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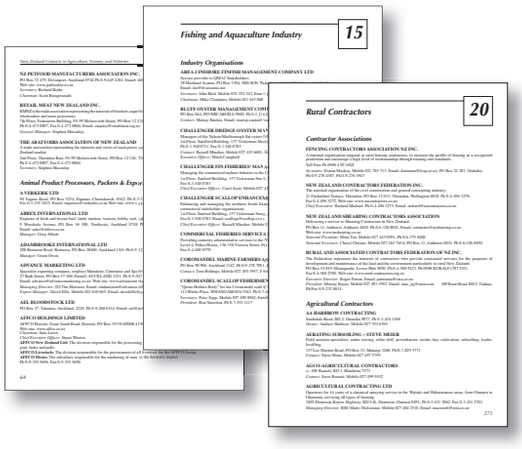
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Julian Bateson

Where to now for New Zealand primary industry?

The latest Fonterra estimate for the milk payout in 2010/2011 may now reach close to a staggering eight dollars for each kilogram of milk solids. This assumes that the following winds are favourable and all the ducks stay in a neat row, if I am allowed to mangle a few metaphors. It was not very long ago when the payout was not much more than half this figure, with a few higher ones in between.

The increased amount will bring significant benefits to the New Zealand economy along with the extra income for dairy farmers. But is there a downside? Once you are at the top the only way you can go, other than staying the same, is down. This may seem pessimistic, but is realistic. The milk price may stay high for a while, but the world outside New Zealand decides what they will pay and things may change again and the price drop.

Options being lost

How many more dairy farm conversions will these high milk solid figures encourage and as a result, what other primary industry enterprises that are not dairying will never get going? The attraction of the money will be sure to turn a few more heads, whether they are national or international.

A few days ago a small group of primary industry consultants were discussing a conference one of them had recently attended. At this conference a question was raised about the possible use of 50 hectares of good agricultural land not a million miles from Gisborne. Various suggestions were made, and each one was shot down as being a poor investment. Grapes, certainly not at the moment, fruit perhaps kiwifruit but not without a lot of help. Obviously not sheep or beef. Other fruit such as apples or stonefruit just do not seem worth growing. How about trees and the carbon credits? Not on land expected to cost many tens of thousand of dollars a hectare. In fact the only suggestion that made any economic sense to the group was dairying.

This is a problem. What about the innovative New Zealand farmer? If every suitable hectare becomes a dairy farm New Zealand may become quite well off for a while, certainly if the price stays at or near eight dollars, but it may not be a long while. In the meantime the diversity of opportunities will have gone, along with a lot of water.

It is very difficult to think outside the box when being in the box seems so attractive. We should not make comparisons with the 1980s when anyone and everyone had a big bundle of shares, many of which became worthless after 1987. Neither should we think of all those who thought it was much better to get the extra couple of per cent by investing in finance companies, and we know what has happened to many of them. In the early 1990s when trees were getting a very good price planting radiata pine was though of as the best pension plan ever, but log prices have fallen regularly since then. Dairying is not going to go along this route. But having most of your eggs in one basket, or all your milk in one pail, is never a good plan.

Where are the opportunities

In this issue of *Primary Industry Management* are a number of articles that should make primary industry think about other opportunities. The short feature on the Waikato raises the question of whether dairy farming is the best use of the soils in the region. Innovation in the Waikato seems to be needed to make sure primary industry can succeed in the face of strong regulatory pressures.

Elsewhere in New Zealand aquaculture has been quiet for 10 years but is now pushing to become a billion dollar a year industry. Carbon sequestration and trading has its good points. It could all go up in smoke one day but it could be here for ever. Growing biomass for fuel seems to be a good option, especially when you look at the figures for radiata pine or redwood in New Zealand.

Would worm farming be a missed opportunity? The soil seems quite short of them in many places, although the land seems productive in spite of this. Bee farming may be a much better possibility. We really do need these industrious creatures and without our help there could well be none left, especially if colony collapse disorder gets here. Around 30 per cent of bee colonies are dying each year in the US due to colony collapse and it is getting worse, not better. The latest I heard was that bee keepers were now charging twice as much as a year or two ago to put bees in orchards in the US.

The opportunities are all out there, we just need to think of them for the long term

Nico Mouton and James Allen

Challenges and opportunities in the Waikato

This issue of **Primary Industry Management** *journal has a small feature on the Waikato. Changes have occurred and are occurring in both capital land value due to the current economic climate and the potential challenges around environmental new standards for the region.*

There is an important role in the process of change, especially around farm efficiency and nutrient management, for the qualified farm management consultants in the region.

Main issues that have challenged consultants in the region are –

- Property scale enlargement and increased on-farm management skill required and which is likely to continue. The average Waikato dairy farm is now 322 cows on 112 hectares. There are significant numbers of farms emerging with 500 to 1500 cows.
- Seasonal weather patterns have fluctuated wildly in the previous three years. There was the 2007/2008 drought which was a one-in-a-100 year event. The two subsequent years included the 2010 autumn. This was exceptionally dry and without the traditional autumn rain and it put pressure on feed supplies throughout the region.
- The traditional ryegrass system is being challenged with pressures from insect damage, especially black beetle. Issues around longevity of new pastures are frustrating the farming community.
- Within the dairy farming sector the main challenges are economic and the pressure on nutrient management. There are increasing inspections, both voluntary and statutory, to improve the effluent management and nutrient management of properties. The Environment Waikato upper catchment survey is particularly useful as a guide to show what options are available to maintain profitability, while reducing nutrient output.
- The establishment of the Waikato River Authority is an important feature for the following years and will bring this subject into sharp focus.
- In the western bays of lake Taupo regulations and systems have been introduced to change nutrient inflow into the lake. Nitrogen trading has been put into place over a specified area which may be a forerunner of similar schemes for the wider Waikato in the future

The farm management consultant in the Waikato region will need to have diverse skills and be able to focus not only on the financial and technical aspect of the farm but also on the nutrient output of the property.

Additional challenges will be the Emissions Trtading Scheme and the ability of consultants to advise farmers with regard to their energy and carbon management. Farm consultants must get up to speed with the regulations and the opportunities that this new issue creates. The demand for farm management advice is continual, and apart from practical advice, there is also an increasing need for higher level management and strategic consultancy.

With relatively high land prices, subdivision pressure, and increasing nutrient output pressures, this raises the question of whether dairy farming is still the highest and best use for elite soils in the Waikato? The market will ultimately answer this question, but the market may become influenced by regulatory pressures. The farmer community in the region has shown continual innovation, and will continue to develop and innovate within their constraints to maintain profitability.

Nico Mouton and James Allen work for Agfirst Waikato

John Sweeney

Waikato rural land values 2009 to 2010

This time 12 months ago vendors of medium sized dairy farms in the heart of the Waikato and large sheep and cattle units west of Hamilton had successfully negotiated unconditional contracts on their properties. Deposits were paid and plans made on what to do next before the 1 June 2009 settlement. In some cases this would involve the purchase of a larger farm property, a lifestyle block, a modern home on the coast or in a city or perhaps other investments or simply banking proceeds for a later opportunity.

As the winter of 2009 approached the word recession became a household word. Fonterra was hinting at a $4.50 payout, although nine months later it was up to $6.30. Lamb, wool and beef prices were plummeting and suddenly some bank managers started to fear their lending portfolios were looking a little less secure, as not only ability to pay but also their client's equity started to erode.

The examples

The dairy farm scene mentioned in the first paragraph is demonstrated by one example. This is a well farmed, low input 1,300 kg per hectare all grass farm of 80 hectares that sold for $80,000 a hectare in April 2009. Settlement failed to materialise and the vendor was left with a much larger property they had purchased, as well as the 80 hectares that were a now unsold.

The 80 hectares were subsequently auctioned in November 2009 and failed to reach the reserve of $4.5 million, the best offer being $4.3 million. The farm eventually sold for $4.5 million in March 2010.

The example of the sheep and beef farm on the coast related to a 1,600 stock unit farm with a new four-stand woolshed, new cattle-yards, and a house with views over Aotea harbour. The vendor was working on a deal worth $2.1 million for the 120 hectare property which failed to settle despite being an unconditional offer. A more realistic figure on today's market would be a sale price of $1.5 million or $12,500 a hectare. The vendor received a five per cent deposit for his troubles but was unable to proceed with further developments to his own 405 hectare farm.

Succession and exit

There have not been many sheep and cattle farms sold in the region this season. We have an ageing population owning and operating these farms. Their well-educated sons and daughters are no longer returning to the land because of greater job opportunities. Succession planning and exit strategies are a priority for this sector in our region.

If we were to turn the clock back to the spring of 2008 when settlement was due on 1 June 2009, dairying land in the Waikato was selling from $65,000 to $75,000 a hectare, sometimes even more. Some of these sales were to Transpower for the construction of the new 400 kv transmission line and up-grade from Whakamaru to Auckland.

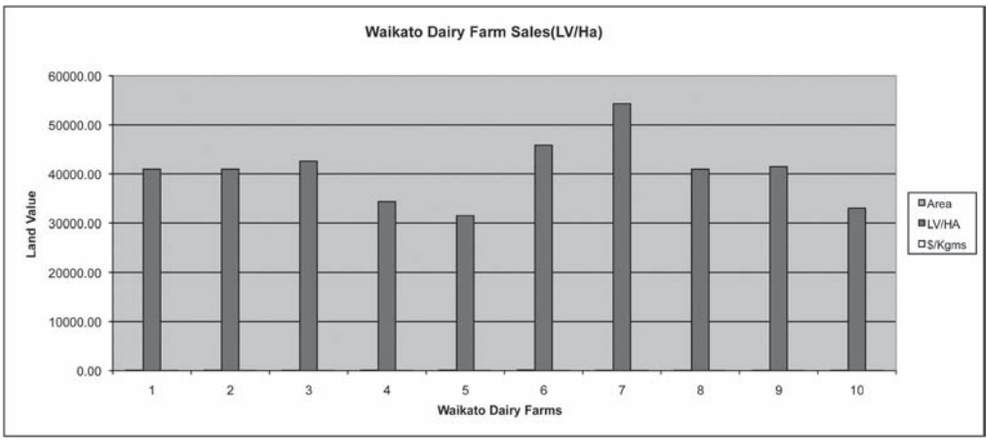
Other examples were genuine willing seller and willing buyer deals where a vendor had received an offer they could not refuse. This meant the vendor was in a strong position to negotiate another deal on a larger farm or one in a better locality that could be taken to another level. A lot of farms from 50 to 100 hectares changed hands in this market.

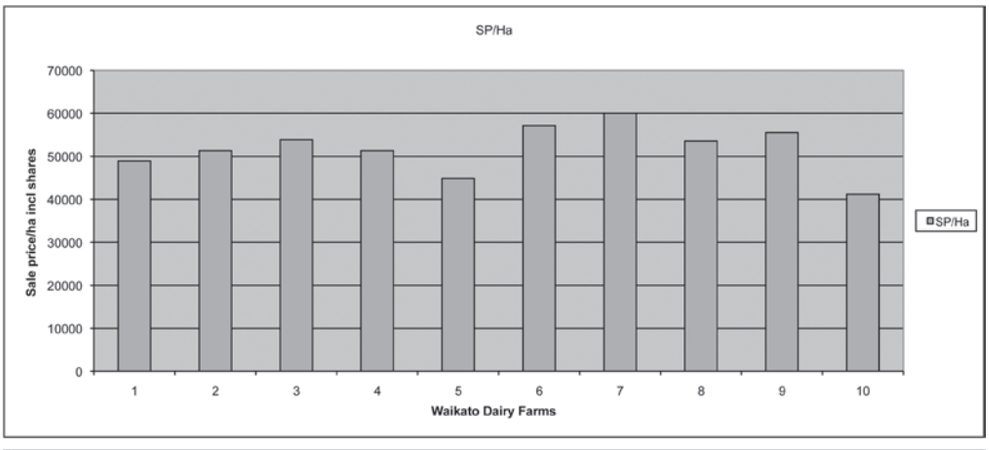
Now we have the opposite – cautious purchasers, reluctant vendors and fewer properties to choose from. This has resulted in a lower number of transactions and real estate agents who have little to show for the many hours and litres of diesel used in trying to secure a deal.

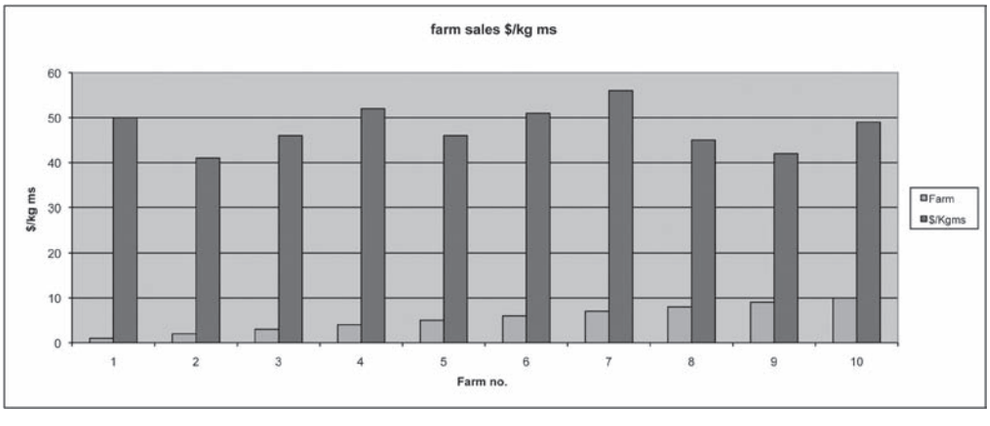
The following table summarises some of the transactions that have occurred in the heart of the Waikato since January

Dairy farm sales - Waikato from Jan 2010

Farm	Area	Land value per hectare	Dollars per kg milk solids	Sale price per hectare	Sale price
1	92.00	41000	50	48913	4500000
2	94.50	41000	41	51320	4850000
3	84.00	42560	46	53869	4525000
4	111.00	34370	52	51320	4600000
5	127.00	31500	46	44880	5700000
6	161.00	45870	51	57142	9200000
7	70.00	54333	56	60000	4200000
8	84.00	41000	45	53571	4500000
9	81.00	41500	42	55556	4500000
10	85.00	33000	49	41175	3500000







2010. Supporting graphs analyse these sales on a dollar per hectare, dollar per kilogram of milk solids and overall land value basis.

Lifestyle blocks

We have seen a large number of good quality blocks on the market. Again there has been a price correction combined with some mortgagee sales which has seen this market drop $200,000 or more depending on presentation and locality. This is always a problem if there are more sellers than buyers.

The number of transactions over a million dollars is a lot less than six months before April this year. Properties from $1.5 million to $2 million bracket have been hard to sell for several reasons –

- Lack of cashed-up buyers
- Reluctant lenders
- General negativity.

A recent mortgagee auction saw an 18 hectare lifestyle farmlet with a $3.5 million new dwelling, a large implement shed, good races, water supply and nine hectares of bush sell for $8.5 million.

Summary

For the dairy industry as a whole we may at long last see a pattern of more stable pricing and better returns on capital value, on an as yet untaxed capital gain. The possible trading of Fonterra shares from a proposed funding source could alleviate cash-flow problems around supplementary feeds in feed-pinch periods. Lifestyle blocks will be influenced by the above along with the supply and demand for housing in Hamilton and outlying small towns.

Ross Abercrombie and Alan Campbell

Improving nutrient management using a catchment approach

Intensification of Waikato agriculture has led to elevated levels of sediment, nutrients and faecal coliforms in regional waterways. In the upper Waikato catchment between Taupo and Karapiro, loss of nutrients has been studied over the past four years using the Integrated Catchment Management Project. It was recently the focus of the Upper Waikato Nutrient Efficiency Study.

This article reviews the current environmental pressures on the Waikato region, policy context and current review, recent work carried out to start understanding and addressing the problems ahead, and an overview of how consultants may help in future.

Policy context

Regional councils across the country are working on a second generation of regional policy statements and regional plans. A working draft of the Waikato Regional Policy Statement has been sent out for early consultation. This will identify the main soil and water problems for the region and will take into account the recent Waikato river settlement legislation that necessitates protection and restoration of the Waikato River. It signals some tightening up of environmental policies, especially in protecting high quality water. It also starts to address soil health issues affected by agricultural practices such as longer term soil contamination from very small quantities of trace elements in fertiliser.

In addition, Environment Waikato is currently working with Waikato-Tainui to put in place new joint management agreements under the new co-management regime for the Waikato river and its resources from Karapiro to Port Waikato. A new vision and strategy for the river developed under the regime will be included in the strategy. This will probably exert considerable pressure for cleaning up diffuse discharges from agriculture, as well as other measures such

Background of pressures on the Waikato region

The recent University of Waikato technical report, *Implications of Agricultural Change in the Waikato Region: Current Trends and Future Scenarios,* included the following.

> Significant trends in the dairy industry include a recent wave of dairy conversions, changes in ownership patterns, higher stocking rates, and more intensive farming practices. These changes have been facilitated by, among other things, increases in nitrogen fertiliser, and increased use of feed-pads and supplementary feed.
>
> The key drivers of agricultural and land use change were perceived to be economic, especially the dairy payout, land values, and costs of production. The relative profitability of dairying has driven the conversion of large areas of land to dairying, as well as encouraging many sheep and beef farms to move into dairy support roles, such as the grazing of dairy heifers or cropping for maize silage.

There has been significant conversion from forestry to dairying in the southern Waikato, although forestry remains significant. Environmental policy drivers were described as likely to increasingly influence farming and forestry practice, but current uncertainty is delaying investment in forestry. Farmers have become more aware of environmental management issues, in part due to community expectations. Farm management practices are changing as a result, but uncertainty about future environmental policy persists.

A number of respondents commented on the difficulties of predicting agricultural norms and noted that adaptive management will be required. Nevertheless, dairying is expected to maintain its status as the dominant form of pasture-based agriculture in the region, and there will continue to be a variety of land use across the region and within industries.

as riparian fencing and planting throughout the Waikato River catchment. Settlements with other river iwi, covering upstream of Karapiro, are progressing.

Integrated catchment management

In September 2006, Environment Waikato began piloting the integrated catchment management project. It was a response to concerns about the increasing effects of agriculture on water quality in the Waikato hydro lakes. The purpose of the project was to determine how integrated implementation of existing policies could achieve the objective of no net decline in water quality. The project is focused on working with farmers in two upper Waikato sub-catchments to find ways of reducing their environmental effects to levels that are acceptable, sustainable and relevant to the issues of the catchment.

Since the start of the programme the project staff have held many meetings with local farmers in the two sub catchments the Little Waipa and Waipapa. These were to oversee issues and update on progress, run workshops on topical issues such as nutrient management, and run field days. They have now completed between 60 per cent and 70 per cent of farm plans in each catchment.

In 2009 an independent evaluation of the project was carried out and found people were happy with the way staff had worked with them and highlighted that the one-on-one approach was a favourable aspect of the project. Now in 2010 the project staff are starting to re-visit farms with farm plans to identify the uptake and implementation of on-farm actions. This will be formally reported in the long term plan.

Early on in the project, farmers said that more information was needed on the suite of best practices needed to increase nutrient efficiency and decrease nutrient losses. AgResearch was contracted to help with development of best practice understanding, and to help in identifying costs and benefits.

This work has recently been built on by a wider study to test if it was possible to lower nitrogen loss to hypothetical targets of 26kg of nitrogen per hectare, the current estimated threshold for no net decline in water based on earlier work. This work also had a minor focus on reducing phosphate losses.

Developments from integrated catchment management

Environment Waikato formed an agreement with the dairy industry to undertake the Upper Waikato nutrient efficiency study. This work was co-funded by DairyNZ and Fonterra. Ballance AgriNutrients provided staff assistance for the

Upper Waikato nutrient efficiency study nutrient mitigation options

Option	Potential percentage reduction in nitrogen leaching	Issues to consider if using these options
Farm system analysis		Whole farm business and systems analysis to help mitigation options.
Lower nitrogen use No winter use, and lowered overall use	15% (10-20%)	No nitrogen use in the winter period, along with nitrogen applications only at the high growth times of year – 10 to12 kg dry matter response
Better capture of effluent and use on grazeable forage crops without extra nitrogen use.	12% (10-15%)	Crops must be grazeable forage crops such as chicory or regrowth crops that do not allow a prolonged soil mineralisation period. Minimum tillage and effluent application was used.
Lower stocking rate by between 10% and 25%	12% (3-20%)	Results can be variable depending on soil types. This can be a profitable option on highly stocked farms, but pasture management skills are critical to maintain pasture quality.
Nitrification inhibitor DCD	10% (0-10%)	The response to this was variable and greatly depended on climatic conditions.
Infrastructure change/feed pad/standing cows off and capturing effluent	9% (3-15%)	This was variable, and assumed effluent capture into ponds and storage and re-use on summer crops. Costs of infrastructure changes included. Time standing on pads in winter and autumn need consideration. Generally was a cost to the business.
Higher per cow production /lower stocking rate, using low nitrogen supplements	7% (3-10%)	Via improvements in nitrogen conversion efficiency of the system, this was a sound option, but only if feed was at 5% to 7% of milk solids price. This option allowed productivity levels to be retained, and can reduce negative effects on profit if managed well. Sound skill level is critical.
Use balanced diet	3% (0-5%)	In cases where a low protein feed source is available at a similar price, this did not negatively impact on profitability. Improved nutrient efficiency through higher nitorgen conversion efficiency.
Land use change	3%	Afforest steep less productive land.
Alternative options		Issues to consider if using these options
Winter grazing off outside the catchment	20% (15-25%)	Where this practice was used, it allowed the most effective, and profitable way to lower nitrogen leaching. This practice may become limited in future as more catchments become nutrient sensitive.

project. AgFirst Waikato was contracted to carry out the study with the aim of gaining a better understanding the farm systems involved, developing a suite of nutrient management options to bring about greater nutrient efficiency and to identify farm system profitability from change

Findings showed there was a wide variation of nutrient management technologies that could be applied. With the variation in farm systems no one recipe of practices could be applied. For this reason the main intervention identified was farm system analysis using a whole farm plan. Typical mitigation techniques, magnitude of influence on nutrients and issues to consider are seen in the table.

Whole farm plans

The whole farm plan takes fertiliser company nutrient management plans a step further, identifying business objectives and working around the farm system to help in mitigating farm effects on water quality. The whole farm plan also carries out business analysis of each mitigation strategy to identify how changes will affect the production system, and therefore financial effects.

In this way whole farm plans have developed to build on nutrient management plans and to integrate the integrated catchment management farm plans carried out by Environment Waikato staff. The role of skilled farm consultants has been identified as a need for the industry in the provision of this extension of whole farm planning. They provide the relationship with the farmer enabling discussion of the hard issues, the skill in modelling farm system changes particularly in feed supply, and the knowledge of the interaction between production system and environment. There is a clear requirement for these skills as over the next decade more focus comes on the effect of farming on the environment from media, regional policy development and the public.

More training

The first step in this evolution from farm consultant to environmental farm consultant may come in the upskilling of graduates in soils or nutrient management at university. Most agricultural focused courses at a tertiary level now offer agricultural science graduates options of courses for further development, such as Massey's courses in sustainable nutrient management.

Around the country fertiliser representatives and regional council staff have taken up such training to the advanced level. These courses are likely to become an accredited industry standard offering a benchmark for skilled advice. In time such courses may offer wider course linkages to make sure nutrient advice also fits within production system modelling and takes a whole farm approach.

At present there are few nutrient management or farm consultancy companies offering whole farm planning services in the Waikato and throughout New Zealand. It can be expected that demand for such a service will grow and as a result, industry quality standards will be needed.

Where to in future?

Over the last few years Environment Waikato's integrated catchment management programme, and latterly the Upper Waikato Study, have provided clear information about nutrient management. With more pressure coming on agriculture to stem the loss of diffuse nutrients, new approaches are needed to address losses on farm.

Efficiency of nutrient use is one positive way to assess such losses. Whole farm plans are a tool to marry up production system and farm goals with nutrient loss mitigation strategies, include production efficiency and ensure profitability. The farm consultancy industry has opportunities to carry out such analysis using skilled farm advisors who can bridge the gap between production systems and environmental themes.

Different directions

In response to lower nutrient loss targets in future we will see a divergence of farm systems develop. One direction could be the low cost biological farm system that maintains low losses using low stocking rates and aims to maximise ryegrass and clover based feed as its predominant source of nitrogen. The other direction will be towards high input systems capturing much of the winter losses of nutrients using capital infrastructure such as feedpads or animal housing. These farm systems will maintain their profitability by effective monitoring of feed prices and may require closer relationships between supplementary feed producers and the farm.

Both of these systems have could meet environmental standards. However the latter requires more focus on management and far greater emphasis on technology inputs such as feed and environmental modelling. Farmer innovation continues to change farm systems and it can be expected that pressure will encourage further innovation. Farm consultants have a critical role in helping farmers to make the transition to profitable high nutrient efficiency systems.

Ross Abercrombie and Alan Campbell work for Environment Waikato

Graeme Fleming

Taupo project gains momentum

It is always good to see some light at the end of the tunnel and for the Lake Taupo protection project recent innovative approaches to land change around the lake have provided that little glimpse of success.

In a previous article I outlined the objectives of the Lake Taupo Protection Trust and the issues involved in achieving a goal of a reduction of 153,000 kg of manageable nitrogen entering the lake. I also expressed a view that for many landowners or affected parties they need to move on from objection to looking for innovative solutions to the problem. This article shows some of the progress and looks at an example of a number of innovative business approaches by farmers in the catchment.

Nitrogen capping

The Lake Taupo project is unlike any other environmental project in New Zealand. It aims to introduce regulatory controls including a nitrogen capping system with an economic approach by purchasing nitrogen reductions through an independent Trust. In this case it is the Lake Taupo Protection Trust.

It acts as a trial of economic and regulatory forces combining to eventually achieve a beneficial environmental result along with a balance with the economic effects of change. The Trust has taken the view that rather than appealing to environmental ethics there is a need to show an economic incentive for change backed up with a sound business proposal.

Not an easy task

The reduction of over 150,000 kg of nitrogen is no easy task as much of this reduction will come from change of land use from traditional farming to low nitrogen uses, such as forestry. Originally it was estimated that approximately 12,000 to 15,000 hectares of land change may be needed out of an approximate total of 50,000 hectares of pastoral land in the catchment. This figure is probably less than first thought as a number of land owners try to reduce nitrogen loads by changing farming practices rather than total land change.

To date the Trust has been actively achieving its aim with two main approaches. The first is by buying land and then on-selling that land with restrictions in place limiting nitrogen production. The second is by purchasing nitrogen reductions directly from the land owner who enters contracts and land agreements to reduce nitrogen while still maintaining ownership of the land.

Buying properties

Initially the emphasis was on buying properties because a number of landowners in the catchment were keen to sell. These purchases were made at a price determined by an independent valuer as the Trust felt that it was not their role to lead or depress the market. A number of these properties were leased back to farmers for a period of time to enable them to farm out over a period time.

All of these properties have now been on-sold with a number of owners introducing a variety of different farming techniques, including traditional grass cut-and-carry through to eco tourism and mixtures of different forestry plantings. A number of these ventures are experimental and it remains to be seen whether their business model works fully in practice. Nitrogen reductions are, however, secured by land covenants and agreements ensuring that changes to the business model still needs to meet a requirement for low nitrogen levels.

Recently the Trust has been concentrating more in working with the larger farm owners to develop business opportunities which involve both nitrogen reductions and carbon selling agreements. In particular a major breakthrough

occurred when a recent agreement was completed with a Tuwharetoa Maori economic entity which included both a nitrogen reduction payment and a 15-year contract for carbon offsetting under the ETS.

Carbon agreement

The carbon agreement was formed with energy producer Mighty River Power who are obliged to offset their carbon dioxide emissions under the new legislation. It seemed ideal that they do that than in an area where they draw their hydro energy from, and where there is an opportunity to achieve multiple environmental benefits by looking after the lake and offsetting carbon emissions.

The Tuwharetoa entity in this particular agreement contracted to remove 22,000 kg of nitrogen over the following eight years. This is being achieved by planting approximately 500 hectares of pasture in forestry and changing their farming operation by reducing stock numbers, changing stock types and wintering stock outside the catchment in winter. These changes are developed in conjunction with Environment Waikato staff by creating a nitrogen management plan for the farm operation. This is also secured through a Resource Consent which is then actively monitored by Environment Waikato.

The business case looks very promising for others to follow. It consists of good use of marginal land for forestry, which generates an annual cash flow from carbon offsetting, combined with prudent use of their available nitrogen allowance generating efficiencies and excess nitrogen to sell to the Trust. As the Trust's funding is allocated on an annual basis, payments for nitrogen reductions will be paid each year over the duration of the Trust until 2018.

This agreement allows the nitrogen to be reduced as farming changes or forestry locked in. This time payment still allows people to borrow against an incoming cash flow, and importantly for Maori land, allows use of the income which could be for buying private title land should staying in farming be the preferred option.

Important for these opportunities is Mighty River Power who have seen the benefit in sourcing their carbon offsetting requirements in this way. It is foreseen that this agreement will be the first of many within the catchment. Despite the criticisms of the ETS legislation, this project is able to extract considerable benefit for the catchment by Mighty River Power using its carbon requirement to maximize joint environmental benefits.

Trading risks

There are risks in both selling nitrogen and trading in carbon. The Trust in particular encourages landowners to fully review their farm options before entering into negotiations. This is actively encouraged by the Trust which will pay half the cost of an independent farm review by a consultant. They will consider the risks, opportunities and economics on a range of farm options, including nitrogen and carbon trading.

Overall the Trust is happy about what this breakthrough can achieve. With careful planning, landowners in the catchment can achieve significant business improvement in their farming operation and cash flow by being involved in this opportunity. At the same time the resulting long term reduction in nitrogen provides an increasing safeguard to maintaining the water quality of a lake which is recognised as a national and international icon.

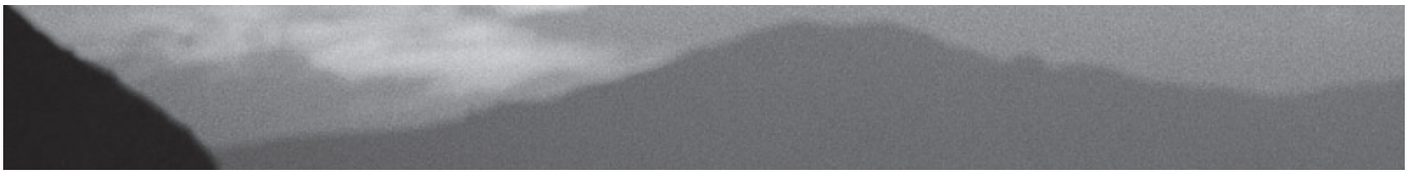
Looking after Lake Taupo

To date the Trust has contracts to reduce approximately 65,000 kg of nitrogen towards our target. With the business opportunities being presented using carbon offsetting, good land use and nitrogen reduction payments, nitrogen reductions should continue to accelerate.

At first there was considerable concern regarding the Lake Taupo Project from a number of sources. Can farmers farm under a nitrogen cap? What would be the effect on land values ? What will be the effect of requiring farmers to hold a Resource Consent to farm?

While it is too early to answer all these questions it does seem to be the case that, from facing apparent adversity, farmers in the catchment have moved on constructively. They are now actively looking to maximise their business interests while looking after Lake Taupo.

Graeme Fleming is the Chief Executive Officer of the Lake Taupo Protection Trust



Ross Gray, Alec Mackay, Alan Palmer, Nicole Schon and Ricky Tuck

Soil bioengineers
Earthworms the forgotten workers

Beneficial earthworm species, like the pasture and animal species used in pasture agriculture, are not indigenous to New Zealand, but are introduced from the northern hemisphere. There is a strong case for the immediate introduction of surface active earthworm species using proven technologies, and for developing a commercial technology for the introduction of the deep burrowing species to provide greater biological support to all pasture soils.

Our pasture agriculture farming systems are highly engineered above ground. There has been significant investment in animal and plant genetics, management packages and nutrient programmes, as well as in technologies such as drainage and irrigation There are some technologies that attempt to provide additional support or modify the behaviour of the soil biological community.

One example includes biopesticides, which contains live non-spore forming bacterium *Serratia entomophila* to treat grass grub *Costelytra zealandica,* a soil macro-fauna pasture pest. Another example includes nitrification inhibitors which suppress the action of nitrosomonas bacteria to inhibit the conversion of ammonium to nitrite to reduce nitrogen loss. However, attempts at manipulating the size and composition of the invertebrate community in soil using bio-engineering to provide added support to soil services, has been largely overlooked.

A critical role

Earthworms are the most obvious of the soil organisms and play a critical role in sustaining a wide range of soil attributes such as soil aggregates or pore structures, and processes. These underpin the majority of the soil provisioning – supply of nutrients, water, physical support – and regulating services required for sustainable pasture agriculture. In addition to macro-fauna, meso-fauna and micro-fauna also play a pivotal role in a wide range of soils services.

History and survey

This article provides a brief history of earthworm introductions and earthworm species in New Zealand as well as the findings of an on-farm survey conducted last spring on the Central Plateau of the North Island. The survey included sheep and beef farms, but was predominantly based on dairy farms.

Approximately half the farms sampled had over 50 years of history in permanent pasture, and the other half were pastures on land recently converted from exotic forest. The current survey had two objectives –

- Establish the diversity and abundance of resident earthworm species
- Assess the potential benefits of earthworm introductions to help intensively managed pasture soils with limited invertebrate communities.

Sub-critical invertebrate communities limit the soil's capacity to sustain pores and pore function, and incorporate surface plant litter and dung into the soil profile. This may be reflected in reduced pasture growth from slower nutrient cycling, less effective use of rainfall, increase in nutrient losses in overland flows and increased animal health risks from fungi and toxins associated with greater plant litter residues on the soil surface.

History of earthworm introductions

Referring to earthworms, Charles Darwin quoted in 1881, 'It may be doubted whether there are many other animals that have played so important a part in the history of the world as these lowly organised creatures'.

When native forest and bush was cleared to make room for agriculture during the latter part of the 19th century the soil was exposed to fire, wind, and rain. Much of New Zealand is now covered by managed exotic pasture, crops or forest, and exposed the pasture to treading by stock. The indigenous earthworm fauna of New Zealand, of which 200 species remain, was not evolved for conditions under grazed pastures and disappeared from these areas.

Exotic introductions

With European colonisation came the unintentional introduction of exotic earthworm species that thrive in

grazed pasture soils. These introduced species were the European and other exotic species that survived the long ship journey within the soil of potted plants and ships ballast. Gradually these exotic species replaced the lost indigenous species. However, due to a few, very limited releases of earthworm importations, the species diversity is very limited compared to that found in European farmland soils.

Despite the small number of earthworm introductions, all introduced species are of great importance to the viability of pasture and cultivated lands, as the earthworm fauna consists entirely of a few species. Research in the 1950s and 1960s found that many of New Zealand's pastoral, arable and horticultural soils were devoid of earthworms.

Native Megascolecidae species are rarely found in agricultural land, and there are many areas where exotic species have not been introduced or have been introduced and have failed to persist. Therefore the colonisation of pasture by some of the beneficial earthworm species remains patchy. A nationwide survey of earthworms in over 200 farms in 1984 and 1985 highlighted the lack of diversity of earthworm species compared with European countries from where the economically beneficial species were derived.

Earthworm species

There are over 15 earthworm species common in European grassland soils, often with a diversity of between four and nine lumbricus species. In contrast, even in New Zealand agricultural soils favourable to Lumbricidae, only two or three earthworm species are commonly found. Here we find that the most common is the grey worm *Aporrectodea caliginosa* that lives a few centimetres below the surface.

European soils usually contain species from each of three identified functional groups – epigeic, anecic and endogeic. Earthworm species from each functional group play distinct roles in the maintenance of soil structure and nutrient cycling.

Epigeic species consume surface litter or dung and incorporate it into the surface soil. Endogeic species live in the topsoil, burrow laterally and mix the soil. Anecic species feed on surface litter or dung and incorporate this deep into the soil profile as they live up to a metre deep. The burrows of endogeic and anecic earthworms improve soil aeration and drainage and provide channels for plant roots.

All earthworms excrete vermicasts that improve soil fertility by providing plant-available nutrients. It is important that all three groups are present and active as they occupy different parts of the soil profile, with each group playing a different role intensive pasture systems.

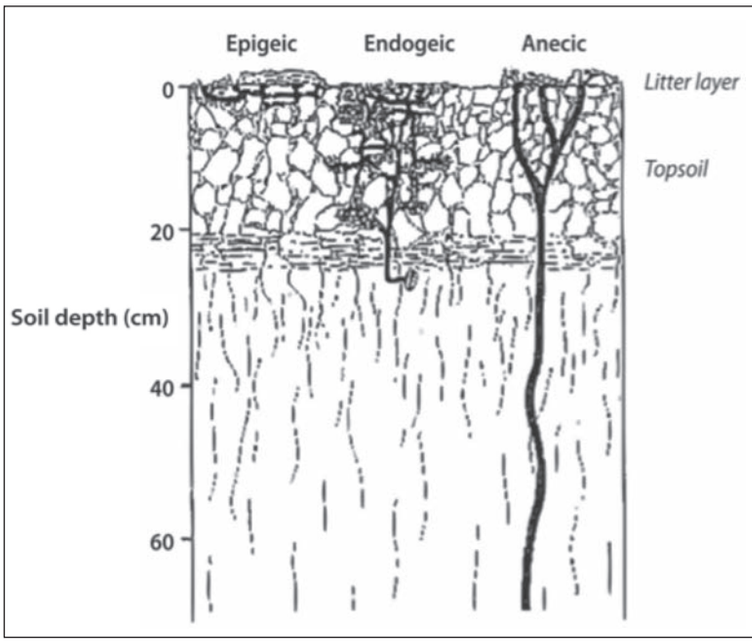
A survey in 1984/85 found the most varied earthworm populations in the north of the North Island, where over 50 per cent of farms had three or more species of earthworms. In contrast 70 per cent of farms in the south of the South Island had only one or two earthworm species.

Earthworm survey in the central North Island

The survey included farms of the Central Plateau Pastoral Group, located mainly on the Central Plateau, but also included members located as far north as Hamilton, east to Rotorua and south to Taupo. A total of 116 paddocks on over 40 farms, predominantly dairy pastures, were sampled for earthworm species diversity and abundance.

A total of 59 paddocks were on land that had been converted from exotic forest to pasture in the previous five years. The balance of paddocks had been under long term permanent pasture. Soil textures ranged from sand through to clay, with topsoil depth recorded in some cases. A total of 27 paddocks had received dairy shed effluent from either a sump or pond. Levels of pasture production, as reported by farmers, ranged from poor to good levels, with Olsen P ranging from10 to 100 μg per ml.

Depth of activity of the three functional earthworm groups



Three functional earthworm groups are grouped largely by species burrowing behaviour

Endogeic earthworms, such as *Lumbricus rubellus*, build complex lateral burrow systems through all layers of the upper mineral soil and rarely come to the surface.

Anecic earthworms such as *Aporrectodea caliginosa*, build deep permanent, vertical burrows that extend from an opening at the soil surface down through the mineral soil layer. They are generally large earthworms that feed on decaying litter on the soil surface.

Epigeic earthworms such as *Lumbricus terrestris* live in the top soil and litter layer on the soil surface where they feed on dung and plant litter

Location of farms in the survey in the North Island

Findings of the survey

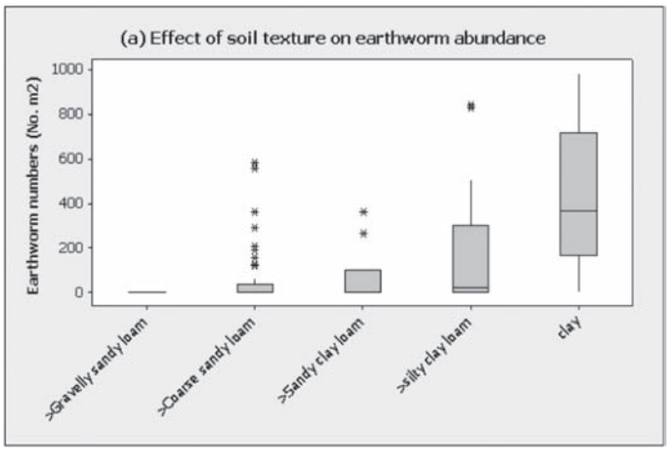
Over half the pasture soils sampled, 59 paddocks, had no earthworms. These were predominantly from pastures recently converted from exotic forest. The failure to also find earthworms at some sites that had been under pasture for more than 50 years highlights that the lack of earthworms and their limited diversity is not necessarily a result of agricultural practices alone.

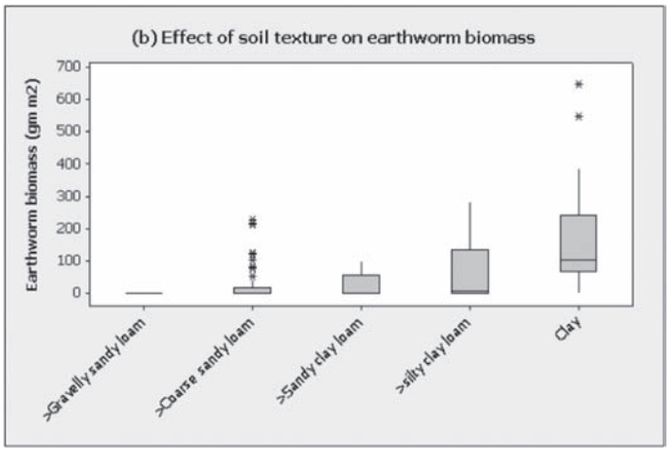
In addition, it supports the fact that beneficial earthworm species have a patchy distribution in New Zealand and are the result of accidental introductions. Unless introduced either accidentally or intentionally, earthworms will be absent from pastures regardless of the years in permanent pasture.

The balance of paddocks sampled in the survey all contained earthworms, but only 16 of the 116 paddocks sampled had all three functional earthworm groups. Only three paddocks had five or more earthworm species. Recent findings highlight the importance of earthworm diversity and the potential of the anecic deeper burrowing species to substitute for the actions of the surface epigeic earthworms under high stock treading pressures. Recent study is suggesting that an active earthworm community increases the uptake of nitrogen by plants, even where nitrogen fertiliser is used.

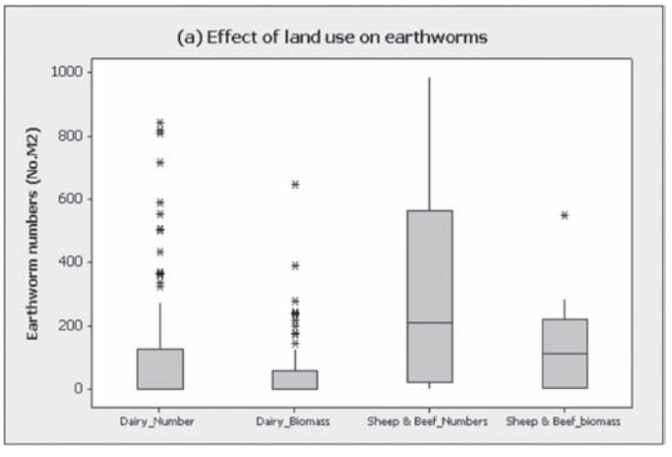
Influence of soil texture

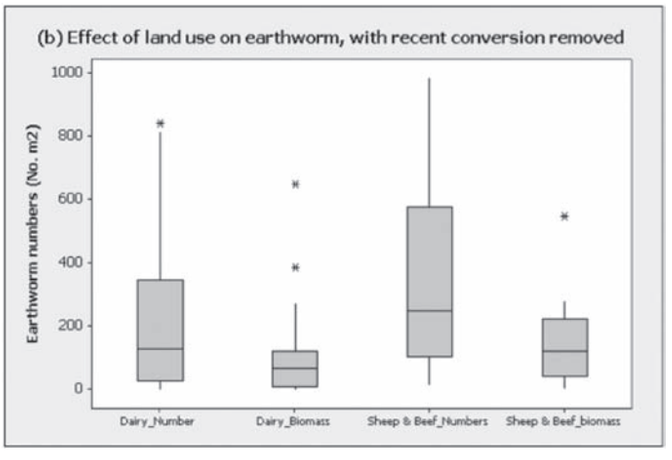
Many of the recent conversions were on pumice soils. Soil texture classes ranged from coarser than a gravelly sandy loam, to coarser than sandy loam, to coarser than a sandy clay





Relationship between soil texture and earthworm abundance and biomass





Earthworm abundance and biomass as influenced by dairy management and sheep and beef

loam, to coarser than a silty clay loam, to a clay. Historically the coarser textured soils have been viewed as unfavourable to earthworms for reasons ranging from abrasiveness, low organic matter content through to low water holding capacities and shallow profiles.

Soils with a texture coarser than a gravelly sandy loam, that included gravelly sands, sands, and very gravelly sandy loams, had no earthworms. Soils with textures in the particle size ranges finer than a gravelly sandy loam through to a coarse sandy loam had earthworm populations that ranged from nil in recent pasture conversions to populations of 600 per square metre, that would be regarded as insufficient to fully support soil services.

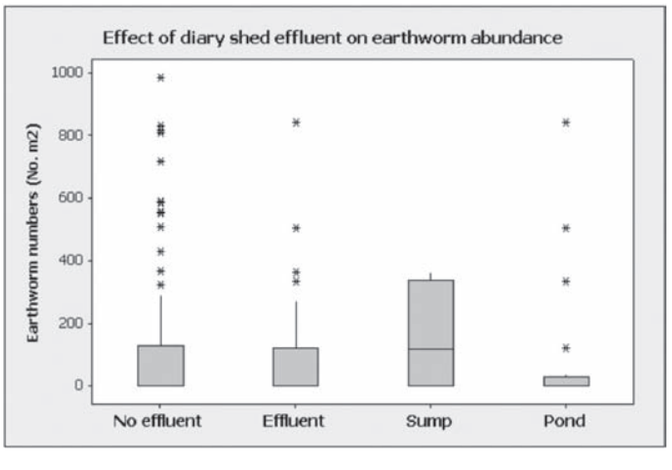
The lower biomass of earthworms in the coarser textured soils, which translates into smaller average earthworm sizes, indicates that the environment is limiting the growth and therefore the likely level of earthworm activity. The data suggests that earthworm introductions would be successful, but the benefits gained from their introduction may be less than that reported previously.

In addition to soil texture, another feature of the recent conversion from exotic forest to pasture was the topsoil depth or the depth to the subsoil. While no relationship was found between soil depth and earthworm abundance, a combination of a shallow soil profile and a coarse texture would limit options for earthworms to survive prolonged dry periods, not uncommon across the Central Plateau.

Land use

Earthworm abundance and biomass on the dairy farm operations sampled were lower than on a smaller number of sheep, beef and deer operations sampled. Restricting analysis of earthworm populations to dairy farms that had been out of exotic forest for more than five years, the average abundance and biomass of earthworms increased.

But it was still less than that of the sheep and beef operations, despite higher Olsen P levels and pasture production. This suggests that food supply was not the factor limiting earthworm abundance.



Influence of effluent on earthworm abundance including.

Influence of effluent disposal

There was no evidence to suggest that effluent application had a positive effect on earthworm abundance. The assessment of the influence of effluent was limited in the present study because a large number of the effluent paddocks sampled were from dairy operations from recent forest conversions that did not have earthworm communities.

The suggestion that earthworm introductions on recent conversion might be more successful on the blocks receiving effluent does not appear to be supported by the data. There were no irrigation sites included in the study, limiting the ability to assess the effect of water versus effluent on earthworm abundance.

Cultivation

The influence of cultivation has to be separated from the influence of past land use. Any relationship between cultivation and earthworm numbers or biomass for all sites was very weak. At individual sites there was an indication of lower earthworm numbers in the years immediately after cultivation. Limiting the analysis of the influence of cultivation on earthworm numbers and biomass to sites with a long-term pasture history also indicated no long-term impact of cultivation on earthworm numbers.

Looking forward

New Zealand research has suggested that the introduction of earthworms into soils with no earthworm activity could increase pasture production by between 10 per cent and 30 per cent. However, there is a lack of data on the productivity that could be gained from inoculating farmland with additional species, beyond those active in the topsoil.

In the present study half the paddocks sampled, predominantly from recent exotic forest conversion to pasture, had no earthworms and only 16 of the 106 pasture samples contained all three earthworm functional groups. Only three paddocks had five or more earthworm species.

Significantly, active earthworm populations were found in some of the coarse textured volcanic soils that have been considered unfavourable to earthworms, indicating that earthworms can establish when introduced in these landscapes.

The findings of the survey provide a strong financial case for introducing surface active earthworm species where they are absent using proven technologies. The survey also provides more data to show the very patchy distribution of the deep burrowing earthworm species. Developing a commercial technology for the introduction of the deep burrowing species to provide greater biological support to all our pasture soils would also appear to have merit.

Alec Mackay and Ross Gray AgResearch, Grasslands, Nicole Schon Massey University, Ricky Tuck Maxwell Farms, Reporoa and Alan Palmer Institute Natural Resources, Massey University.

Mark Goodwin and Lisa Evans

Value of honey bees to New Zealand

Honey bees are coming under increasing pressure from pests and diseases internationally with unexplained losses of bees in Europe and the USA. With the spread of the varroa bee mite throughout New Zealand it is useful to take a closer look at the economic value to New Zealand of honey bees. Their value goes far beyond honey production. Bees pollinate more than a third of the foods we eat and without bees, many crops would not be viable.

Number of hives

All New Zealand bee keepers have to report the number of colonies they have. At the end of the last reporting year, beekeepers reported 362,540 managed honey bee colonies in New Zealand. Commercial bee keepers own the majority of hives, with less than two per cent owned by hobby bee keepers. However most of the 2,669 registered beekeepers in New Zealand are hobby beekeepers with fewer than 10 hives, mostly distributed within cities. The number of these hobby bee keepers has halved since the invasion of varroa.

The number of unmanaged or feral honey bee colonies is unknown. There were likely to be significant numbers before varroa entered New Zealand. In 1991/92, 107 feral colonies were identified in and around Hamilton city, and 246 feral colonies were identified in the Nelson/Marlborough area in 2006.

Before varroa, many feral colonies survived for more than 10 years and the occasional hive was reported to occupy the same location for more than 25 years. Because varroa kill most hives within a year if they are not treated with miticides, most feral colonies can now only survive for one or two years. So there is probably only a fraction of the number of feral colonies that there were before the varroa incursion.

The value of honey bee products

Honey bees produce a number of beehive products that bee keepers trade both within New Zealand and internationally – honey, propolis, bee-collected pollen, beeswax, queens, live package bees and small amounts of royal jelly and bee venom. Bee keepers produce an average of 12,375 tonnes of honey each year, with about half being exported, at a value of $70 million.

The value of the approximately 6,000 tonnes consumed in New Zealand can only be estimated, as it all depends on its floral origins. Bee keepers with a mixed floral source honey can expect wholesale prices of around four dollars a kilo, whereas honey with a high manuka content can command prices of more than $10 a kilo. At an average price of $4.50 a kilo paid to beekeepers, the New Zealand market is worth approximately $30 million. We export beeswax worth about $3.5 million and bees worth $3 million.

The value of bees for pollination

Estimating the exact value of the pollination services that bees provide is somewhat problematic because they are not

responsible for all insect pollination in New Zealand, and artificial pollination is carried out in some crops. Our native solitary bees, introduced bumblebees, flies and a range of smaller insects often add significantly to the pollination of many crops and can at times be found in higher densities on some crops than honey bees.

However, their presence cannot be relied on, so it is not possible to reliably produce commercial crops without introduced honey bee colonies. Bumblebees are produced commercially to pollinate high value glasshouse crops, such as tomatoes, but they are generally too expensive to use to pollinate most other crops.

Artificial pollination is sufficiently developed to replace insect pollination. Even in the kiwifruit industry, which has the most advanced systems, artificial pollination is carried out to augment honey bee pollination rather than to replace it.

The value of the crop pollination carried out by honey bees to the agricultural industry, excluding clover in pasture, was estimated to be $1,760 million dollars in 2008.

The value of crop pollination by honey bees in New Zealand

Crop	Value million dollars
Kiwifruit	870.7
Apples	344.9
Other fruits	240.8
Berries	108.3
Vegetables including squash	174.8
Seeds	15.4
Nuts	5.7
Total	1,760.6

Pollination of clover in pasture

Potentially the largest value of honey bees is their pollination of clover in pasture. An analysis completed by MAF assumed honey bees were essential in the maintenance of clover in pasture, and it has been determined that clover pollination was worth $1,746 million a year. This is almost the same value as the total of crop pollination shown above.

However, there are major problems in calculating the value of honey bee pollination of clover. White clover's importance to the palatability of pasture to stock and its role in nitrogen fixation are well documented, but the level of pollination required to maintain clover in pasture is unknown and may vary throughout New Zealand.

In summer dry areas, clover is often an annual plant and must be either re-sown or re-grown from the seed that is present in the ground. How much seed and therefore how much pollination is required to replenish the seed bank continually is unknown. If the seed set required is very low, there may be enough unmanaged pollinators in the environment to ensure the replenishment of the seed bank.

In summer wet areas, clover is a perennial plant and much less pollination is required for its maintenance in pasture. As the importance of bees in the maintenance of clover in pasture is unknown, its value is not included in this analysis.

Mark Goodwin and Lisa Evans work for the New Zealand Institute for Plant & Food Research Limited

Peter Hall

Exploring the oil wells of the future

New Zealand's reliance upon imported liquid transport fuels is a key issue for its future energy security and supply. Currently 90 per cent of our oil is imported at a cost of about $6 billion a year. Scion has conducted research which shows how New Zealand can break this dependence using home-grown biomass on low productivity land. Scion's findings point to trees as possible oil wells for the future.

Creating energy from plants

Biomass is a term used to describe any organic material. This biomass is effectively a store of solar energy, captured using the process of photosynthesis. In fact biomass in the form of wood has been used as a source of energy to provide heat and light, for thousands of years. While this simple use remains popular, woody biomass can also be used as a source of energy for larger-scale commercial and industrial applications, including liquid fuels for transport.

Bioenergy provides a real alternative to fossil fuels for many applications. New Zealand already uses biomass as an industrial energy source in the wood processing sector. Most sawmills use their wood wastes to generate heat for timber kilns, and larger plant have co-generation facilities that produce electricity. As a renewable energy source that can be grown and used sustainably, burning biomass has zero net greenhouse effect as the carbon dioxide given off during combustion is absorbed by the growth of the next crop of biomass.

Competitive bioenergy

New Zealand's geography and climate have placed the country at the forefront of the production of food and fibre internationally. This natural advantage has a prime role in making New Zealand competitive for many forms of bioenergy production.

Scion began the Bioenergy Options for New Zealand project in March 2007 to consider the potential contribution of bioenergy to New Zealand's energy future. It began by exploring the bioenergy potential of existing biomass resources – the residues or wastes from a range of industries. The project concluded in October 2009 with a report that demonstrates how New Zealand can become self-sufficient in transport fuels produced from biomass grown in sustainably managed forests.

What are the bioenergy options?

A number of primary industries produce biomass waste that can already be used for energy production in New Zealand. Examples include horticultural wood residues, straw, fruit and vegetables, agricultural effluents and tallow. Woody biomass is the largest existing biomass resource, and forest and wood processing residues are the largest contributors. Even if all of these available residues were converted into energy, they would meet less than 10 per cent of New Zealand's total energy demand.

As demand rises in the future, especially for oil and gas, the need for substitute fuels will become increasingly urgent. For this reason, many countries overseas have started growing crops, such as canola, maize or sugar cane for conversion into liquid fuels. The problem with these agricultural crops is that they compete with food production on arable land.

Trees are best

While some biomass feedstocks such as algae and canola offer New Zealand niche opportunities, trees offer the best opportunities for large scale bioenergy production. By planting purpose-grown forests on hill country with low agricultural productivity, New Zealand could create a national bioenergy resource that does not significantly affect food or feed production.

The use of biomass from forests is more efficient in its land use than seed or nut crops as the entire biomass volume can be used, as opposed to just a specific part of the plant. In addition, forests produce much higher volumes of biomass per hectare than any other crop. Land use efficiency will be critical in future development of biofuels, due to competition for land for food.

Sustainability plan

Scion has produced a plan which shows how New Zealand could gain a long-term, sustainable alternative to imported transport fuels by establishing 1.8 million hectares of energy forests, an area equivalent to the current plantation forest estate. This highly achievable goal would reap huge benefits for the economy, the environment and for greenhouse gas reduction. By using some of the lowest value marginal land to produce low-carbon transport fuels, New Zealand can mitigate some of the risks of rising oil prices and reduced availability.

Assuming projected oil prices of around $120 to $140 a barrel, Scion estimates there will be a net gain to the New Zealand economy of $4.8 billion a year via import substitution. In addition, by replacing 65 per cent of imported transport fuels, New Zealand would reduce its total consumer energy reliance on imported oil for energy by 60 per cent. Once established, the forests would also provide a carbon stock of 650 million tonnes of carbon dioxide equivalent, reduce transport related greenhouse gas emissions by 45 per cent, and gain other environmental benefits on hill country landscapes such as erosion control and flood protection.

What could energy forests look like?

Scion has identified potential species for afforestation by determining maximum biomass productivity from best sites and ranking them. Some species, while highly productive, are only suitable to a limited range of sites.

It is apparent that the hardwoods such as eucalypts and to a lesser extent acacias, with their higher wood density and reasonable growth, offer greater productivity than many softwoods. However the high volume production from redwood places it in the 10 most productive species, along with radiata pine, the eucalypts and some acacias. Radiata topped the ranking, but other species identified as worthy of further investigation include –

- Grand fir *Abies grandis*
- Sitka spruce *Picea sitchensis*
- Western hemlock *Tsuga heterophylla*
- Giant sequoia *Sequoiadendron giganteum*
- Swamp cypress *Taxodium distichum*

Ranking of bioenergy potential by maximum productivity of potential bioenergy species

	Species	Stem volume cubic metres per hectare per year	Basic wood density kg per cubic metre	Stemwood oven dry tonnes per hectare per year
1	*Pinus radiata*	60.1 to 63.8	420	25.2 to 26.8
2	*Eucalyptus fastigata*	46.0	500	23.0
3	*Eucalyptus nitens*	42.5	520	22.1
4	*Eucalyptus regnans*	45.7	460	21.0
5	*Eucalyptus saligna*	33.8	610	20.6
6	*Sequoia sempervirens*	57.9	340	19.7
7	*Eucalyptus maidenii*	31.4	561	17.6
8	*Acacia dealbata*	33.5	510	17.1
9	*Eucalyptus botryoides*	23.7	620	14.7
10	*Acacia melanoxylon*	22.0	590	13.0
11	*Eucalyptus globoidea*	19.8	630	12.5
12	*Eucalyptus delegatensis*	24.5	470	11.5
13	*Cupressus macrocarpa*	27.3	400	10.9
14	*Cupressus lusitanica*	27.4	380	10.4
15	*Pseudotsuga menziesii*	23.9	400	10.1
16	*Eucalyptus pilularis*	15.9	580	9.2
17	*Pinus ponderosa*	20.8	400	8.3
18	*Pinus nigra*	18.8	430	8.1
19	*Larix decidua*	17.8	450	8.0
20	*Eucalyptus muelleriana*	13.6	550	7.5

Where is the most energy potential?

Scion developed a number of land use options to explore energy supply volume, cost, land use change and associated impacts. The table below shows the potential energy production by region, assuming 1.8 million hectares of new planting.

Summary of potential biomass and liquid fuel production assuming harvest on 25-year rotation

Region	Total extractable biomass Millions of cubic metres a year	Litres of petrol equivalent a year in millions
Northland	1.08	94.2
Auckland	0.51	44.3
Waikato	4.39	382.0
Bay of Plenty	0.44	39.4
Gisborne	6.26	544.8
Hawke's Bay	8.47	736.8
New Plymouth	2.60	226.5
Manawatu-Wanganui	16.08	1,389.2
Wellington	5.73	499.0
Tasman	0.81	710.4
Nelson	0.11	9.3
Marlborough	3.24	288.1
West Coast	0.34	30.1
Canterbury	12.14	1055.7
Otago	8.27	714.3
Southland	3.00	261.0
Total	**73.55**	**7,039.1**

This large-scale afforestation analysis was based on the assumption that the crop would be radiata pine. It does not mean that all the afforestation would or should be radiata. However it is the species that has the most information available at a national level on its productivity, allowing more detailed and accurate prediction than is possible for other species.

The regions showing greatest promise for new forests, in terms of suitable land and growing conditions, were Manawatu and Wanganui. These were closely followed by Canterbury, Hawkes Bay and Otago.

The biomass regime gave the following market options –

- 56 per cent sawlog and 44 per cent chip
- High volumes of carbon

Energy end-use options would be –

- Solid fuel for heat or cogeneration of heat and power
- Liquid fuel
- Feedstock for gas production.

For a given estate area, some of the land could be retained as carbon forests, some logged, and there are a range of options for marketing the material produced.

Tapping the potential of woody biomass

New Zealand researchers are not the first to recognise the potential of woody biomass. Massive overseas investment, particularly in the United States, is driving rapid development in technologies to convert trees into transport fuels. In January 2010, a high profile delegation gathered in Rotorua to discuss US and New Zealand research collaborations that will help New Zealand with this investment.

Hosted by Scion, the meeting was part of the wider programme of the New Zealand-United States Joint Commission Meeting on Science and Technology Cooperation. Delegates met to explore US and New Zealand research into the opportunities for new bioenergy products and identified where researchers from the two nations might collaborate to speed their development and deployment.

The meeting brought together the highest ranking and most significant US science delegation ever to visit New Zealand. Scion already has a strong network of research collaborations in the US. This forum afforded the chance to extend these relationships and speed the development of new bio-based products domestically and globally.

Work to be done

There is much to be gained from scientific collaboration in this field as both countries see potential in creating new energy products from renewable resources. While Scion presents an argument for New Zealand's energy self-sufficiency, more cost-effective conversion technologies are still needed to realise this vision. Scion has already demonstrated that the process is technically feasible, despite the inherent difficulties associated with breaking down woody biomass.

The technology to convert New Zealand grown softwoods and hardwoods to transport fuels is rapidly progressing towards commercialisation encouraged by research investment overseas. New Zealand is linked to these efforts via a range of partnerships.

Following closely on the heels of the Joint Commission Meeting, Scion signed an agreement with Sandia National Laboratories in California aimed at focusing research on the cooperative development of low carbon energy technologies. The collaboration will explore research topics important to both organisations. Such topics include biofuels supply chain analysis, renewable energy and alternative transportation fuels, and modelling and systems analysis of energy resources.

Sandia is engaged in a wide variety of transportation energy research activities. The company has worked extensively with General Motors and enjoys a long standing relationship with all the major US automakers. This agreement provides a tangible example of how New Zealand can contribute to and benefit from international efforts to solve global issues.

General conclusions

Over the next 25 years New Zealand is likely to face a substantial increase in gas and oil prices. One response to this challenge is to increase oil and gas exploration and to convert coal into liquid fuels to meet energy demands. Another option is to pursue the biomass suggestion using forests. These options are not mutually exclusive.

Significant risks are associated with each pathway. The biomass scenario is dominated by techno-economic risks, due to high costs associated with immature technology. However, it does not have the long term environmental and security supply risks associated with fossil fuel redevelopment.

The bioenergy option puts New Zealand on a path that could meet our energy supply needs. At the same time, we would be reducing our greenhouse gas emissions, mitigating risks in the forest industry, which is important for offsetting carbon emissions from other industries. We could also use our land more sustainably, and promote regional development. In the long term this is the preferable path.

The true challenge in the looming transition from oil is to deploy environmentally acceptable energy technologies rapidly enough to replace current options. Scion has demonstrated that sufficient biomass resources exist from the current forest harvest for bioenergy to play a key role in this. The advantages of avoiding a disrupted climate and other fossil-fuel problems outweigh the costs of doing so.

Biomass supply from existing and new plantation forests can provide a continuum of increasing biomass supply that builds over time from 2010 to 2050. This is a realistic means of evolving from a fossil based energy supply to a renewable and domestic energy supply.

If fossil energy has declined and become substantially more expensive, it becomes even harder to build the next generation of energy infrastructure. This implies a need to plan now and act soon to develop the alternatives.

Lizzie Chambers

Forest carbon – Into the great wide open?

Following the abandonment of Australia's proposed Carbon Pollution Reduction Scheme in late April, both Prime Minister John Key and Minister for Environment Nick Smith, have been quick to advise that New Zealand will not be following suit. This is welcome reassurance for those in the forestry sector. Interest in carbon forestry has grown significantly and MAF recently reported that this year's post-1989 forest applications to opt into the Emissions Trading Scheme (ETS) represent a ten fold increase on last year.

As provided for in legislation, the ETS will undergo a general review over the course of 2011. The risk is that given the current economic climate, the government could decide to prolong the transitional measures, originally intended to remain in place only until the end of 2012.

These measures were designed to limit the cost of the ETS on the economy until the end of 2012 and include a halving of obligations such that emitters need hand in only one New Zealand Unit (NZU) for every two tonnes of physical emissions up until the end of 2012. In addition, a fixed price option is also available throughout the same period, meaning emitters can simply pay the government $25 a unit not surrendered, rather than buying NZUs on the market.

On the demand-side, these amendments have created a great deal more flexibility and certainty for emitters. Unfortunately the same cannot be said for forestry participants on the supply side of the ETS. The supply and demand balance for NZUs is now very uncertain.

The government has taken the view that, as the ban on export of NZUs does not apply to forestry, transitional measures will not have a significant effect on the forestry sector. However, the international export opportunity is also subject to the limitations and uncertainties.

Murky outlook for NZU sellers

In April 2010, New Zealand's net position report under the Kyoto Protocol projected total emissions of 111.4 million tonnes of carbon dioxide equivalent from the energy sector and the industrial process sectors for the years 2010 to 2012. These sectors do not enter the ETS until 1 July 2010 and the transitional measure means emitters must surrender only one NZU for every two tonnes of physical emissions until the end of 2012. Therefore this indicates that the total potential demand for NZUs prior to the end of 2012 is unlikely to exceed 46 million NZUs. A significant portion of these, perhaps 11 to 12 million, will be freely allocated to those carrying out activities which are emissions intensive and trade exposed.

The balance will be met by emitters using a combination of NZUs, other acceptable Kyoto units, and the fixed price option of $25 per NZU. The government also expects to award 6.8 million Kyoto units under the projects to reduce emissions programme.

By contrast, it is estimated that forestry has the potential to supply a total of up to 100 million NZUs. Of these 21 million relate to a one-off allocation to pre-1990 forest owners, and the balance from NZUs allocated to post-1989 forests that have opted into the ETS.

At first glance this seems to indicate a potentially large imbalance. However, the total supply of NZUs depends not only on how many post-1989 forest owners choose to opt into the ETS, but also how many actually decide to sell their NZUs.

As an example, assume that by the end of 2012, half of post-1989 forests have opted into the ETS and adopted a conservative strategy of selling just 30 per cent of credits. In this case, the potential 79 million that could be supplied from post-1989 forests over the first commitment period would reduce to 11.85 million.

Difficult predictions

To date less than 20 per cent of post-1989 forests have opted into the ETS. However, post-1989 forests can opt into the ETS at any time up until 31 December 2012 and claim NZUs in respect of carbon sequestered in forests since 1 January 2008.

In summary, the supply-demand balance of the ETS depends on the extent to which participants with NZU surrender obligations pay out the $25 fixed price and the level of opt-in by post-1989 forest land owners. Both these factors are difficult to predict.

While emitters have the safety net of the fixed price option, for would-be sellers, it remains difficult to assess the

best course of action. Continuation of the ETS after 2012 is not a certainty. Nor is the ability of forest owners to convert and export NZUs. At the moement holders of forestry NZUs have three options –

- To claim and simply hold NZUs
- To sell these domestically
- To convert these into Kyoto units and export them.

International opportunity

Each NZU is backed by, and technically convertible to, a Kyoto compliant assigned amount unit (AAU). Until the end of 2012 there is a ban on the conversion of NZUs to AAUs for the purposes of export, but this ban does not apply to NZUs from forestry. So New Zealand forestry AAUs can be exported.

The problem is that talk of a global carbon market, or even the carbon price is misleading. The market is real and significant and expected to top 121 billion in 2010. However it is still better described as a patchwork of regional and country-based initiatives. A leading research firm has said in 2009 that over 70 per cent of carbon market participants expect a global reference price for carbon by 2020. The status quo is that a number of different types of credits exist. While most of these represent a tonne of carbon dioxide and its equivalents, prices vary considerably and not all types of carbon credits can be used interchangeably.

European domination

The carbon market still remains dominated by the European Union's Emission Trading Scheme (EU ETS). This scheme was established in 2005 and created a unit of trade known as the European Union allowance. Inclusion of more than 10,000 large and emissions-intensive installations in sectors such as cement, glass, metals, pulp and paper, electricity generation and oil refining, meant that the EU ETS quickly developed reasonably good liquidity. It is for this reason that carbon market participants look towards the EU ETS for a reference price for a tonne of carbon dioxide equivalent.

These can also be used for compliance in the EU ETS subject to certain limits. They are also often quoted as a useful secondary reference price.

However in contrast, NZUs are underpinned by, and convertible into, AAUs. They cannot be used for compliance in the EU ETS. They are not widely traded project based credits like certified emissions reductions. Instead an AAU represents a Kyoto allowance to emit one tonne of carbon dioxide equivalent, and of these there is an enormous surplus.

The hot air issue

While the Kyoto Protocol is still the widest reaching emissions reduction agreement we have, it has flaws. In particular, failure to anticipate the full economic effects of the collapse of the Soviet Union has meant that many economies in transition hold large surpluses of AAUs.

Across countries that will not meet their targets, the aggregate deficit has been estimated at approximately two billion tonnes. However, considering countries with surplus allowances, the aggregate AAU surplus has been estimated at up to 10 billion tonnes. So overall, the Kyoto Protocol looks likely to be oversupplied by seven to eight billion AAUs in the period up to the end of 2012. Up to 90 per cent of this surplus is held by Russia, the Ukraine and Poland.

Trading AAUs

Partly for this reason, the AAU is not a credit that can be used for compliance in the EU ETS. However the European Union and other governments can trade AAUs directly. Such trades began in 2008 but have only become more common in 2009.

On the buying side, the AAU trades are dominated by EU-15 governments with Kyoto gaps. In 2009, buyers of AAUs included Spain, Austria, Ireland and Norway. Japanese utilities are allowed to buy AAUs in their own right and were also active buyers.

By contrast, sellers included the Czech Republic, Poland, the Ukraine, Slovakia, Latvia and New Zealand. Among recent sellers of AAUs, New Zealand is notable in that it is probably the only AAU seller not to be a hot-air country. Sales of AAUs from New Zealand compete against AAUs sold by economies in transition.

A risk

The risk to a seller of AAUs of New Zealand origin, and to the wider international carbon market, is that increasingly large numbers of AAUs could come to market between now and the end of 2012, the expiry of the first commitment period of the Kyoto Protocol. Dumping of AAUs on the market could see carbon prices collapse.

This risk has long been acknowledged by carbon market participants as having the potential to undermine the EU ETS and other carbon markets. As a result, significant pressure has been placed on potential government buyers to exercise caution in their purchases of AAUs and not to dump such surpluses on the market.

In fact the risk of this possibility is limited. The Kyoto Protocol provides for unlimited banking of surplus AAUs into future commitment periods, which is one factor which will serve to limit the number of hot air AAUs brought to market in the first commitment period. Economies in transition do not wish to see the value of their AAUs evaporate, and ideally they would like to see their surpluses banked forward to accommodate future economic growth.

Post-2012 is uncertain

Unfortunately, the Copenhagen meeting provided little clarity on the nature of a post-2012 international climate policy agreement. There is an argument that, if this uncertainty persists, it is possible that an attitude of compliance at least cost could emerge as the end of 2012 approaches. What could then ensue is a race to the bottom in terms of the quality

of credits purchased by countries with a deficit. The result could be that, the nearer we get to 2012, the more likely New Zealand foresters will be to find their AAUs competing against large volumes of cheap AAUs.

Green investment schemes

The debate is complex. Some research firms doubt that restrictions on AAU banking will materialise within a future international agreement because such limitations might prevent Russian participation in a post-2012 deal. However, the International Emissions Trading Association (IETA) is concerned that the current surplus does not make its way forward and soften the effort required in order to meet commitments under any post-2012 deal. IETA notes that surplus AAUs could be tackled by means of an amendment to the Kyoto Protocol so as to limit the ability to carry forward assigned amount surpluses into a subsequent period.

One mechanism that has been developed in an attempt to re-inject environmental integrity into the market for AAUs is the concept of green investment schemes. Under these schemes, the revenue from sales of surplus AAUs is directed towards domestic emissions reductions projects, such as community insulation or other energy efficiency initiatives. The general idea is that the effort involved in such initiatives is comparable to that involved with the generation of project based credits. The spectrum of greening can range from soft to hard commitments, and the price achieved for such AAUs should reflect this.

Not all hot air

As New Zealand is not a hot air country, sales of our AAUs are not subject to greening requirements. There is an argument that AAUs from a non-hot air country should trade at a premium to other AAUs. But achievement of this premium is only possible by effective communication of our national status, and this communication comes at a cost.

The governments of countries that are considering the purchase of AAUs to cover their Kyoto deficits are conscious of the need to be able to justify their purchases and the need to point to concrete emissions reductions efforts. To date the only country that has seen fit to purchase New Zealand AAUs in any significant number is Norway. In that country, parliamentary questions were recently asked about the appropriateness of buying credits from a developed country like New Zealand when it is not obvious that the proceeds create any significant social or extra environmental benefit.

The Commitment Period Reserve

International trading of AAUs is subject to the limits set by the Commitment Period Reserve. This is a Kyoto Protocol requirement which is aimed at reducing the risk that someone might oversell their units and not meet their own emissions target. For New Zealand, until the end of 2012, this means that a reserve of AAUs and other acceptable units of not less than 278,608,260 tonnes of carbon dioxide equivalent must be maintained in the New Zealand Emissions Unit Register (NZEUR).

Should the holdings of the NZEUR drop to this level, the registry would be closed for transactions until more Kyoto units entered the registry again. Therefore exports of AAUs which would see the NZEUR's holdings drop below this level would not receive Ministerial approval. At 11 May 2010, the NZEUR held 307,607,667 units, well above the required level.

So, on the face of it, further exports of some 29 million units could be approved. In fact, to the extent that significant imports of units to the NZ EUR are made, the number of AAUs that could be exported would increase.

Green shoots

This article was not intended to put a dampener on the forestry sector, but rather to highlight the significant uncertainty that confronts potential sellers of New Zealand forestry units between now and the end of 2012. However, longer term, the prospects are still hopeful. It is worth keeping a good watching brief on the new markets on the horizon, particularly those of North America.

In early May this year, Canada's lower house of parliament passed the Climate Change Accountability Act. The Act requires Canada to reduce emissions by 25 per cent below 1990 levels by 2020, and 80 per cent by 2050. The bill must now pass through the Senate, but is widely expected to have a good chance.

In June 2009 the US House of Representatives passed American Clean Energy and Security Act. That sought to establish a cap and trade scheme with the potential to demand up to two billion offsets a year. Half of these were envisaged to come from international sources. While a Senate energy and climate bill has been complicated by the recent oil spill and domestic political issues, a new bill is due to be unveiled at the time of writing and is also expected to involve significant demand for international offsets.

In theory, these are markets which New Zealand would be well placed to serve. However, for this to become a reality, greater clarity on a post-2012 deal and favourable linking arrangements would have to emerge. The question is, how long might that take and, in the run up to 2012, should holders of NZUs take the risk of waiting, or the bird in the hand?

Lizzie Chambers is a Director of Beyond Carbon Ltd. She has over 10 years' experience in finance, latterly working for a large European carbon fund.

Mike Burrell

Aquaculture – New Zealand's next billion dollar industry

Four years ago New Zealand's aquaculture sector set itself an ambitious target – to grow from a $300 million dollar industry to a billion dollars over the next two decades. To do this the sector established a new lead industry body Aquaculture New Zealand, and set out a bold 10 point plan aimed at putting in place the necessary measures. This article looks back over the past four years to see what has been achieved and what remains to be done.

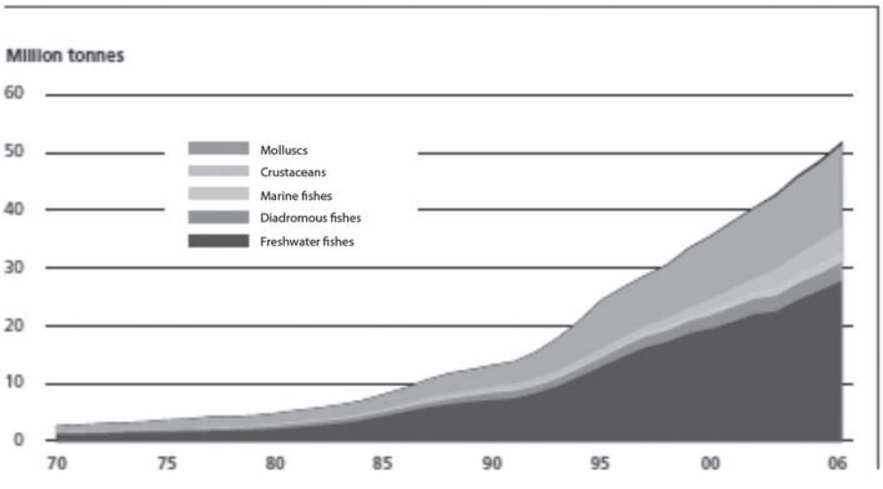
As we enter the second decade of the twenty-first century many commentators are talking about a blue revolution. In much the same way as global food production was revolutionised in the post-war period through a green revolution, this century looks set to see aquaculture as a major source of the world's protein from this blue revolution.

The chart at the bottom of the page from the FAO's report, *The State of World Fisheries and Aquaculture 2008*, is the one most often referred to when discussing the growth of aquaculture over the past two decades.

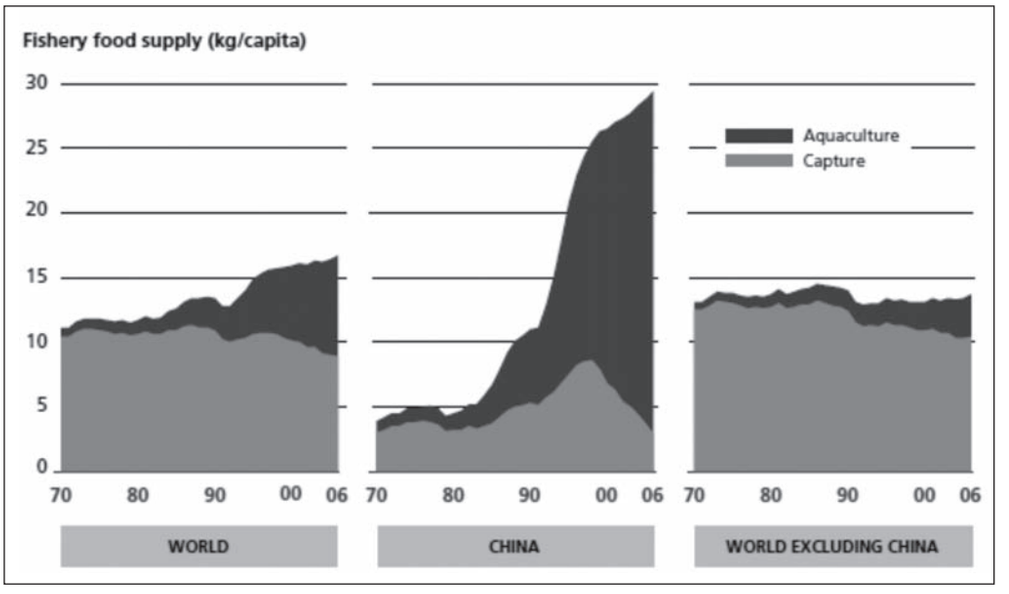
The chart shows how overall aquaculture production has grown from less than 20 million tonnes in 1986 to over 50 million tonnes by 2006. This is predominantly driven by freshwater fish and mollusc production. In the report the FAO states that the aquaculture sector is the fastest growing primary sector in the world. It predicts that the world's seafood consumption will rise by 35 per cent over the next ten years, suggesting this growth trend for aquaculture products is likely to continue.

However, this really only shows part of the story. When you turn to look at the relative contributions of aquaculture and capture fisheries to global fish consumption measured in kilograms of fish consumed per person per year, some very interesting facts emerge.

Trends in world aquaculture production – major species groups



Relative contribution of aquaculture and capture fisheries to food fish consumption



A gradual decline

The first graph in this series shows the trend we most often see in the literature. There is a gradual decline in the world's production of capture fisheries, and its replacement from the dramatic growth of aquaculture. But the second graph shows a dramatic explanation for where most of that volume is coming from, which is China. If you look back to the very first chart you can see what most of this growth from freshwater fish. This is mainly pond aquaculture and is predominantly for domestic consumption. What we are seeing here is the classic development take-off curve, where a rapidly industrialising country and increasing wealth is causing a dramatic shift into protein consumption, in this case farmed fish.

The third panel of the graphs shows that once you take the rapid economic growth of China out of the equation, we see what is more typical of OECD countries. This is a more gradual decline in global capture fisheries and the sustained growth of aquaculture to replace the shortfall.

Some implications

There are some significant implications for New Zealand in this series of charts. First, excluding China, the global demand for seafood is relatively stable at about 13 kilograms per person per year. This level is now being maintained, at a global level, by farmed seafood. This presents a real opportunity for New Zealand to export both its sustainably harvested capture fish as well as its sustainably farmed seafood.

The second implication is that the decline in capture fisheries does not apply to New Zealand, where our quota management system has been very successful in protecting our fish stocks. It is largely because of the quota management system that we have been able to avoid the fate of most other countries. Third, the rapid growth in seafood consumption, particularly by the fast-emerging middle class, presents New Zealand with a new opportunity for exporting our high quality farmed and captured seafood to emerging markets within China.

The New Zealand situation

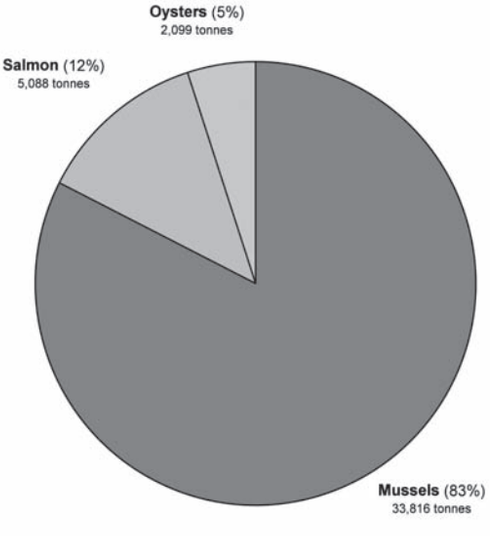
From small beginnings in the 1970s New Zealand's aquaculture sector has grown into an industry worth in excess of $350 million in annual sales. The sector has set itself a target of being a $1 billion industry within 15 years.

Although New Zealand has the fourth largest marine zone in the world, the specific needs of aquaculture mean that marine farming only occurs in a relatively small area of New Zealand's coastal marine area – approximately 17,630 hectares of water space. Of this area approximately 41 per cent of these farms are near-shore sites, 51 per cent are open ocean sites and the rest is space that is still under development. This is equivalent to around 0.02 per cent of New Zealand's coastal marine area.

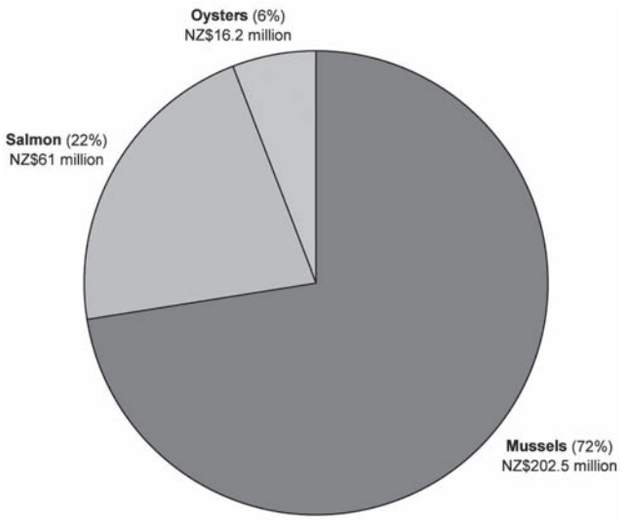
Aquaculture exports in 2009 were valued at just under $280 million. New Zealand had 79 active export markets in 2009 for greenshell mussels, Pacific oysters and salmon.

The following charts provide a snapshot of the most recent export statistics for the sector.

Proportion of aquaculture exports for 2009 by volume



Proportion of aquaculture exports for 2009 by value



Greenshell mussels continue to be the largest export, although in terms of export earnings the value of salmon is much greater than suggested by the volumes.

Greenshell mussels

In 2009, New Zealand exported over $200 million worth of Greenshell mussels to the global market with the largest market the United States. The United States makes up over a third of Greenshell exports, followed by South Korea, Hong Kong, Canada and Spain

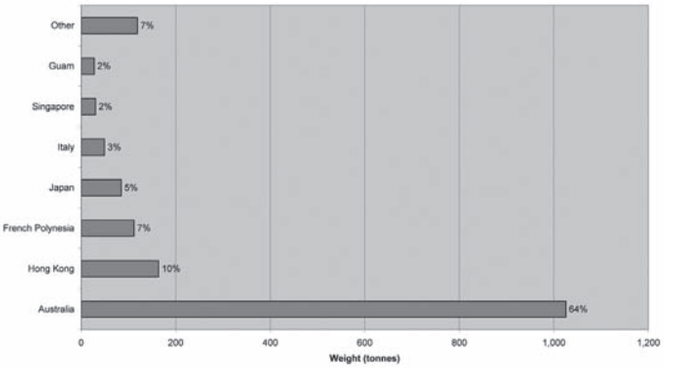
New Zealand Greenshell mussel exports 2009

Product category	Export Weight (kg's)	% of exports	% change on 2008 exports
Half shell frozen	28,739,874	84.99%	0.94%
Meat frozen	2,546,855	7.53%	-1.20%
Whole frozen	1,343,914	3.97%	0.18%
Preserved/marinated	506,753	1.50%	0.15%
Live	374,735	1.11%	-0.18%
Freeze-dried powder	207,323	0.61%	0.00%
Smoked	36,253	0.11%	0.09%
Other not live/chilled/frozen	13,055	0.04%	-0.02%
Whole chilled	11,576	0.03%	0.01%
Half shell fresh/chilled	9,163	0.03%	0.01%
Meat chilled/fresh	7,770	0.02%	-0.01%
Crumbed, battered	6,612	0.02%	0.02%
Processed in can, jar	6,014	0.02%	0.00%
Powder in capsule	5,730	0.02%	0.01%

New Zealand Greenshell mussel quick facts
Greenshell mussels *Perna canaliculus* are a native New Zealand shellfish
They are the single largest seafood export with an export value of NZ$202.5 million
In 2009, total production of Greenshell mussels was 89,850 tonnes
Mussels are filter feeders, meaning they literally filter their food from the sea by pumping the water through their gills. A typical mussel filters 360 litres of water each day.
Although no different in quality or flavour, the colour of the mussel meat varies according to sex. The female is a deep apricot and the male, a soft cream.
Greenshell mussels can be grown to market size in 12 to 18 months from final seeding
They will grow in temperatures between 12°C and 24°C, thriving most in temperatures between 16° and 19°C.

Pacific oysters

In 2009, $16 million worth of Pacific oysters was exported to global markets. The majority were exported in half shell format with by far the largest market being Australia.



New Zealand Pacific oyster quick facts
The scientific name is *Crassostrea gigas*
In 2009, total production of New Zealand Pacific Oysters was 2,708 tonnes
Pacific oysters are filter feeders, and at an adult size are 80 to 100 mm in length and may filter up to 240 litres a day
For best growth results, Pacific oysters thrive in temperatures between 15°C and 18°C
In New Zealand, Pacific Oysters can be grown to market size within 12 to 18 months
Pacific oysters may change sex more than once during their life span, usually spawning first as a male and subsequently as a female.

King salmon

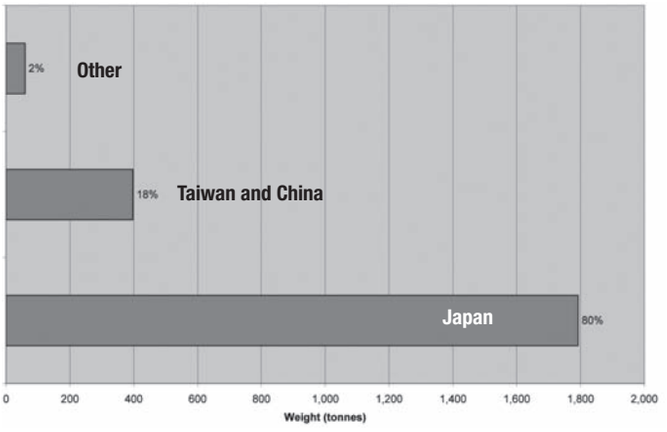
In 2009 New Zealand exported NZ$61 million worth of King salmon to the main markets of Japan, US and Australia.

King salmon exports 2009

Product category	Export Weight (kg's)	% of exports	% change on 2008 exports
Frozen headed and gutted	2,249,221	44.20%	21.93%
Chilled whole	1,835,908	36.08%	-21.39%
Frozen other form	402,944	7.92%	4.58%
Processed smoked	194,405	3.82%	-3.36%
Chilled headed and gutted	117,965	2.32%	-0.95%
Chilled other form	81,635	1.60%	1.00%
Frozen fillets	73,344	1.44%	-0.11%
Frozen whole	47,639	0.94%	-0.62%
Chilled fillets	60,964	1.20%	0.08%
Processed cans or jars, whole or in pieces	23,164	0.46%	-0.98%
Processed other	1,442	0.03%	-0.01%
Processed cans or jars, minced	2	0.00%	-0.16%

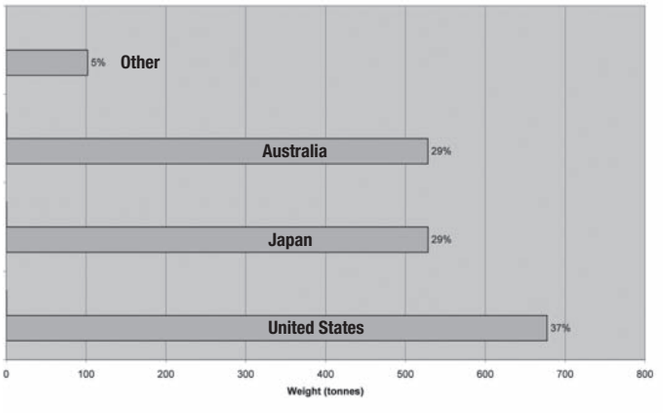
The following graph shows that the majority of King salmon frozen product is exported to Japan.

Where does frozen King salmon go?



New Zealand's chilled King Salmon exports are divided between the United States, Japan and Australia.

Where does chilled King salmon go?



King salmon quick facts
The scientific name for King salmon also known as Chinook is *Oncorhynchus tshawytscha*
In 2009, total production of King salmon was 12,392 tonnes.
New Zealand is the largest producer of farmed King salmon in the world, where no antibiotics, growth promotants or vaccines are used in salmon farming practices.
Temperature is an important factor in determining fish health and growth. Salmon thrive in cooler waters and best growth is achieved at a temperature of 12°C to 17°C.
Salmon take around 12 to-18 months to grow in sea water and depending on market requirements, they are harvested at an average of approximately 3.5 to 4.0 kg.
King salmon has the highest natural oil content of all salmon varieties, making it a rich source of healthy long-chain Omega-3s.

Where is New Zealand's aquaculture?

The map on the next page shows where marine farming occurs in New Zealand. The majority of Greenshell mussel is sourced from the Marlborough region, with another 20 per cent coming from the Coromandel. Chinook salmon is also predominantly grown in Marlborough with another quarter from Southland.

Pacific oysters are mainly grown in the top of the North Island. The location of the growing areas is largely due to the environmental requirements of the different species, and the opportunities afforded by the regional councils who administer the allocation of aquaculture space.

The aquaculture strategy

In response to a plateau in growth in the first half of the 2000s the aquaculture sector developed an industry strategy. The process took place over the first half of 2006 and involved extensive industry consultation.

The result was the New Zealand Aquaculture Strategy. It was an industry growth plan with the goal of focussing the attention of both industry and government on the environmentally sustainable growth of the aquaculture sector. The strategy was built around a 10-point action plan. The key priorities were –

- Establish a new national sector organisation
- Strengthen the partnership with government
- Strengthen other stakeholder partnerships
- Secure and promote investment in aquaculture
- Improve public understanding and support for aquaculture
- Promote Maori success in aquaculture
- Develop the market for New Zealand aquaculture products
- Maximise opportunities for innovation
- Promote environmental sustainability and integrity of aquaculture
- Invest in training, education and workforce.

The strategy was launched in mid-2006. Within a year a new levy had been put in place to fund the implementation of the strategy and in mid-2007 a new industry organisation had been established and launched.

Aquaculture New Zealand

Aquaculture New Zealand (AQNZ) was established as the sector's peak body. It was formed to provide a single voice for aquaculture. It did so by consolidating four existing organisations. AQNZ represents over 650 aquaculture companies throughout New Zealand.

AQNZ is funded by a levy on Greenshell mussels, King salmon and Pacific oysters. It also manages a number of co-funded programmes including a significant NZ Trade and Enterprise-funded market development programme. AQNZ is governed by a board of directors made up of industry, iwi and regional representatives elected by industry shareholders.

Will we reach a billion dollars?

We often get asked, 'Why a billion?' as though there is something particular about this goal. The truth is much more prosaic – is simply an inspirational goal. It is an organising principle that focuses the mind on the kinds of actions that are necessary to achieve this goal.

The billion dollar figure was chosen because it provided a target that seemed achievable within the time frame. It could not be reached simply with business as usual. But it was quite achievable simply by focusing on a relatively small number of actions that are common to most growth strategies – enabling legislation, a focus on investment in innovation and research, a focus on improving export and domestic marketing, and investment in training and education. In fact, the 10-point plan was based in large part on a simple growth equation.

Although the billion dollar target was intended to be an inspirational goal we came under pressure to provide some more formal evidence of how this could be achieved. Ernst and Young were contracted to undertake an analysis estimating a range of growth options based on a set of underlying industry principles. The factors that were considered included –

- Expansion of permitted space
- Productivity increases
- Real price growth and higher-value end products
- Foreign exchange rates
- Inflation rates
- Demand.

The consultants then estimated a series of industry growth options separated out by species. These include –

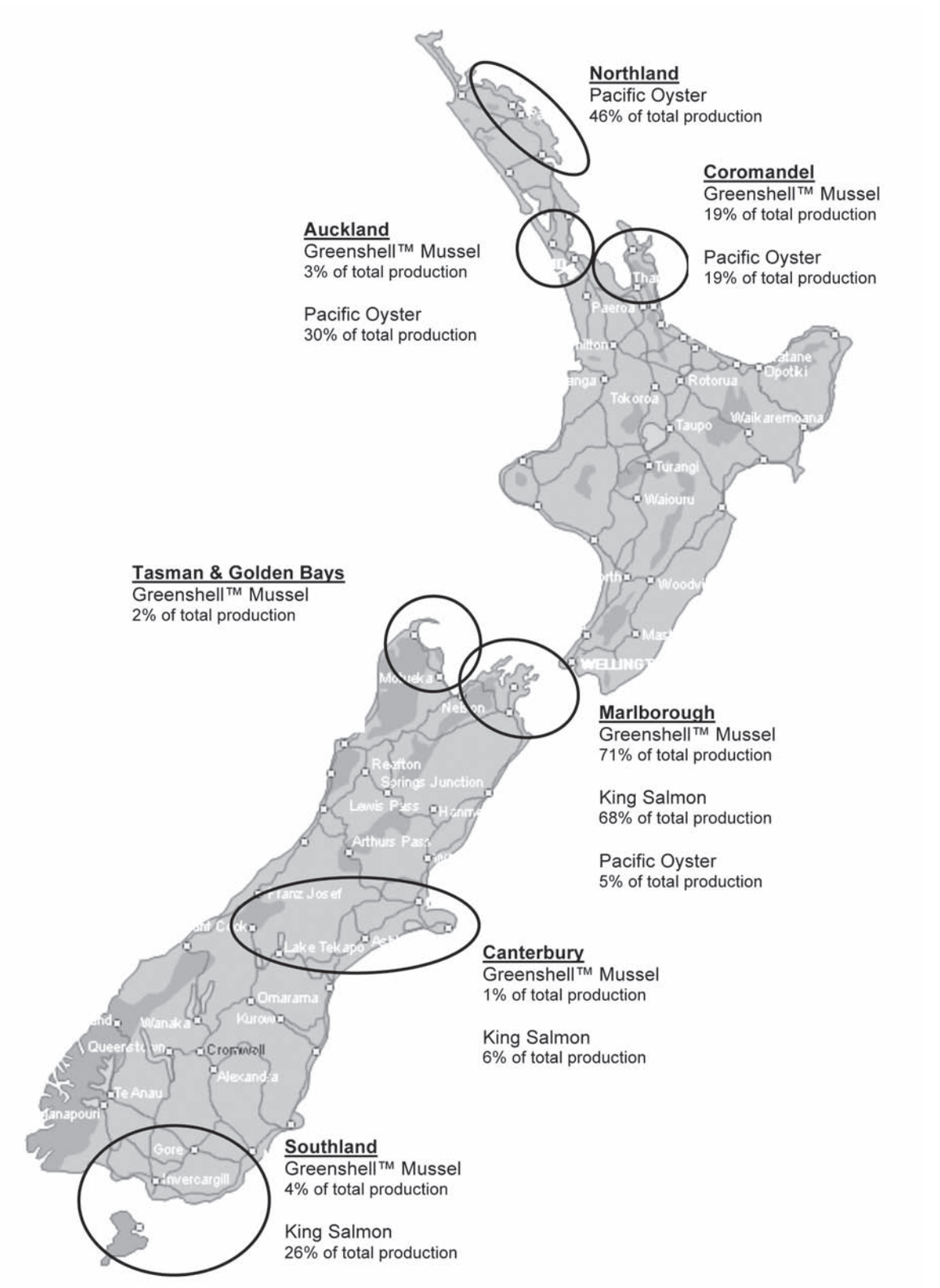
- Business-as-usual
- Gradual transfer of production into higher value end products
- An increase in permitted space and introduction of a new species
- Productivity improvements from currently known technologies
- Incorporating incremental adjustments.

The results of the study were that there were possible revenue ranges in the year 2025 of $623 million to $858 million for the business-as-usual case, through to $1,590 million to $2,190 million for the composite scenario. This provided us with the reassurance that we needed.

Business as usual was not an option for the sector if it wanted to reach a billion dollars by 2025. In addition, by focusing on a multi-factor approach then the billion dollar target was not only achievable but might, in fact, be on the low side.

Regulatory environment

Like most countries, the regulation of New Zealand's aquaculture sector is relatively recent. The following list sets outs a brief history of aquaculture governance and management in New Zealand


Northland
Pacific Oyster
46% of total production
Coromandel
Greenshell™ Mussel
19% of total production
Pacific Oyster
19% of total production
Auckland
Greenshell™ Mussel
3% of total production
Pacific Oyster
30% of total production
Rotorua
Tokoroa
Taupo
Tasman & Golden Bays
Greenshell™ Mussel
2% of total production
Marlborough
Greenshell™ Mussel
71% of total production
King Salmon
68% of total production
Pacific Oyster
5% of total production
Reefton
Springs Junction
Lewis Pass
Arthurs Pass
Franz Josef
Lake Tekapo
Canterbury
Greenshell™ Mussel
1% of total production
King Salmon
6% of total production
Omarama
Wanaka
Cromwell
Alexandra
Te Anau
Gore
Invercargill
Southland
Greenshell™ Mussel
4% of total production
King Salmon
26% of total production

1950s/60s	Harbours Act 1950
1964	Rock Oyster Farming Act
1971	Marine Farming Act (structures controlled under Harbours Act)
1991	Resource Management Act (RMA)
1993	Resource Management Amendment Act
1998	Independent review and government develop a paper outlining amendment proposals
2000	Aquaculture – Join the Discussion public consultation document
2001	Moratorium introduced
2005	Aquaculture Reform Act (2004)
2009	LECG report Review of Regulatory Regime for Aquaculture
2010	Cabinet policy decisions on new regulatory regime

Following rapid growth in the sector in the 1980s and 1990s and a general desire on both the part of industry and government to improve the regulatory regime, the government in 2000 embarked on a review of the regulatory system. This resulted in the Aquaculture Reform Act (2004). The Aquaculture Reform Act was in fact a package of legislation, which amended five Acts and created two new Acts –

- Maori Commercial Aquaculture Claims Settlement Act 2004
- Aquaculture Reform (Repeals and Transitional Provisions) Act 2004

Although the new legislative package did improve some elements of the regime for existing farmers, it was a complete failure in terms of helping the development of new space for aquaculture.

What went wrong?

So what went wrong with the 2004 reforms? There was a range of factors, which included –

- Misalignment of incentives to plan and regulate
- Aimed for one stop shop and ended up with two stop shop
- Lack of clarity about roles of central government agencies, territorial authorities and industry in the planning and consenting processes.

The new regime was complex, not necessarily a bad thing, but was unclear and messy which is a bad thing. Within a few years it became clear that the new regime was unworkable. This was evidenced by the fact that until now, five years after the regime was first introduced, there has not been a single application for a new marine farm under the new legislation. The new regime had misaligned the incentives for undertaking planning for aquaculture and the result was paralysis.

Following a series of independent reviews in 2009, the government is currently undertaking a new review of the aquaculture regime. A few weeks ago it released its high level policy decisions relating to the proposed new regime. The main direction of the new regime was summarised as in the box at the bottom of the page.

It is too early to say at this stage what the final outcome of this new set of aquaculture reforms will be. We are hopeful that it results in a regime that encourages investment in aquaculture and enables New Zealand to return to the growth path other OECD countries have continued on throughout our lost decade.

Research and development

Although an enabling regulatory regime is a critical component in achieving the sector's billion dollar goal, it will not get the industry all the way to its goal. Two other components are essential – innovation and marketing.

The New Zealand aquaculture industry was built on decades of on and off water innovation – from biology and animal husbandry through to engineering and post-production innovation. In order to promote a change in investment in research and development AQNZ worked with the sector to develop a research strategy. The strategy –

The reforms

The reform package aims to encourage investment in aquaculture by providing a clear role and framework for central government involvement, ensuring that national and regional benefits are considered in the decision-making process, and increasing investment certainty. Specific measures include –

- Identifying a Minister responsible for aquaculture
- Establishing a branded aquaculture unit within the Ministry of Fisheries (through reprioritisation of existing budgets) to be the government's principal advisor on aquaculture and lead implementation of the reforms.
- Broadening the range of factors the Minister of Conservation may have regard to in deciding whether a proposal under the Resource Management Act is nationally significant and should be 'called in' for national decision-making.
- Agreement in principle to establish a new regulation-making power to enable the Minister with overall responsibility for aquaculture to amend Regional Coastal Plans in exceptional circumstances where it is in significant regional or national interest.
- Developing a national aquaculture strategy and action plan to provide consistency, clear guidance and a unified programme of action for aquaculture development.
- Developing guidance material to help councils and the aquaculture industry operate effectively under the new regime.
- Requiring a 20-year obligatory minimum term for aquaculture consents; it is expected that most consents will be issued for between 20 and 35 years.
- Establishing a simplified and streamlined process for re-consenting existing aquaculture activity.

- Provides strategic long term direction for aquaculture sector research
- Identifies a set of research priorities
- Ensures availability of sufficient resources including funding and people

Some of the priorities include –

- Developing novel aquaculture products, systems and technologies
- Increasing the value of aquaculture products
- Maintaining and enhancing the productive capacity of aquaculture.

The strategy was developed in conjunction with industry, research providers and government. Over the past year the focus has been on working with government and providers to identify a set of long-term research programmes, which will be co-funded by industry and government. These programmes will include selective breeding of shellfish, commercialisation of finfish, and exploration of open water aquaculture.

Market development

Following the launch of AQNZ a four-year market development programme was established. The programme was based around a market development strategy and was funded by New Zealand Trade & Enterprise.

The purpose was to guide the marketing initiatives for the sector over the medium to long term. The goal of the strategy was to provide insight and focus for the sector to optimise its activities around –

- Building capability and cohesion across the sector
- Building value through greater margins of existing species and products
- Building value through higher-value products
- Identification of new species driven by market demand
- Strengthening the industry's position in accessing new markets.

The market development programme is now in its third year and has been successful. It has provided the sector with market research around identification of opportunities which exist from a demand perspective in the priority markets of the US, Australia and South Korea. It has identified key emerging consumer trends that will influence seafood consumption over the next five to 10 years.

A brand identity has been developed to help in repositioning New Zealand farmed seafood beyond the commodity status. The profile of New Zealand aquaculture products has been increased. A contestable fund is available that helps and accelerates commercial market initiatives of individual companies. This fund supports projects that will substantially increase returns from exports.

Environmental sustainability

Underpinning the strategy is a commitment to environmental sustainability and integrity. The market development strategy, which aims to position the sector's products as the world's best farmed seafood, recognises the importance of environmental integrity. Having the world's best farmed seafood means we need to have the best environmental management framework.

From an environmental management perspective, New Zealand aquaculture legislation and environmental codes of practice have been independently assessed by Global Trust Certification Ltd as equal to or the best in an international context. The main findings included in the report were –

- The codes of practice perform exceptionally well when compared to selected international or national standards and codes of practice.
- The New Zealand legal framework for the environmental protection of aquaculture sustainability can be characterised as well defined, provisioned and administered at national and regional level. It compared favourably with other legal frameworks that have been developed for larger aquaculture nations such as Norway, Canada and Australia.

Aquaculture relies totally on the aquatic environment in which it exists. This is why water quality and ensuring a low environmental impact are fundamental to the development of aquaculture.

Working towards environmental certification is another way we can ensure that our products are produced in the most environmentally sympathetic way possible. This includes maintaining a watching brief and participating in the development of best aquaculture practice not only in New Zealand but internationally. This makes sense from an environmental, sustainability and a business perspective. The purity, taste and environmental credentials of our products is all that separates us from our competitors. It is this synergy between environmental sustainability and business that makes New Zealand aquaculture unique.

The next 15 years

As can be seen, a lot of the past three years has been spent putting in place the foundations for the sustainable growth that will be necessary to reach our billion dollar goal. Of course the sector has not been standing still. During that time we have seen the Greenshell mussels become New Zealand's single largest seafood export, and growth in the value of Chinook salmon exports, all the more remarkable given the space constraints of the past decade.

Over the next five years we expect to see the three current species groups grow in value considerably as the benefits of law reform, investment in research and development and innovative marketing result in significant increases in export revenue to New Zealand.

In addition we expect to see a number of new products come on stream and a move towards greater added value and a focus on non-traditional product forms, including nutraceuticals. The combination of these factors means that the billion dollar target that the aquaculture sector has set itself is well on track to being achieved within the 2025 timeframe. It will make aquaculture New Zealand's next billion dollar industry.

Mike Burrell is the CEO for Aquaculture NZ

Julian Bevis

Traders and ships inextricably linked

The container shipping business is built on the international carriage of goods – whatever is good for trade is good for us. As a result we tend to have a lot in common with traders, importers and exporters. If their business is flourishing, so is ours. And in New Zealand, that means the container shipping industry and the country's primary producers are likely to share similar concerns.

Over the past 18 months, economic and environmental issues have been front and centre for all of us. This continues to be the case – and international trade is a major topic of conversation both for those looking to solve the world's financial woes, and those concerned with the conundrums of climate change.

Matters economic and global

The shipping industry is something of a bellwether for the overall economy. When times are good, and trade volumes are high, the demand for containers to transport both raw materials and finished products sees our industry thrive. However, when times get tough, we are among the first to feel the pinch.

Shipping's financial trials and tribulations have been well documented. Excess capacity, a function of both reduced trade volumes and a growth in total fleet numbers, led to unsustainably low rates and huge financial losses. It has forced all of us to take a good look at how we ran our businesses.

By the end of the year, the pall of gloom had lifted. Capacity growth was slightly less than had been predicted earlier in the year as shipping lines around the world cancelled or postponed the building of new vessels, and a greater than expected number of ships were either scrapped or laid up. Despite this, there is still a long way to go before rates on many routes return to a sustainable level.

Matters local

In New Zealand, that so-called sunset industry, agriculture, entered the third decade of a very bright and long-lasting twilight. Once again, the often criticised agricultural commodities proved the difference for the overall New Zealand economy.

Obviously, New Zealand has not been exempt from the effects of the global financial crisis, as noted above. However, people still need to eat. Trade volumes to the developing economies have in general, been less affected than trade volumes to the established markets of North America and Western Europe. These markets, and in particular India and China, are home to the emerging middle classes who are likely to become an increasingly important source of customers for New Zealand primary produce. Therefore New Zealand can afford some optimism as we move into the new decade.

Maersk has significantly revised its operational structure, both here in New Zealand and around the world, and is continuing to look for new efficiencies. So are our customers. And of course, the decisions our customers make on what they will ship, and from where, affect our plans as well.

The port sector

Thinking along these lines inevitably raises the subject of port rationalisation. This is a subject which has, over the past couple of years, moved from the shipping press to the business pages to the front section of the newspaper.

The trend for container shipping companies around the world to have larger vessels calling at fewer ports is well established. New Zealand currently has a large number of ports for the volume of cargo transported, and it would be impractical and uneconomic, for all of them to carry out the capital work necessary to accommodate the larger vessels coming into service around the world. The desirability of some form of rationalisation is clear.

Merge or not

The process of designing how that might work is altogether less clear. Creating, for instance, one hub port in each island let alone one national distribution centre as has recently been mooted, would place considerable extra pressure on road, rail, and coastal shipping networks. Putting in place the infrastructure to support such a change would require close co-operation between land transport modes, shipping companies, and local and central government.

Then there is the need to strike a balance between avoiding destructive competition, and maintaining or somehow substituting for the checks and balances provided

by having a number of competing suppliers. Take, for example, the reported exploration by the ports of Christchurch and Otago of a proposal to merge their operations.

While there would doubtless be benefits in such a merger, the share of the container market by these two ports would almost certainly give them the ability to exert a considerable influence on port prices. Like all businesses, the port companies have shareholders looking for a return on their investment. In the absence of some sort of control mechanism, it would be fair to assume that sooner or later costs to container lines would rise. Even more inevitable would be that these cost increases would be passed on to shippers.

The government has, quite understandably, expressed a preference to leave port rationalisation and associated issues such as the development of a coastal shipping network, for the market to resolve. It is a preference that has come in for some criticism from such unlikely allies as Maritime Union General Secretary Joe Fleetwood, Shipping Federation Executive Director Sam Buckle, and ex-Pacifica CEO Rod Grout.

Whatever is done, or not done, primary producers and associated businesses will be affected This will be as port users, as ratepayers, and as citizens interested in the economic and other benefits of having a successful working port in their home region – three roles that may not always be entirely compatible.

Matters environmental

Concerns over climate change and greenhouse gas emissions have been a mixed bag for New Zealand-based shipping companies and for primary producers here in New Zealand. The initial knee-jerk reactions calling for consumers, especially in Europe, to demonstrate their concern for the environment by buying local, were blunted. Research demonstrated that New Zealand apples, onions, lamb, dairy products, and other primary exports were more environmentally friendly than their northern hemisphere counterparts when the entire carbon life cycle was considered.

This research confirmed what our industries already knew. New Zealand primary producers are world leaders in environmental efficiency. Shipping is the most energy efficient form of bulk transport available.

Improved efficiency

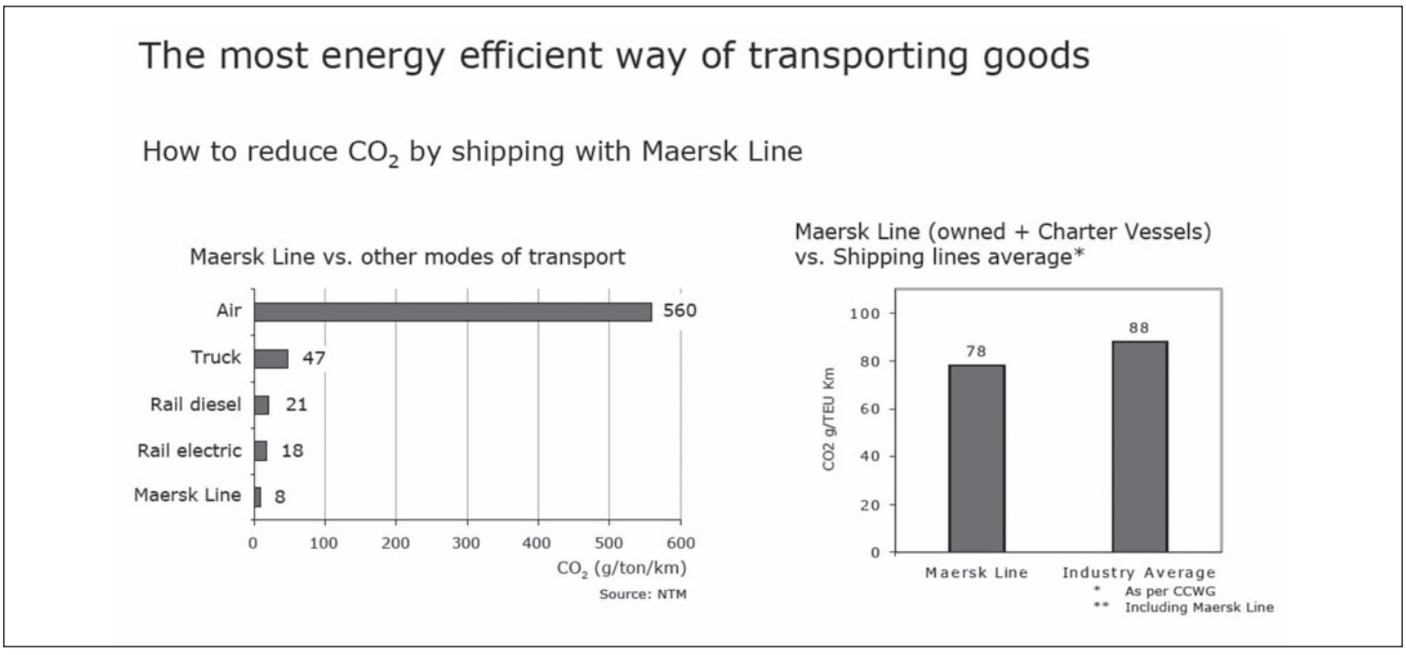
We need to build on this competitive advantage. The Copenhagen conference demonstrated the difficulty of getting inter-governmental agreement on such a complex issue. However the attention individuals and the media devote to global warming and to who is addressing the issue shows no sign of abating.

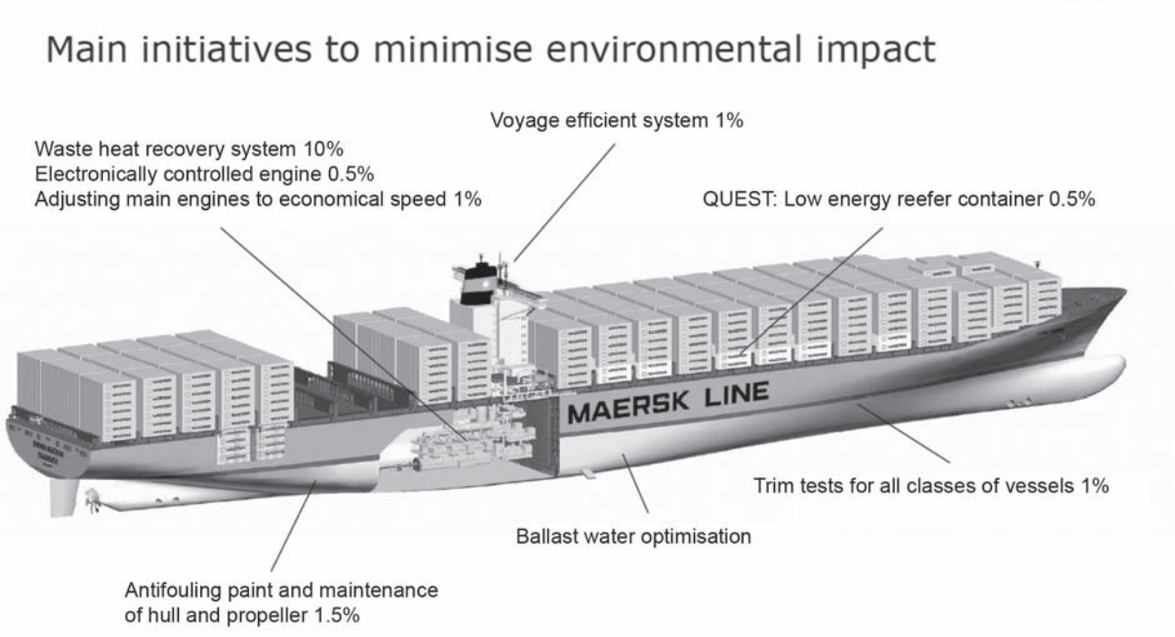
Direct financial benefits, such as a reduced fuel bill, or a more optimal use of fertiliser, are another reason for primary producers and shipping companies alike to continue to focus on improving efficiency. Maersk Line was last year named Sustainable Shipping Operator of the Year at the Sustainable Shipping Awards held in London. The award organisers cited the work the company has done to establish the savings potential of slow steaming.

Initiatives designed to minimise our environmental footprint cover the entire lifecycle of our ships, from energy efficient construction, to voyage planning programmes. These identify the most fuel-efficient route and emissions standards well in advance of International Maritime Organisation regulations, right through to Maersk's ship recycling initiative. Even the choice of paint plays a part in minimising friction and reducing fuel consumption.

The carbon check

All this benefits producers who are looking to lower the carbon footprint of their own goods. Maersk has also





developed a way for companies to map that footprint, and identify the most effective ways to reduce it.

The most common way of assessing a product's carbon footprint uses industry averages and a simplified system and the carbon check uses live data, and more detailed calculations to map a product's current carbon footprint. The Massachusetts Institute of Technology Centre for Transportation & Logistics recently concluded that the Maersk approach is up to 25 per cent more accurate than others available in the market.

The carbon check provides an excellent example of how the goals of primary producers and shipping lines are often aligned – and how sharing information with our customers can benefit us all. Scheduling offers another – the more accurately we can forecast demand, the better we can match supply.

New Zealand's economic history, present well-being, and future success, are very much a function of the primary producing sector. The shipping industry has a vital role to play in linking that sector to the rest of the world. It is important we work together to achieve the best possible results.

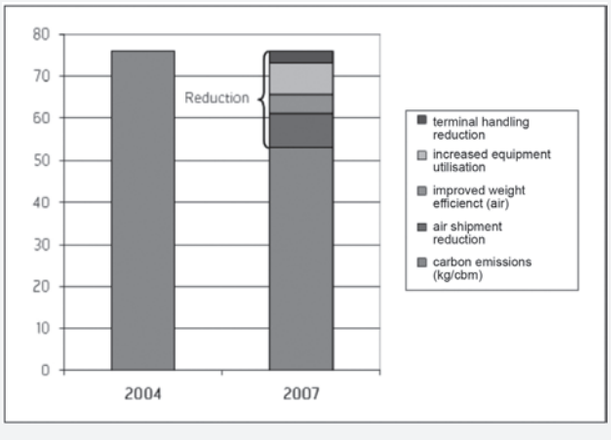
Julian Bevis is managing director of Maersk Line in New Zealand.

Boots cuts costs and carbon emissions

In 2004 Boots, the international pharmacy, health and beauty group set itself a significant environmental challenge – a 30 per cent reduction in carbon emissions by 2020. As part of this initiative, the company approached Damco, to see how it could reduce the emissions generated by its Asia to Britain supply chain.

The first step was to identify the existing level of emissions. Damco began by quantifying Boots' carbon footprint from ocean transport, aviation, trucking, rail, barge, port operations and warehousing. Then the company modelled a number of alternative supply chain set-ups, and evaluated the potential for each initiative to reduce emissions.

Based on these alternatives, Boots identified opportunities to reduce the percentage of cargo sent by air, improve container use by consolidating cargo, and increase the use of larger containers.



The results were impressive. Within three years, Boots had reduced their carbon dioxide output per cubic metre by 29 per cent. Along with that, the company was able to cut its supply chain costs by 21 per cent.

Tim Hale

Future for genetic modification animals in New Zealand

Genetic modification (GM), also referred to as genetic engineering, is being researched or used in numerous countries throughout the world. Acceptance is at a variety of levels, with many affluent countries having strong political and consumer resistance to this technology. Genetically modified crops for pest and herbicide resistance have now been grown for 13 years and the exploration of the use of animals to produce biopharmaceuticals has resulted in the approval of the first beneficial drug for humans.

In New Zealand researchers have been investigating GM in plants and animals for over 20 years. Most of this has been in the laboratory but applications for field testing in controlled situations have been approved during this period. The Environmental Risk Management Authority (ERMA) regulates any work involving GM and in the last 11 years they have given approval for the field testing of GM sheep, cows, brassica, onions and trees. All this work is undertaken MAF approved and supervised facilities. Each application in recent years has normally been challenged by those who do not want this type of research carried out for a variety of reasons.

Ten years of management

I have been involved with AgResearch's GM animal programme for nearly 10 years. I started out as the manager of the containment facility at Ruakura, and during later years as the operator for the facility. Before joining AgResearch I managed a commercial sheep and beef property, so while interested in science, I do not have a science background.

All of the GM animals at AgResearch that have been developed are kept in a facility that meets the MAF/ERMA containment standard for the field testing of animals. For the physical containment of cattle this requires a double fenced perimeter of two metre high netting meeting specific size requirements. This perimeter has to be alarmed on the interior fence to detect attempted escapes and gates are required to be hung a specific way and kept locked.

All animals are currently required to be double tagged and identified with a micro chip, animal locations are required to be recorded and numbers verified regularly. Access to the facility is restricted and animal treatments and manipulations are required to be recorded for all animals, along with genetic records, births, deaths and the quantities of products produced.

Main entrance to ACF at Ruakura

GM cows with recipients and heifers behind

Under the current ERMA approvals any developed GM animals, their progeny or any non GM animals we use as recipients are restricted to this facility, with further specific controls stipulating many requirements. Animals or any resulting products are prohibited from entering the food chain.

Current AgResearch programme

AgResearch applied to ERMA in 1998 to genetically modify cattle with three specific modifications –

- Add extra cattle casein genes,
- Remove or disrupt the beta-lactoglobulin gene (BLG^{minus})
- Add the human myelin basic protein gene (rhMBP).

The first two were approved in 1999 and the rhMBP was approved in the year 2000 following a requirement for further consultation because of the use of human genes. An application was also made to add the myostatin gene to sheep and was approved in 2000. A further broader development approval was gained in 2002, again specifically for work with cattle. AgResearch also has applications with ERMA, either in progress or on hold, to continue work with cattle and expand the programme into other species, with initial indoor work on goats being recently approved.

Nuclear transfer

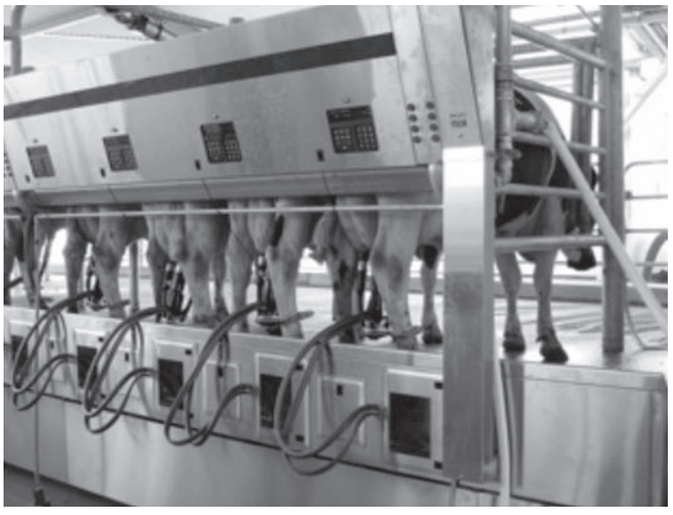
The method used by AgResearch to generate the initially developed or founder GM cows is that of somatic cell nuclear transfer, known as SCNT or commonly NT. The same process is one of the methods used to clone animals. However GM also involves the removing, modifying or adding of genes to or from an organism's DNA to delete, change or incorporate specific characteristics.

With nuclear transfer this is done at the individual cell stage. This method is acknowledged to be very inefficient in the generation of founder animals, but those that are born have grown in most cases to have normal productive lives within the facility. Subsequent progeny perform as you would expect line bred cattle to perform.

Adding casein genes is a model to show you can alter the functional properties of milk by enhancing the expression of casein protein. Higher levels of casein are beneficial in cheese making, but being food related this is not likely to progress beyond the research phase in the near future. There are now three generations of cattle which have matured to milking age and all positive animals are producing as expected for the modification. Founder cows have passed the modification to subsequent progeny using normal breeding techniques. This programme has successfully achieved the initial science targets of altered expression in milk and stable modification in subsequent generations.

A challenge

Removing the beta-lactoglobulin gene is also related to altering the properties of milk, but has proved more challenging, with no live cattle produced for this. This project



is targeted at reducing the lactose levels in milk, of nutritional benefit to those who are unable to drink milk as a result of lactose intolerance, so if eventually successful would have nutritional benefits.

Adding rhMBP genes is also a model to show you can produce a recombinant human protein in cow's milk. Cattle transgenic for rhMBP are shown to be producing that protein when the milk is tested. Initial work with founder animals has provided rhMBP milk for purification, with the resulting purified product then being used by a collaborating partner in trying to find a treatment for multiple sclerosis.

This is a medically related result and this type of modification is now the focus of AgResearch research programmes progressing under the newer approval. If taken further in production or commercialisation stages it would be known as biopharming or the production of biopharmaceuticals.

Adding the myostatin gene was aimed at improving muscle size in sheep, providing more meat per carcass for processing. Like the beta-lactoglobulin project this also did not progress beyond the laboratory and a decision was made to let this approval lapse at the approval end point.

Future direction – biopharming?

As identified above, AgResearch is aligning the current GM animal programme with the production of proteins which will have a medical or human health application rather than as a basic food product. Research by AgResearch social scientists and others has clearly identified a much higher level of acceptance for GM if it has medical benefits.

My own research for a Kellogg rural leadership project also confirmed this view. It is also anticipated that the production of biopharmaceuticals will require smaller numbers of animals in specialising facilities than those that would be required for the production of standard food products. A change in focus could easily occur if acceptance levels change around GM food, given the possible solutions to some of the disease or environmental challenges New Zealand farmers face.

The biopharming farm

I have briefly described the regulatory requirements in New Zealand for GM. It is probable that these requirements or similar will be required for a biopharming operation whether for animals or plants. This would be the case unless a full public consultation process, along with the comprehensive safety or environmental effects studies required for a full release application to ERMA, are completed.

Biopharming will generally add extra requirements above these regulatory requirements specifically related to the product. Farm animals are probably going to be required to be managed in a good laboratory practice or similar environment. There is a possibility that animals will require specific diets, have feed available analysed, intakes monitored or be housed in controlled environments. Raw material collection such as milk, will need to take place in good manufacturing practice compliant facilities, as will further processing.

Avoid contamination

Important areas of concern in this area are the ability to avoid contamination of the product at all stages and by this, to be able to satisfy the necessary levels of purity and to to provide traceability via audit trails. Accurate records for all individual animal treatments are critical for this to be achievable.

If approval to release is obtained, the potential for products derived from GM animals to be available for use or consumption will need compliance with NZFSA, FDA and other similar global regulatory authorities. While most of these products will be further processed before availability, traceability will again be critical to maintain consumer confidence and clearly provide the opportunity for choice.

Some of the requirements are extra and more specific to this type of operation. However many are also similar to those that are required to meet processor supply requirements or recording requirements under the Animal Welfare Act which are now required of all farmers.

Specialised farms

The biopharming farm will most probably be owned by a corporate or specific biotech company, which is in a sense self-contained. This would have to be the case while operating under any ERMA approvals as these are generally specific to an applicant. It may be a sub unit of a larger operation, but will be very small when compared with today's farming operations, for both operational and risk management purposes.

Because of the specific requirements related to what is being produced and hopefully their value, any biopharming operation will mean that in most cases they will need to be secure segregated facilities. Farm operations or management would ideally be similar to the point of harvesting, but that is where the similarity to conventional farming operations would in finish. Purification or processing facilities could be on facility or elsewhere, but again are expected to be specialised plants rather than mainstream because of purity requirements.

Relative to this and the associated expense of carrying out the required process for approval, it would be quite logical that, whatever is produced in a commercial GM animal or plant operation will be acceptable to the market it is intended for. Of those working with GM in New Zealand, AgResearch is probably the closest to moving towards this type of operation. This will only be able to happen when current or new applications in process with ERMA have successfully completed the approvals process.

Risk mitigation

It will not be possible to operate a biopharming operation outside a containment facility under current legislation, unless as stated previously a release approval has been gained for the GM animal or plant. Containment facilities are approved and supervised by MAF Biosecurity. For large animals the MAF/ERMA Standard 154.03.06: *Containment Standard for Field Testing Farm Animals* will be used.

The first part of this standard outlines the requirements for the approval of a facility and an operator. Applications for approval of a facility site are submitted to MAF Biosecurity who act as supervisor for these types of facilities. It will contain information which –

- Identifies the facilities intended for use, the species and capacity
- Has plans of the proposed facility and description of how the structural requirements of the standard will be met
- Includes a site plan which shows the physical location, and identifies entry points and boundaries of neighbouring properties
- Has evidence of consultation with neighbours and that they have no unmanageable objections
- Has evidence that the proposed facility complies with all local or regional council requirements.
- Includes a recommendation from the assigned MAF Biosecurity supervisor.

Approval of a facility site is given in writing to the designated facility supervisor by the Director-General of MAF or his delegate, who will also approve in writing the operator for a facility. Actual facility approval does not occur until after the supervisor is satisfied all requirements of the standard have been met and recommends approval. These requirements highlight that to set up this type of operation will require substantially more than just locating a suitable piece of land and putting the correct infrastructure in place.

Secure and suitable

Maintaining and controlling viable livestock is a critical part of any agricultural operation in which animals play the main role. Efficient, profitable farming is based on management systems which keep livestock secure and enable best use of resources. Every non productive loss of an animal has an effect on productive output as well as on the bottom line.

continued on page 40 >>

Peter Fennessy, Peter Amer, Neville Jopson, Jude Sise, Tim Byrne and Simon Glennie

Current issues and future directions for sheep breeding

Genetic improvement is a major contributor to the improvement in productivity in the New Zealand sheep flock. From the late 1980s, the productivity of the New Zealand ewe increased at a compound rate of around three per cent a year over about a 20 year period. This improvement in productivity was due to advances in both genetics and management. Our estimates indicate that both contributed about equally.

While genetic gain can appear to be quite slow, providing that it is focused on economically-important traits, the benefits are cumulative. Therefore a reasonable genetic gain of 2.5 per cent a year represents a doubling of genetic merit in less than 30 years. Before considering some of the current issues, and then looking at possible directions in genetic improvement, there are several issues that need clarification.

Clarifications explained

Assessment of genetic merit

Effective genetic improvement means that we can estimate the proportion of an animal's superior performance which is due to genetic factors – its genotype. In essence, superiority is due to a combination of genetic and environmental factors along with the interaction of the animal's genotype and its environment. The phenotype of an animal refers to its actual performance.

For example, an animal that is born earlier in the season has an advantage over one born later, and a single animal has an advantage over a twin or triplet – these are environmental factors. If an animal has superior genetic resistance to internal parasites, but never gets challenged because it is routinely treated with anthelmintics, it cannot reveal this superiority.

However if the animal is not treated or there is drench resistance within the flock, the individual's own genetic resistance can be appear. These are examples of genotype by environment interactions.

Genetic evaluation schemes

In New Zealand, Sheep Improvement Ltd (SIL) operates a genetic evaluation scheme and produces breeding values for rams. A breeding value simply expresses the superiority of one ram over another in terms of the particular trait, such as live weight gain or resistance to internal parasites.

Generally these traits are combined and expressed as an economic index, which is an estimate of the overall economic breeding merit of an individual animal as a parent. The economic value of a trait depends on the production system. Therefore SIL uses a number of indices for different systems. For example, the terminal sire index describes a system where all progeny are slaughtered. The dual purpose index describes a system where ewe lambs are retained as replacements for breeding. SIL indexes are expressed as cents per ewe lambing, except for the terminal indexes which are expressed as cents per lamb born.

Select for genetic improvement, cull for productivity

Selection of rams is the most effective means of ensuring genetic gain. This is because one ram can easily settle a hundred or more ewes and so rams can be very highly selected.

In contrast, in a practical situation, a farmer can have little genetic effect by selecting ewes, as the vast majority are required to maintain flock numbers. However at the flock level, culling of poor performing ewes or culling of replacements on bodyweight can have a major immediate effect on productivity and profitability.

Genetic improvement is not simple

The operation of an effective genetic improvement plan is non-trivial. The most effective schemes internationally involve large populations which are well connected genetically so that the performance of an individual male in one flock can be compared with that of another male in another flock. Such genetic connectedness between flocks is needed to be able to compare the genetic merit of animals born in different flocks and run under different conditions. It is achieved by sharing rams within and between years.

This requires breeders to invest in schemes that enable

the analysis of the performance of individuals within the flock to produce robust estimates of genetic merit including across-flock comparisons. In the case of sheep in New Zealand, this is managed by SIL which is supported by levy funds and user fees. SIL also provides data for genetic trends which show how successful breeders have been in making improvement.

Current issues

The major push for genetic improvement in the sheep industry is to increase the rate of genetic gain and improve profitability. The most effective means of increasing genetic gain in the national flock are to –

- Increase the uptake and use of superior genetics by farmers
- Increase selection pressure in ram breeding flocks
- Focus genetic improvement on traits that are going to continue to make a difference financially
- Ensure that superior animals are capable of performing in the commercial environment
- Capitalise on the genetic variation present within the national flock due to the diversity of breeds.

Increasing uptake

The benefits of genetic improvement are much more difficult to grasp for sheep farmers than for dairy farmers. The latter have a history of seeing the benefits of genetic improvement from the use of artificial insemination so that the superiority of artificial insemination sires is evident in terms of production of individual cows. The superiority is apparent because of the very high selection pressure on bulls that is enabled by using artificial insemination and progeny testing. In addition there is the immediacy of feedback that is evident when the production of cows is recorded regularly.

In contrast sheep farmers are dependent on very indirect evidence of genetic progress. These include increases in lambing percentage, faster rates of weight gain and the ability to grow lambs to heavier weights without becoming over-fat, as well as evidence provided by breeders and SIL. Therefore accepting statements that breeders are making genetic progress involves an act of faith.

However in some situations farmers can see the evidence in traits that have a profound effect on phenotype. Two good examples are the muscling genes and bare points, and consequently farmers will readily accept that these traits will provide benefits.

Increasing selection pressure

The major opportunities lie in increasing the size of ram breeding flocks, improving the genetic connectedness between ram breeding flocks, and better use of technology. Increasing the size of flocks enables much greater selection pressure on sires. The assessment of genetic merit involves statistical approaches. The accuracy of estimation of an individual's merit is much less than the accuracy of assessment for a group of individuals. Therefore genetic progress by using a group of sires is much more reliable than that that would be achieved by using a single sire. In addition, larger flocks enable much higher ram to ewe ratios as the risks of sire failure are much less important.

The SIL advanced central evaluation (SIL-ACE) is made possible by genetic links between breeds generated by both breeders and the Alliance central progeny test. Therefore the Meat & Wool NZ and Alliance Group investments in the scheme have helped the improved genetic connectedness between flocks.

SIL-ACE is New Zealand's national flock and breed evaluation to identify the best rams for economic traits. Ram breeders provide permission for their flock to be included, and the flock also has to satisfy specified criteria. This includes recording on SIL, and having appropriate genetic links. External rams are listed if they have been used in SIL-ACE flocks and have sufficient progeny evaluated.

Other technological opportunities include the use of CT scanning which has been used by Landcorp Farming to select for carcase and growth traits since 1996. A number of other breeders are now adopting this technology. The evidence of its value is apparent in the ranking of Landcorp sires in SIL-ACE.

The use of Animate, a software tool developed by AbacusBio, to minimise inbreeding is a simple effective means to maintain high rates of genetic gain. The application of genetic marker technology, developed by Ovita, a research consortium with AgResearch and Meat and Wool NZ, and commercialised by Pfizer Animal Genetics, offers considerable benefits, especially for specific traits such as muscling.

However the greatest effect to date has been in the use of Shepherd, a DNA-based scheme to define parentage. This has enabled breeders to greatly increase the scale of their operations as it has eliminated the need for shepherding to record dam-offspring relationships. The development of the single nucleotide polymorphism-chip technology will offer greater gains in the future.

Focus on important traits

The importance of a focus on valuable traits cannot be underestimated, as dilution of effort in genetic improvement programmes is a costly exercise. Therefore the focus should be on traits that are both economically important and responsive to selection. That is, they are sufficiently variable and the heritability is sufficiently high, or in other words, the traits have a high genetic variance.

One important group of traits are those that reduce costs. For example, a reduction in costs of inputs, such as animal health costs, or a reduction in animal wastage and a reduced requirement for replacements. Another important group of traits are those that increase animal performance or productivity, such as increased weight gain or improved lambing.

A further group includes those that effect product quality, such as reduced fatness or increased muscling. In respect of animal performance, a valid question is how far

can or should we attempt to increase ewe fecundity, especially considering the fecundity and survival conundrum?

The selection of a ram breeder is a decision that is far more important than the selection of an individual ram from within a breeder's flock. The track record of the performance of a particular breeder's rams on a farm provides the best evidence of their ability to perform in that environment.

Capitalising on genetic diversity

The New Zealand sheep population is relatively diverse, with a range of breeds and a relatively large number of sires in use especially when compared with the dairy cattle population. The value of that diversity has been especially evident in the development of the composite sheep strains. The Texel, East Friesian and Finnish Landrace breeds have all contributed specific characteristics along with contributions from the traditional ewe breeds such as the Romney, Coopworth and Perendale.

That diversity is also being exploited in the use of terminal sires where both the specific breed contributions, such as specific muscling genes and higher growth rates, and hybrid vigour contribute to a positive outcome. However it could be argued that terminal sires are under – used by farmers as they tend to over-mate ewes to dual purpose breeds to produce replacement ewe lambs. The recent importation of Ile de France with an extended breeding season, and the Charolais with high growth rate and yet another muscling mutation, offer further opportunities to devise effective ways of exploiting this genetic diversity.

Directions of influence

Despite the improving productivity, the New Zealand sheep industry cannot survive except by extracting a larger proportion of the value achieved in the market. Lamb is already a premium product so that we are unlikely to see higher prices in many markets. However this premium status and the extraction of a higher proportion of the final value will not last because we need it Consumers have to continue to want the product and the supply chain can be modified to return a larger share to the farmer probably via a more direct supply route.

Should this occur, we can expect a much greater focus of genetic improvement on meeting specific market demands although we will not be able to neglect pressures to improve productivity. The following are some directions and factors that we believe will influence our approach in the future –

- A focus on both productivity and the market
- Less control of the commercial farm environment
- The need for data.

A focus on productivity and the market

While one aspect of the focus of genetic improvement is expected to move to factors that are important in the market, productivity cannot be neglected. Market factors include consistent quality, especially with respect to flavour and tenderness, and a product that meets consumer expectations with respect to farming practices such as carbon footprint, animal management and environmental management. In this respect, aspects of the carbon footprint and animal management are amenable to genetic approaches.

Increasingly on the international scene, genetic improvement schemes are looking at approaches that will reduce the carbon footprint associated with meat and milk production. In New Zealand, resistance to internal parasites, which enables a reduction in chemical use, has been a target for many breeders for almost two decades.

Many traits are relevant to both a productivity and market focus. For example, larger carcases provide meat processors with more options, while also potentially improving productive efficiency, as long as the feed supply can be managed without significant increases in cost. Given the need for lambs to be less than a defined age at slaughter

and a need for year-round supply for some markets, there is a demand for sheep with a longer breeding season. Therefore some breeders are now pursuing selection for out-of-season breeding. In this respect, the recent importation of the Ile de France breed offers new possibilities.

Less control of the commercial farm

Sheep farming can only maintain market supply in the face of an ever-expanding dairy industry. There are also and increasing cost pressures from greater productivity and intensity in farming areas where control of feed is often challenging.

Potentially extreme weather conditions in the winter and at lambing also contribute to a need for sheep that are robust as much as they are productive. In this respect, some of the most progressive and highest performing sheep breeds have not enjoyed the market share that might have been expected based on productivity alone. This may reflect a suspicion that they do not perform up to expectations in tougher environments, an example of a genotype by environment interaction.

However, there is a lesson for the breeding industry that adaptability and robustness have an important role to play in the commercial sheep farming environments of the future. But the question remains – how do we identify the animals that are performing in large-scale commercial operations to provide guidance to our breeders? Recent developments, where some large scale breeding operations are focusing their breeding programmes in more rugged farming environments, reflect recognition of the importance of this robustness.

The focus on new traits that can only be measured on slaughtered animals is encouraging approaches to collect data at the processing plants, and even in the market. At present this requires full product tracking with animals identified on the farm through the processing plant and potentially right through to the market, which is a very complex task. However new developments in electronic identification with ultra high frequency tags, and rapid developments in software and logistics systems mean that the barriers will be overcome. The fundamental problem of defining the genetics of the individual remains and at present this must be integrated with the identification system.

In the longer term with reductions in the price of DNA technologies, it will be possible to reconstruct genetic relationships or pedigree on any individual animal. Therefore large scale genetic of evaluation or progeny testing of rams would become feasible under commercial farming conditions. While this will be of considerable value for productivity traits, it will provide the opportunity for direct feedback from the market to the processor to the farmer to the breeder to become a practical reality.

General conclusions

The New Zealand sheep industry is in a very difficult situation with relatively low prices and increasing costs. Genetic improvement is fundamental to improving productivity. Increasingly market demands will focus genetic improvement more directly on factors that are important in the market. This will require a much more integrated system to enable the simple collection of relevant data.

>> **Future for genetic modification animals in New Zealand** continued from page 36

Biopharming operations will, in reality, have even higher value livestock and the effects of poor management or animal loss will be greater. So even if GM animals were able to be farmed outside a containment facility it is highly unlikely they would be farmed in an environment which was not secure or suitable.

General conclusions

Realistically it will be some time before GM moves out of controlled facilities or situations in New Zealand. Work with GM is still in the research phases and it will be a few years before it moves beyond this to commercial viability.

It is my view that the people working in this field are as concerned for the environment or the welfare of animals as the majority of New Zealanders are – the last thing they want is detrimental effects. In the 10 years the Ruakura facility has been operating we have not identified any detrimental effects on the environment.

Strict regulations

New Zealand has one of the strictest regulatory environments in the world with rigorous investigation and compliance a requirement at all stages. This gives credibility to the results achieved and the safety of any approved products. As a country New Zealand may choose not to allow GM outside secure facilities, but as with previous agricultural expertise, we may be able to develop and then supply other countries with solutions or animals.

New Zealand is in a unique position. Our arable or animal farming is affected by few, if any, of the major identified problems of overseas environments, so there is no need for the use of current GM crops in New Zealand. Worldwide, the farmers who have chosen to use them would not have if they were unable to market the produce resulting from their plantings.

Whether to use GM or not is still a very politically charged question in New Zealand, with science being pitted against beliefs and emotions. As identified by a senior AgResearch scientist we are currently looking for tools for the tool box, not solutions to be imposed on all. What is needed is more open discussion and wider distribution in lay language of what is happening with GM and what could be realistically achieved if possible modifications are successful.

Chris Murphy

Comparisons between Australian and New Zealand advisory systems

Since relocating to New Zealand in February I have frequently been asked for a perspective on the similarities and differences between the two countries. Comparisons between dairy farming in both countries have been well documented, so the focus of this article is to contrast the dairy advisory systems in both New Zealand and Australia.

The article presents my personal perspective gained from involvement in Australian dairy extension over the past 20 years and frequent visits to New Zealand before moving here. There are a number of significant differences in how dairy advisory services are organised in both countries at present. However the challenges faced in either Australia or New Zealand around providing future services are remarkably similar.

Australian advisory resources

Australian public good dairy extension is predominantly levy funded through Dairy Australia, with varying levels of state government funding contributions. Dairy Australia's total funding in 2008/09 was equivalent to $66 million (New Zealand dollars). Of this sum $36 million came from dairy farmers and $24 million was contributed by the Australian tax payer through the Research & Development Corporation model with an additional $6 million of other income. Approximately a third of this total budget was allocated towards extension and programme development.

Over the past two decades, state government funding for public service advisory services and extension in Australia has declined. This has been a result of the reduction in the prominence of agriculture, coupled with state government budgets that have been under pressure.

When allocating funds, agricultural extension has been a less compelling political option compared to funding hospitals, police and infrastructure. There was also a shift by governments from productivity to sustainability priorities. For example, the New South Wales government claimed they were spending more on extension in 2002 than in 1992. However the majority of this funding was going into catchment and environmental projects rather than productivity related services.

These pressures resulted in a range of responses by individual state governments. Some governments chose to withdraw completely from funding dairy advisory and extension services, as was the case in South Australia during the 1990s. Dairy farmers in that State were then reliant on private sector provision of advisory services and the majority of extension activities.

Joint ventures

Another approach by state governments was to form joint ventures with industry, as has been the case in Victoria and Tasmania. Australia is characterised by a diversity of advisory systems that vary on a state by state basis, so I will focus on the most significant of these from a dairy perspective.

The Dairy Extension Centre (DEC) was established in October 2005 and is a collaboration between the Victorian Department of Primary Industries, Dairy Australia and more recently, the South Australian Department of Primary Industries and Resources. The DEC is supported by funds from these three organisations along with other state and federal governments, catchment management authorities and other dairy industry funding sources.

DEC funding is on a rolling three-year basis with a total annual budget of more than $8.3 million. The Victorian Department of Primary Industries is the largest funding source, contributing about half the DEC's income with about a third of the income coming from industry.

As at June 2009 there were 53 dairy extension staff making up 45 full-time equivalents, covering approximately 5,800 dairy farmers in Victoria and South Australia producing 72 per cent of Australia's milk. Priorities for extension by the DEC are a combination of top down from the two major funders, Dairy Australia and Victorian Department of Primary Industries, and bottom up from stakeholders in each region. Each of the four regions covered by DEC has a regional extension committee structured to guide the strategic direction of the dairy programmes in that region.

Each regional extension committee is comprised of farmers, rural professionals, dairy company staff and dairy extension staff. The highest priorities identified recently were profitable feeding systems and dairy nutrients programmes.

Benefits and challenges

This joint industry government model has a number of major benefits. The government is more likely to commit to public-good extension funding when an agricultural industry is also contributing significantly. For some industry sectors, such as beef and horticulture, where industry funds have not been partnered with state governments in this way, there has been a rapid and severe reduction in publicly-funded extension and advisory services. The DEC model provides a higher level of certainty of funding tenure, as it is based on a three-year horizon rather than annual funding rounds. This reduces staff turnover and creates an environment where innovation in delivery has more opportunity to flourish.

The joint industry government model also has a number of challenges. One of the potential areas of tension is between major funding providers and ensuring that their needs are met, based on their respective areas of focus and strategic direction. Ultimately the decision really sits with the government.

For example, some of the Victorian state government's priorities are managing environmental risks, adapting more sustainable farming practices and building resilient rural communities. Whilst industry endorses these priorities, it is important that the emphasis of dairy advisory services on helping farm businesses to become more productive and competitive is not overshadowed.

At an operational level, DEC staff members remain Victorian government employees. While the dairy industry makes a substantial contribution to their costs, they are required to meet their employer's obligations when government priorities, such as emergency response activities, may take priority over day-to-day extension.

New Zealand advisory resources

It is difficult to accurately compare resources directed towards public good dairy extension in New Zealand and Australia. However, over $7 million is invested directly by DairyNZ in a team of 38 consulting officers and regional leaders, with development activities identified and supported separately. New Zealand has a number of advantages that enhance the effectiveness of dairy advisory services compared to Australia.

First, the regional team structure of consulting officers and regional leaders, funded directly by levy funds has significant advantages over the Australian joint industry-government model. One funder in DairyNZ, with a clear and consistent strategic direction, ensures that the consulting officers are focused on industry results as opposed to a combination of potentially conflicting government and industry priorities.

The effectiveness of the consulting officers is enhanced by having only one master. However, increased external input could be valuable. In the same way DEC uses regional extension committees to guide the strategic direction of the delivery of dairy programmes at a regional level.

Secondly, the dairy advisory sector in New Zealand, both rural professionals and consulting officers, has access to much higher levels of support compared to their peers in Australia. This is evident in the number of high quality resources such as tools, fact sheets and templates that are publicly and freely available. Development, administrative and event support teams provided to consulting officers for their extension activities would be the envy of dairy extension staff across the Tasman.

Thirdly, and not inconsequentially, the absence of State governments in New Zealand means there is much greater consistency within the dairy advisory approach across the whole country. This can be compared with Dairy Australia's requirement to deal with six individual State governments. They have enormous variation in funding availability and commitment to dairy advisory services.

Collaboration and leadership

The dairy industries in both New Zealand and Australia have traditionally had cooperative cultures, and collaboration is central to the way the dairy advisory systems operate in both countries. However, the Australian dairy industry appears to have moved to a more highly developed collaborative approach than that observed in New Zealand. Collaboration is obviously evident in New Zealand, but just at a different level.

The considerable challenges faced in Australia over the past 10 years which include market deregulation, milk price volatility, droughts and feed shortages, have all contributed to a enhanced culture of collaboration. The Dairy Moving Forward programme initiated in 2003 in Australia, as a consequence of a one-in-a-hundred year drought and low milk prices, resulted in a new level of collaboration throughout the supply chain and which has since been maintained.

Effort needed

Ultimately, the problems facing the Australian dairy industry were bigger than any one organisation, and required an unprecedented effort to coordinate the industry for the benefit of the farm sector. While tongue in cheek, there was a sense from all partners in the Australian industry that they must 'not waste a good crisis' to achieve change on farms.

Evaluation of the Dairy Moving Forward programme found there was strong evidence that dairy industry organisations were making better use of their resources because of collaboration. Many of those interviewed thought that by sharing skills, expertise and industry information, and co-investing in project development, the limited resources of the industry were put to more effective use.

Besides the adverse conditions in Australia over the past decade that gave little option but to boost collaboration, there are other factors that provide the impetus and infrastructure for this way of acting to thrive. One is that Federal and State governments have given clear direction that rationalisation of research, development and extension services are inevitable, and collaboration as a modus operandi is non-negotiable.

This is evident in the national development of an agreed pre-farm gate research and development research and development strategy which involves all key dairy industry organisations. In addition, the independent regional development programmes, organisations that are part-funded by Dairy Australia, provide the regional leadership, networks and infrastructure for a collaborative culture.

The conditions for, and conduct of, collaboration is more advanced in Australia. However the picture of what the dairy industry is seeking to achieve overall is clearer in New Zealand.

The Strategy for New Zealand Dairy Farming released in April 2009 sets the direction for the next decade and guides industry investment and action across DairyNZ, dairy companies and Federated Farmers. The strategy provides clear targets and measures of success that give specific direction to those providing advisory services and extension support to dairy farmers. It is notable that this is an industry strategy that depends on effective partnerships, rather than a strategy for an individual organisation or government agency.

Challenges for both countries

A focus on the future is critical and the greatest threat to the advisory services of both countries is complacency. Dairy farmers in Australia and New Zealand are facing an increasingly complex operating environment, more than at any time in the past 20 years, with marked increases in the volatility of movements in markets, input costs and farm profitability. Complexity is also being driven by environmental imperatives. The dairy industries of both countries will be challenged to develop and maintain the advisory capability required to manage change with this increasingly complex and diverse situation.

The competition for skilled people is not just an issue on farms but is increasingly an issue for industry advisory services. Capacity building is imperative and there are concerns on both sides of the Tasman that people with advisory and extension capability are ageing and that the pool of talent to draw on may be declining.

Capacity building has got to be adequately aligned with future industry needs. Training and development of the advisory sector must not only cope with the challenges of today but be well-positioned to adapt to future requirements. If existing capacity is inadequate to begin with, either as a function of staff numbers and capability, then the degree of challenge escalates.

Evaluation and the future

A much stronger emphasis on evaluation is more important than ever. The dairy advisory systems of both countries now operate in a more accountable and competitive environment, so they must be able to demonstrate to farmers, funders and partners what effect they are having. The dairy industry must also improve collecting, analysing and using information to improve develop programmes, products and services.

Finally, the dairy advisory systems in both Australia and New Zealand need to define the methods and activities we require to achieve the results specified by industry leaders. The tendency to rely on historic models of extension and advisory services is consistent with human nature – our tendency to stick with what we know.

However, a workshop in 2009 looking at future directions for the Dairy Extension Centre concluded 'that it would be unwise for DEC to simply continue what it does now'. There is much in the past that we should retain and refresh but we need to not be complacent in rethinking extension approaches.

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Gwyneth Verkerk

The dairy cattle Code of Welfare

On 19 February the Minister of Agriculture released the 2010 Code of Welfare for dairy cattle. This event generated a small flurry of media attention at the time. Whether it made it on to the radar of most of those working at dairying's coal-face – the farmers and stock managers who have direct responsibility to care for our 4.5 million milking cows and supporting livestock – is another matter. The document itself is the culmination of several years of work for those involved in its genesis, but perhaps the more important question now is about what should happen next.

What are Codes of Welfare?

Codes of welfare are tertiary level regulations under the 1999 Animal Welfare Act. The Act sets out the fundamental principles of animal welfare law and includes provision for the development of codes by the National Animal Welfare Advisory Committee (NAWAC). The composition of this committee is defined by the Act and must represent the views of the New Zealand community. Nominees are from backgrounds in veterinary, agricultural and animal sciences, commercial use of animals, ethical standards and conduct, animal welfare advocacy and the public interest.

Codes were envisaged by the law-makers as a means of establishing minimum standards to ensure that the purposes of the Act have been met, and to provide recommendations for best practice for the care of animals. The use of codes in this way provides some flexibility as farm practices evolve and opinions change, because they can be reviewed readily without need for specific legislative amendment. The Act requires that all codes are reviewed at least once every 10 years.

Codes for many animals

Since the Act took effect in 2000, codes of welfare have been developed for a range of species and circumstances. Early code development was more focussed on areas that attract public comment, such as layer hen, broiler and pig production, as well as rodeos, circuses and zoos. Since these codes were developed the focus has shifted to codes for the pastoral industries.

The deer industry was the first to have their code issued in 2007, and the dairy cattle code was next in 2010. Other codes currently within the development process will relate to sheep and beef farming, transport, goats and camelids.

Anyone can draft a code, but final approval requires the involvement of NAWAC. In the case of the dairy code, the initial draft writing process was developed within the dairy industry with a broad base of input from Federated Farmers, RNZSPCA, the industry good organisations of Dexcel, Dairy InSight and later DairyNZ, MAF, the Veterinary Association and scientists from Massey University. Once the draft was developed Dairy InSight undertook an industry consultation process that included direct input from practicing farmers to refine the document which was then presented to NAWAC.

Notify and consult

The process that NAWAC has to follow when a draft code is presented is that they must determine whether it meets the purposes of the Act and then notify and consult with the public on its content. The final draft is then developed for recommendation to the Minister of Agriculture. Accompanying the code is a report that documents submissions, explains the issues raised, and provides the reasoning for the final stated standards and recommendations. The code report is also a public document on the MAF website

Resolving opinions about animal welfare standards

Our general concepts of animal welfare have emerged since the 1950s. These were in response to public concerns about standards of care and management of production animals within farming systems that have been progressively industrialised to meet the need to feed our expanding population. Society expresses its views based on opinions that are based on ethical perspectives about the quality of life experienced by the animals concerned. While animal welfare is a concept that is not based in science, scientific method allows the parameters that define quality of life to be established and measured. In this way welfare science establishes some solid ground on which standards and recommendations can be based, helps in the interpretation of societal concerns, and allows diverse views to be reconciled.

The Act is explicit when deliberating draft codes. NAWAC 'must have regard to good practice and scientific knowledge in relation to the management of the animals to which the code relates, and available technology'. This means that, wherever possible, minimum standards and best practice

recommendations made in codes of welfare must be science-based. This is also an important prerequisite for production industries. It enables a defence of farming practices to their local community provided that an appropriate result can be demonstrated for the animals. It also overcomes difficulties of comparison of standards between countries where production systems may vary widely.

How will the code affect dairy farms?

The Dairy Cattle Code of Welfare contains 20 minimum standards on topics from feeding newborn calves and caring for recumbent cows, to the definition of minimum acceptable body condition score and the need for competency of those caring for animals. Minimum standards are the critical component of codes of welfare. They are statements that include the word 'must' and provide the details of specific results required, or actions that need to be taken by those caring for animals, to meet the fundamental needs of the animals concerned.

Failure to meet these standards can be used as the basis for prosecution. Equally, if an animal owner believes they have met or exceeded their obligations with regard to the minimum standards, then this can be used in their defence against a prosecution.

As one example, Minimum Standard 3(b) states that 'When the body condition score of any animal falls below 3 (on a scale of 1-10), urgent remedial action must be taken to improve condition.' This regulation does not deny the possibility that on occasions individual cows may have low body condition reserves. However it does sets the minimum acceptable level and places the onus back on to the person caring for that animal to take the necessary actions.

The range of possible remedial actions, such as feeding more, milking less or culling, are not specified. That decision is left to the stockperson because it is the final outcome for the animal that becomes the point about which judgement would be made.

Recommended practices

The vast majority of dairy farmers already farm in a manner such that they can meet the new minimum standards. If this were simply a matter of compliance with the minimum, then we can anticipate that the code will have little effect on farm operations as they currently stand.

But the code also promotes recommended best practices. While these recommendations are not legally binding, they provide some direction regarding the expectations of the wider community, as NAWAC provides this from its broad stakeholder representation. Community expectation is clearly that animal welfare will be managed at more than the minimum.

The case for good husbandry practice

The Strategy for Dairy Farming's Future promotes an expectation that farmers be seen to have a quality product while demonstrating good stewardship of resources and animals. The strategy recognises this is an important step both to achieve success in the international marketplace and to gain local community support.

The release of the Dairy Cattle Code represents a major step forward as it sets regulatory standards. However but if we are to maintain our success as an industry we must do better than this. Industry reputation is such that we are recognised internationally for upholding good standards of animal care, therefore we must acknowledge that in recent years our farm systems have changed in their intensity. This has led to productivity advances although these gains have mainly been harnessed by improving efficiency.

There are fewer reserves available for managing risk, changing farm ownership structures devolve responsibility, and scarce time and labour resources limit opportunities to provide adequately for the care of individual animals. It is important that we recognise these changes as we consider the current state of welfare of dairy cows, and find ways to ensure our reputation is maintained.

The regulators have provided their guidance, and it is now time for the industry itself to provide leadership on this journey. DairyNZ have stepped up to the mark by developing an expanded definition of good husbandry practice which will be promoted in coming years.

General conclusion

Good animal welfare does not happen by regulations or good practice statements. It is achieved by the everyday actions of those working with animals as they recognise and provide for the needs of the animals.

Managing this will require some changes in the thinking of both farmers and the rural professionals that support their businesses. It is time to re-assess our definitions and understanding of good husbandry practice in light of changing public views, and then we must make sure this is applied to the animals that underpin the industry's success. It will require both expertise in stockmanship and willingness on the part of those who manage farm financial budgets to make good investments that favour good animal welfare.