. It is interesting that none of these issues is listed in the suggested regulations in ***Table 3***. The latter focus on husbandry procedures and transport issues.

Livestock farms have increased in size over the last few decades and there is an ongoing increase in the number of animals per stockperson, which makes the observation of individual animals less possible. Farmers have responded to the increase in animal numbers by improving their management of disease prevention and the provision of different fodder crops. Moreover, remote monitoring of dairy cattle is becoming more and more feasible using a range of equipment. Developments in robotics and artificial intelligence will make the monitoring of animals more effective. They will underpin the consumers' ability to identify the provenance of animal-based food. If livestock farming is to prosper, the farm of origin of meat and milk products will become an important marketing tool.

Table 3: Examples of more proposed regulations relating to cattle and sheep

#66	**Cattle – tail docking.** Must be performed by a veterinarian or a veterinary student under the direct supervision of a veterinarian. May only be performed for therapeutic reasons. Pain relief must be used at the time in the procedure.
#67	**Cattle and sheep – castration and shortening of the scrotum (Cryptorchid).** Castration and shortening of the scrotum (under six months of age) may be undertaken by any person. Conventional rubber rings must only be used for this procedure. Castration and shortening of the scrotum (over six months of age) must be performed by a veterinarian or a veterinary student under the direct supervision of a veterinarian. Pain relief must be used at the time of the procedure. Surgical castration (at any age) must be performed by a veterinarian or a veterinary student under the direct supervision of a veterinarian. Pain relief must be used at the time of the procedure.
#68	**Cattle, sheep and goats – dis-budding.** May be performed by any person. Pain relief must be used at the time of the procedure.
#69	**Cattle, sheep and goats – de-horning.** May be performed by any person. Pain relief must be used at the time of the procedure.
#70	**Tail docking (under six months of age):** May be performed by any person. Must use hot iron or rubber ring only. Tail must not be flush. Tail docking (over six months of age): Must be performed by a veterinarian or a veterinary student under the direct supervision of a veterinarian. Pain relief must be used at the time of the procedure.

Source: MPI (2016)

Animal rights and welfare groups

The philosophies of NGOs which focus on animal welfare and animal rights differ. Those that are rights-based (e.g. SAFE) disagree with the use of animals in farming and believe that it is unethical or immoral. Welfare-focused organisations (e.g. the SPCA) promote good welfare. The rights-based groups often expose instances of crude brutality which yield public dismay and criticism of livestock or poultry farming. This technique is very powerful, as seen with MPI's quick response to the bobby calf brutality exposé, which resulted in the regulations mentioned above being brought in to control this aspect of the dairy industry.

The role of the NGOs is one of exposure and change and all farmers are in the spotlight. Monitoring has never been easier, and with cameras everywhere and social media being widely used, bad animal welfare stories are national and international stories.

Sow gestation stalls and battery cages

The pig and poultry industries have been the focus of animal rights and welfare groups for decades. This eventually resulted in changes with regard to sow gestation stalls and battery cages. At present, the pork industry is in decline due to the importation of fresh pork. This meat may be produced in countries which have poorer welfare conditions than those found in New Zealand. The fact that we do not import eggs or fresh chicken protects the chicken industries, but they have to eliminate their battery cages.

These two industries adapt to changes in public pressure. The pork industry is therefore looking to shift from using farrowing crates for all of the lactation period and the layer industry is installing colony cages. The latter allow roosting, dust bathing and nesting, as these are three significant behaviour needs of hens identified by scientific research.

Animal science research

Science attempts to inform the discussion about animal production and animal welfare. The sciences used in the assessment of animal welfare are diverse and include ethology, nutrition, physiology, immunology, veterinary science, genetics and even agricultural engineering. Scientific research into farm animal welfare issues is carried out throughout the world. The welfare research can be divided across species and specific fields, such as pain assessment and alleviation, stockmanship and environmental effects. However, much animal science research into nutrition, housing and genetics impacts on animal welfare, as does veterinary research into animal disease. In New Zealand, animal welfare research has focused on pain, neonatal survival and environmental effects on animal comfort.

Public acceptance

The public appear to accept that the welfare of animals reared to produce meat, milk and eggs will never be ideal. The television programme *Country Calendar* regularly shows lamb marking, but there appears to be little public disquiet about this practice. Farmed animals and poultry generally live in large groups, much larger than is normal for these species. Some such as broiler chickens are bred to grow at extremely fast rates, being pushed to the limit physiologically, as are high-producing dairy cows. These realities of modern farming systems seem to be accepted. Moreover, even with the very best animal husbandry things can and do go wrong. The public appears to accept that snowstorms can cause mayhem on sheep and cattle farms, but as long as farmers are doing their best to minimise suffering then these can be accepted as a harsh reality of outdoor farming. However, obvious brutality is unacceptable as witnessed by the bobby calf exposés.

Farmers should be grateful that the public accept the difficulties of livestock and poultry farming, but they must recognise that this acceptance is sensitive and may be withheld if they are seen to brutalise animals. That punishing such transgression is a high priority with industry leaders suggests that eliminating such behaviour is an essential element in farming's future.

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NZIPIM PROFILE

James Ryan

Canterbury start

James Ryan still calls himself a townie, but it was through family connections he has had the opportunity to develop an interest in the primary sector. Although he was largely brought up in Christchurch, his parents spent many years living in North Canterbury which gave him a window into rural life.

At the University of Canterbury, James majored in geography which he credits for giving him the opportunity to explore issues concerning people and place. He completed a Masters of Arts thesis on environmental conflicts in the South Island high country. He feels that although he started his thesis as a naive 20 something, with idealistic views about how these magnificent high country landscapes should be managed, his lasting impression was the deep sense of attachment that farmers had for the land. It also sparked a desire to work in the primary sector.

Auckland Regional Council

From looking at the challenges of farming in the high country, James started his career at the Auckland Regional Council in a policy role which he used to develop his strategic planning and stakeholder management skills. At the time Auckland was still divided into eight different local authorities. He felt that a lot of energy was spent squabbling between the different councils on the direction of the region and not on the implementation of some much needed transport and housing infrastructure. Looking back, James felt it highlighted the need to have a well thought through strategy and effective leadership.

UK and Ireland

Like many New Zealanders, James has experienced living and working overseas which has shaped his views on the opportunities available in this country. When young he worked on an arable farm in Essex. He returned to live and work in the UK and Ireland in the 2000s, which included several years at Crossrail, a major new transport project costing $27 billion.

Part of his role involved liaising with local councils in the planning and implementation of its construction that would facilitate significant housing and employment opportunities. At the time he did not appreciate that the experience he developed building relationships with different agencies with different agendas would be relevant for a role in the primary sector back in New Zealand. He returned to Christchurch and worked in a number of local government roles.

Dairy sector opportunity

In 2010, James started at DairyNZ as the regional policy manager. For him, it was an opportunity to work in the primary sector and combine his policy skills with an understanding of local government. It coincided with a period of significant change in environmental policy in New Zealand as regional councils implemented new rules to manage the effects of farming. Dairy farming, in particular, had undergone a period of rapid growth and was facing increasing pressure to reduce some of its environmental effects. James feels it also coincided with a period in which the dairy sector took steps along the grief cycle. He says that:

> *When we look back I think that some of the farming leaders who the media traditionally gravitated to were unduly defensive. This only played into the hands of the environmental groups who mobilised public sentiment against farming, particularly dairying. Looking back it was easy to be critical. But I feel that the primary sector was slow to respond and not coordinated with its response. The world has changed. It's no longer effective to do the 'angry farmer' and expect people to listen.*

He believes that it's easy to lose community trust, but much harder to regain it. Despite this, he feels that most farmers are getting blamed unfairly and that their ongoing efforts (not just those of dairy farmers) in relation to the environment have been remarkable. For James, one of things that is not appreciated is the level of effort that is being made by farmers across the country to manage their environmental footprint more effectively.

He regards the highlight of his period at DairyNZ as the people, as he found the organisation to be full of smart, committed scientists, many of whom were from farming backgrounds. He felt it was a privilege to meet farmers up and down the country committed to seeking out and challenging the information they were receiving to support them with farming decisions. He was also very impressed by their ability to deal with a complex array of challenges and retain their sense of humour. It was this experience at DairyNZ that gave James a desire to remain working in the primary sector.

For James, one of things that is not appreciated is the level of effort that is being made by farmers across the country to manage their environmental footprint more effectively.

James believes that one of the strengths of the Trust is that it is supported regionally by a group of farmers and rural professionals who are very passionate about farming and growing. Many of them donate their time and expertise to support the awards programme.

Kelloggs Rural Leaders Programme

While at DairyNZ he undertook a Kelloggs Rural Leaders Programme and enjoyed the opportunity to mix with some other primary sector professionals, including representatives from the kiwifruit sector. He carried out a research project looking at what could be done to improve public perceptions of dairy farming and sought feedback from some of the sector's biggest critics. One of the recommendations of his project was for the dairy sector to do a better job of showcasing and celebrating farmer achievements.

Sabbatical

In 2015, James and his family embarked on a year in France. He and his wife, Amanda, felt that as their children, Patrick and Joseph, were nine and 10 it was an ideal opportunity to have a break before they reached high school. One of the differences that he and his family noted was the attitude to food and farmers. Much of a typical French day is centred around preparing and meeting over the main meal in the middle of the day. Their local town, Uzes, holds a series of festivals throughout the year to celebrate seasonal food production such as cheese, cherries, strawberries, truffles and wine, and farmers are feted at these events.

While that may not be realistic in New Zealand, James feels it is important that we find touchpoints to build connections with urban communities, and the celebration of food and food producers is an important opportunity for farmers to retain their social licence.

New Zealand Farm Environment Trust

The time overseas gave James the opportunity to reflect on what he wanted to do when he returned home. He was determined to remain in the primary sector and by good fortune an opportunity arose to manage the New Zealand Farm Environment Trust, a charitable organisation set up to promote sustainable farming. The Trust is best known for running the Ballance Farm Environment Awards.

He says that he couldn't have scripted the position description better as he enjoys the opportunity to work cross-sector celebrating the excellent things happening across the farms and orchards of New Zealand. James believes that one of the strengths of the Trust is that it is supported regionally by a group of farmers and rural professionals who are very passionate about farming and growing. Many of them donate their time and expertise to support the awards programme.

Challenges and opportunities ahead

Last year the Trust carried out a review of the Ballance Farm Environment Awards and one of his priorities is to implement its findings. Instead of making significant changes, it is about refining what they have, to make sure they are changing as the world around them changes. He wants to ensure that the awards programme is accessible to all farmers and growers.

James notes that some New Zealand farmers don't feel comfortable being put in the spotlight. So one of the challenges for the Trust is to get them to understand that by being involved in the awards programme, it is an opportunity to receive some independent feedback on what they are doing well and where they can potentially make improvements that will support their farming business.

Increasingly, the Trust is also finding that farmers are rightly proud of what is happening in their communities and they want to share it with others. James feels that sharing these stories is important, not just for farmers to learn from other farmers. It is also relevant for other audiences, so we can inspire our young people to work for New Zealand's most important sector. And it is also important so that people living in urban areas can better connect with the communities in which their food is produced. While farming and food production face some challenges, he also sees opportunities for the Trust and farmers and growers and feels it is an exciting period to be part of the primary sector.

One of the things that James has noticed is the frustration from farmers about how they are portrayed in the media. He believes that we have been good at engaging rural audiences, but our challenge is to get mainstream media to take an interest in some of the achievements that are happening on farms and orchards. He says, 'One of our challenges is that the media landscape has changed dramatically over the last decade. Most people now consume their daily news in about six seconds and increasingly people live in their own information bubbles.'

He is also aware of the need to not slip into a defensive mode. While freshwater management will continue to provide significant challenges, he says that over time the positive efforts being made by farmers will provide evidence that the primary sector is trying to meet community expectations. James feels that while farmers may currently feel under the pump to reduce their nutrient losses, over time the setting of limits will allow them to demonstrate that they are effective stewards of the land.

NZIPIM involvement

James became an NZIPIM member in 2012 when he was working at DairyNZ. He found it a great way of networking across the primary sector and learning more about the different perspectives on rural issues, including from farm consultants and bankers. He has observed how new environmental regulations have created new challenges and opportunities for the primary sector, which has also demanded greater levels of professionalism across rural New Zealand. J

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